In [1]:

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import PowerTransformer
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegressionCV
from sklearn.metrics import classification_report, confusion_matrix
```

In [2]:

```python
df = pd.read_csv("magic04.csv")
df = df.drop_duplicates()
df = df.rename(columns = {"class":"Class"})
X = df.iloc[:,:10]
y = df.iloc[:,10:]
Class = y.Class.unique()
le = LabelEncoder()
y = pd.DataFrame(le.fit_transform(np.ravel(y)), columns = y.columns)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.20, random_state = 101)
scaler = StandardScaler()
scaler.fit(X_train)
X_train = pd.DataFrame(scaler.transform(X_train), columns = X.columns)
X_test = pd.DataFrame(scaler.transform(X_test), columns = X.columns)
pt = PowerTransformer(method = "yeo-johnson")
pt.fit(X_train)
X_train = pd.DataFrame(pt.transform(X_train), columns = X.columns)
X_test = pd.DataFrame(pt.transform(X_test), columns = X.columns)
```

Logistic Regression

In [3]:

```python
Logit = LogisticRegressionCV(cv=10, scoring='accuracy', n_jobs=-1, max_iter = 100)
Logit.fit(X_train, np.ravel(y_train))
y_pred = Logit.predict(X_test)
```

In [4]:

```python
pd.DataFrame(data = Logit.coef_, columns = X.columns)
```

Out[4]:

	fLength	fWidth	fSize	fConc	fConc1	fAsym	fM3Long	fM3Trans	fAlpha	fDist
0	1.383869	-0.189867	1.455469	1.421105	0.218006	-0.049338	-0.292599	-0.018409	1.586697	0.037657

Columns with Higher Coefficients are More Important (fLength, fSize, fConc, fAlpha). Others with low coefficient are less important.

In [5]:

```python
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=Class))
```

```
[[2292  201]
 [ 421  867]]
              precision    recall  f1-score   support

           g       0.84      0.92      0.88      2493
           h       0.81      0.67      0.74      1288

    accuracy                           0.84      3781
   macro avg       0.83      0.80      0.81      3781
weighted avg       0.83      0.84      0.83      3781
```

In [6]:

```python
from sklearn import metrics
```

In [7]:

```python
fpr, tpr, _ = metrics.roc_curve(y_test,  Logit.predict_proba(X_test)[:,1])
```

In [8]:

```python
metrics.auc(fpr, tpr)
```

Out[8]:

```
0.8745026446721628
```

In [9]:

```python
from sklearn.metrics import accuracy_score
```

In [10]:

