Lab 10 : Model Selction

Import Commomn Libraries

In [79]:

```
import itertools
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.ticker import NullFormatter
import pandas as pd
import numpy as np
import matplotlib.ticker as ticker
from sklearn import preprocessing
%matplotlib inline
```

About dataset

This dataset is about the chances of the Rain Today as per the given attributes like Temperature,Rainfall,Evaporation,Wind speed,Humidity and Pressure. It includes following fields:

Field	Description
MinTemp	The Min Temperature of the day
MaxTemp	The Max Temperature of the day
Rainfall	The Rainfall Stats of that day
Evaporation	Evaporation Stats of that day
WindSpeed9am	Wind Speed stats till 9 am of that day
Humidity9am	Humidity stats till 9 am of that day
Pressure9am	Pressure stats till 9 am of that day
RainToday	The prediction of Raining at that day

Import Training Dataset

In [80]:

```
df = pd.read_csv(r"C:\Users\Admin\Downloads\weather_data.csv")
df.head()
```

Out[80]:