```python
accuracy_score(y_test, y_pred)
```

Out[10]:

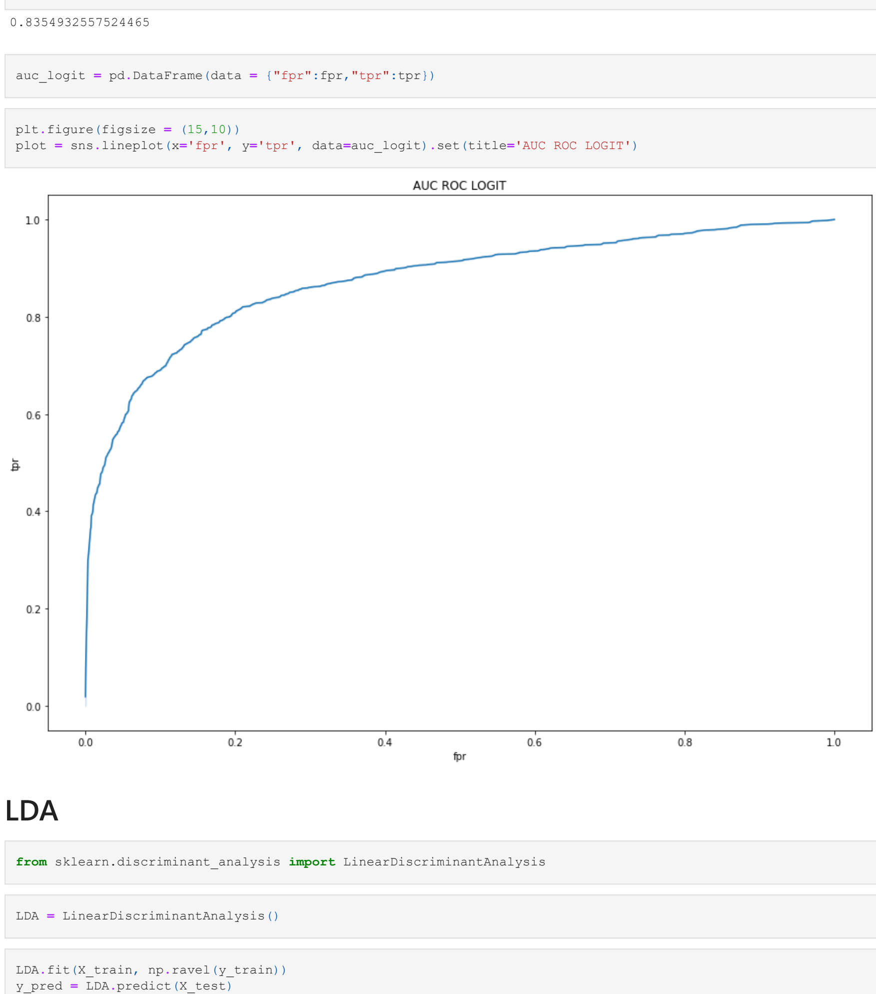
```
0.8354932557524465
```

In [11]:

```python
auc_logit = pd.DataFrame(data = {"fpr":fpr,"tpr":tpr})
```

In [12]:

```python
plt.figure(figsize = (15,10))
plot = sns.lineplot(x='fpr', y='tpr', data=auc_logit).set(title='AUC ROC LOGIT')
```



LDA

In [13]:

```python
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
```

In [14]:

```python
LDA = LinearDiscriminantAnalysis()
```

In [15]:

```python
LDA.fit(X_train, np.ravel(y_train))
y_pred = LDA.predict(X_test)
```

In [16]:

```python
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=Class))
```

```
[[2290  203]
 [ 439  849]]
              precision    recall  f1-score   support

           g       0.84      0.92      0.88      2493
           h       0.81      0.66      0.73      1288

    accuracy                           0.83      3781
   macro avg       0.82      0.79      0.80      3781
weighted avg       0.83      0.83      0.83      3781
```

In [17]:

```python
fpr, tpr, _ = metrics.roc_curve(y_test,  LDA.predict_proba(X_test)[:,1])
```

In [18]:

```python
metrics.auc(fpr, tpr)
```

Out[18]:

```
0.8740526268583089
```

In [19]:

```python
accuracy_score(y_test, y_pred)
```

Out[19]:

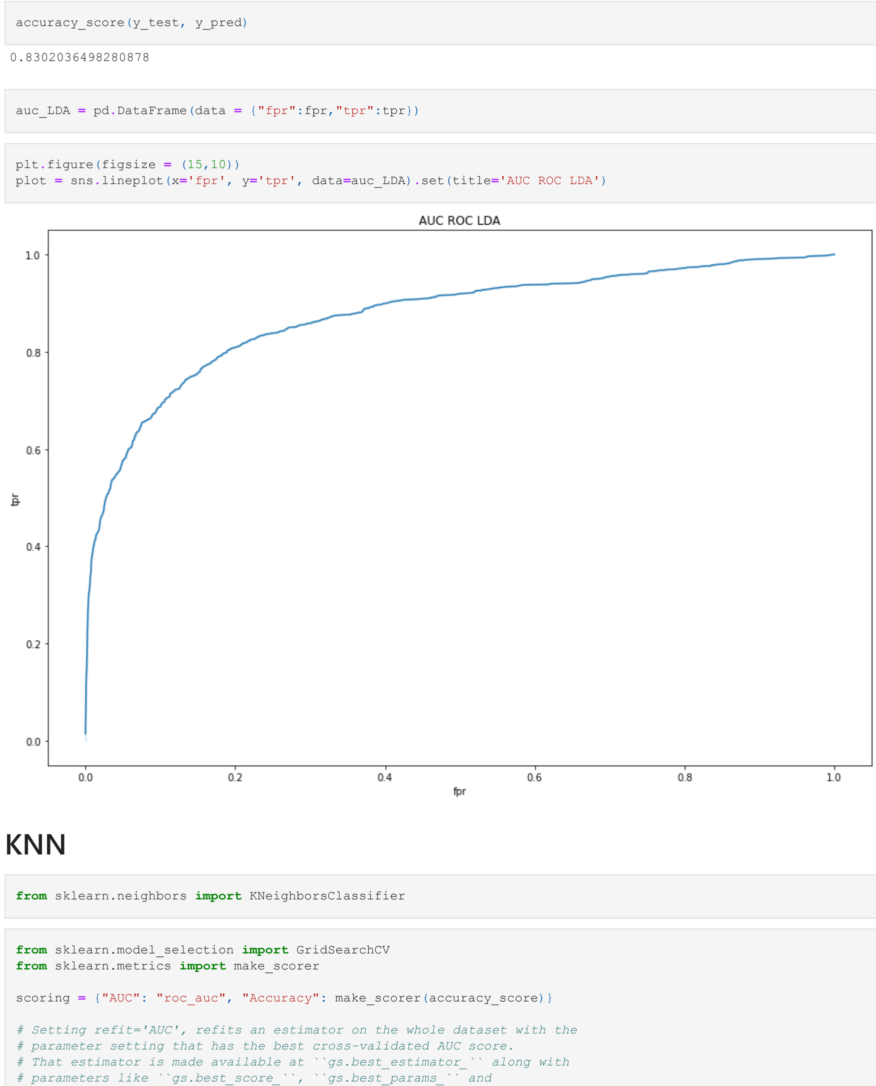
```
0.8302036498280878
```

In [20]:

```python
auc_LDA = pd.DataFrame(data = {"fpr":fpr,"tpr":tpr})
```

In [21]:

```python
plt.figure(figsize = (15,10))
plot = sns.lineplot(x='fpr', y='tpr', data=auc_LDA).set(title='AUC ROC LDA')
```



KNN

In [22]:

```python
from sklearn.neighbors import KNeighborsClassifier
```

In [ ]:

```python
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import make_scorer

scoring = {"AUC": "roc_auc", "Accuracy": make_scorer(accuracy_score)}

# Setting refit='AUC', refits an estimator on the whole dataset with the
# parameter setting that has the best cross-validated AUC score.
# That estimator is made available at ``gs.best_estimator_`` along with
# parameters like ``gs.best_score_``, ``gs.best_params_`` and
# ``gs.best_index_``
gs = GridSearchCV(
    KNeighborsClassifier(),
    param_grid={"n_neighbors": range(1, 21), "weights":["uniform","distance"], "p":[1, 2]},
    scoring=scoring,
    refit="AUC",
    return_train_score=True,
    n_jobs = -1,
    cv = 10,
    verbose = 3
)
gs.fit(X_train, np.ravel(y_train))
results = gs.cv_results_
```

In [ ]:

```python
gs.best_params_
```

In [23]:

```python
KNN = KNeighborsClassifier(n_neighbors=20, p = 2, weights = "distance")
KNN.fit(X_train, np.ravel(y_train))
y_pred = KNN.predict(X_test)
```

In [24]:

```python
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=Class))
```

```
[[2421   72]
 [ 457  831]]
              precision    recall  f1-score   support

           g       0.84      0.97      0.90      2493
           h       0.92      0.65      0.76      1288

    accuracy                           0.86      3781
   macro avg       0.88      0.81      0.83      3781
weighted avg       0.87      0.86      0.85      3781
```

In [25]:

```python
fpr, tpr, _ = metrics.roc_curve(y_test,  KNN.predict_proba(X_test)[:,1])
```

In [26]:

```python
metrics.auc(fpr, tpr)
```

Out[26]:

```
0.9197065447850254
```

In [27]:

```python
accuracy_score(y_test, y_pred)
```

Out[27]:

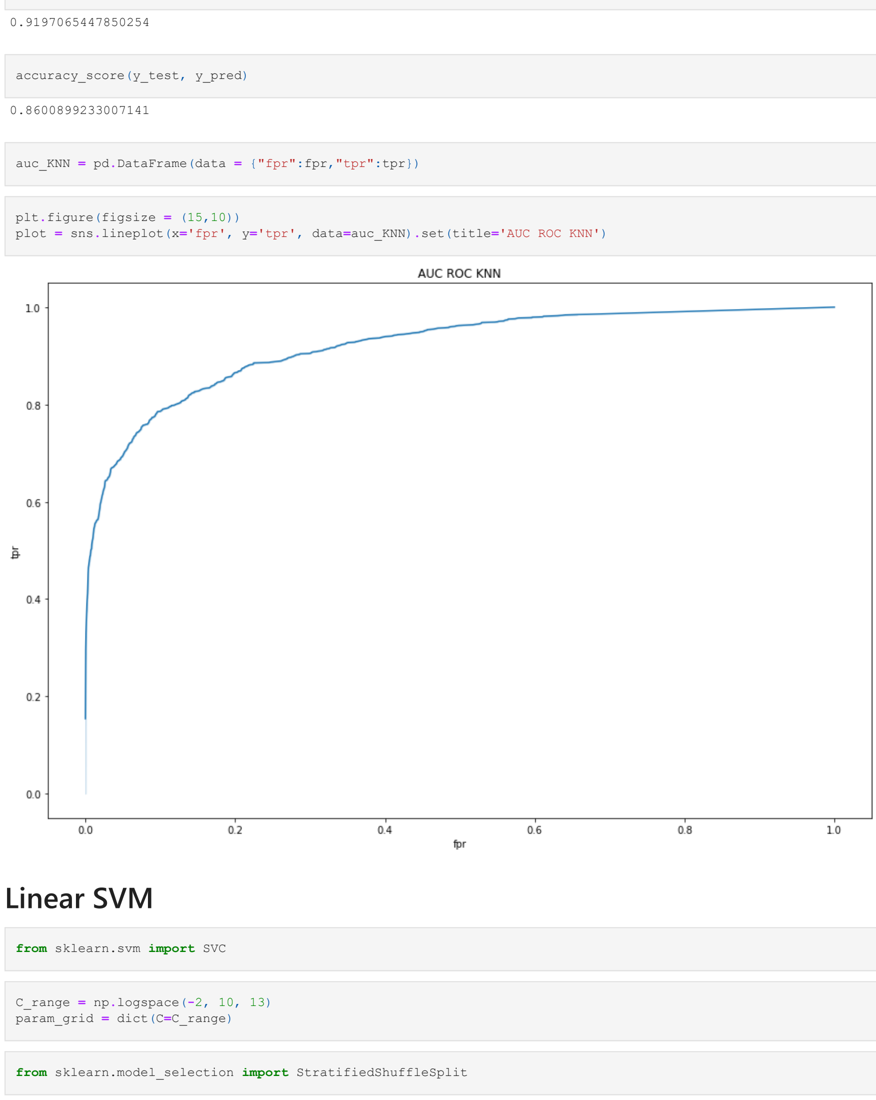
```
0.8600899233007141
```

In [28]:

```python
auc_KNN = pd.DataFrame(data = {"fpr":fpr,"tpr":tpr})
```

In [29]:

```python
plt.figure(figsize = (15,10))
plot = sns.lineplot(x='fpr', y='tpr', data=auc_KNN).set(title='AUC ROC KNN')
```



Linear SVM

In [30]:

```python
from sklearn.svm import SVC
```

In [ ]:

```python
C_range = np.logspace(-2, 10, 13)
param_grid = dict(C=C_range)
```

In [ ]:

```python
from sklearn.model_selection import StratifiedShuffleSplit
```

In [ ]:

```python
cv = StratifiedShuffleSplit(n_splits=30, test_size=0.2, random_state=101)
```

In [ ]:

```python
grid = GridSearchCV(SVC(kernel = "linear", max_iter=10000, probability=True), param_grid=param_grid, cv=cv, n_j
```

In [ ]:

```python
grid.fit(X_train, np.ravel(y_train))
```

In [ ]:

```python
results = grid.cv_results_
```

In [ ]:

```python
grid.best_params_
```

In [31]:

```python
LSVC = SVC(kernel = "linear", max_iter=10000, C = 0.1, probability = True)
LSVC.fit(X_train, np.ravel(y_train))
y_pred = LSVC.predict(X_test)
```

```
C:\Users\matth\anaconda3\lib\site-packages\sklearn\svm\_base.py:255: ConvergenceWarning: Solver terminated earl
y (max_iter=10000).  Consider pre-processing your data with StandardScaler or MinMaxScaler.
  warnings.warn('Solver terminated early (max_iter=%i).'
```

In [32]:

```python
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=Class))
```

```
[[2329  164]
 [ 450  838]]
              precision    recall  f1-score   support

           g       0.84      0.93      0.88      2493
           h       0.84      0.65      0.73      1288

    accuracy                           0.84      3781
   macro avg       0.84      0.79      0.81      3781
weighted avg       0.84      0.84      0.83      3781
```

In [33]:

```python
fpr, tpr, _ = metrics.roc_curve(y_test,  LSVC.predict_proba(X_test)[:,1])
```

In [34]:

```python
metrics.auc(fpr, tpr)
```

Out[34]:

```
0.8726321900077983
```

In [35]:

```python
accuracy_score(y_test, y_pred)
```

Out[35]:

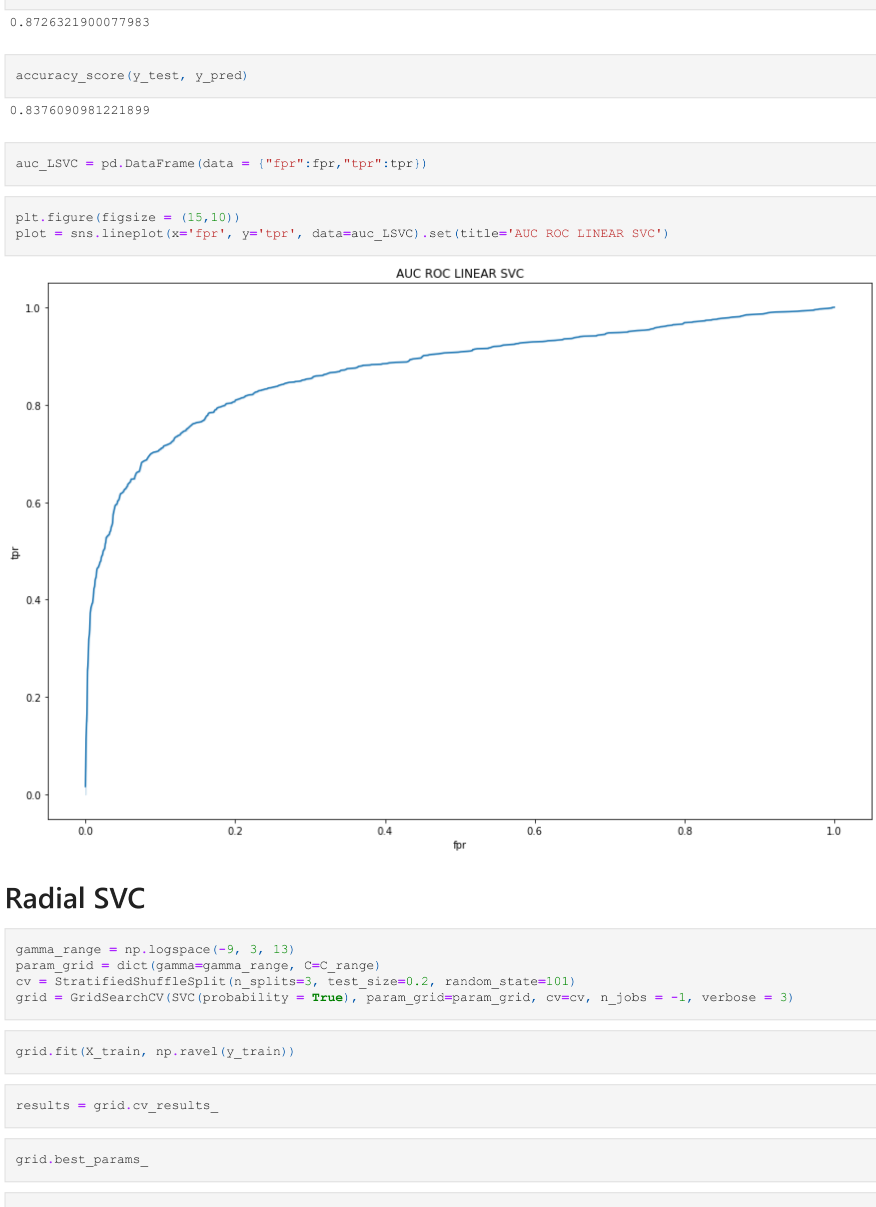
```
0.8376090981221899
```

In [36]:

```python
auc_LSVC = pd.DataFrame(data = {"fpr":fpr,"tpr":tpr})
```

In [37]:

```python
plt.figure(figsize = (15,10))
plot = sns.lineplot(x='fpr', y='tpr', data=auc_LSVC).set(title='AUC ROC LINEAR SVC')
```



Radial SVC

In [ ]:

```python
gamma_range = np.logspace(-9, 3, 13)
param_grid = dict(gamma=gamma_range, C=C_range)
cv = StratifiedShuffleSplit(n_splits=3, test_size=0.2, random_state=101)
grid = GridSearchCV(SVC(probability = True), param_grid=param_grid, cv=cv, n_jobs = -1, verbose = 3)
```

In [ ]:

```python
grid.fit(X_train, np.ravel(y_train))
```

In [ ]:

```python
results = grid.cv_results_
```

In [ ]:

```python
grid.best_params_
```

In [38]:

```python
RSVC = SVC(C = 100, gamma = 0.1, probability = True)
RSVC.fit(X_train, np.ravel(y_train))
y_pred = RSVC.predict(X_test)
```

In [39]:

```python
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=Class))
```

```
[[2389  104]
 [ 318  970]]
              precision    recall  f1-score   support

           g       0.88      0.96      0.92      2493
           h       0.90      0.75      0.82      1288

    accuracy                           0.89      3781
   macro avg       0.89      0.86      0.87      3781
weighted avg       0.89      0.89      0.89      3781
```

In [40]:

```python
fpr, tpr, _ = metrics.roc_curve(y_test,  RSVC.predict_proba(X_test)[:,1])
```

In [41]:

```python
metrics.auc(fpr, tpr)
```

Out[41]:

```
0.9290217578162955
```

In [42]:

```python
accuracy_score(y_test, y_pred)
```

Out[42]:

```
0.8883893149960328
```

In [43]:

```python
auc_RSVC = pd.DataFrame(data = {"fpr":fpr,"tpr":tpr})
```

In [44]:

```python
plt.figure(figsize = (15,10))
plot = sns.lineplot(x='fpr', y='tpr', data=auc_RSVC).set(title='AUC ROC RADIAL SVC')
```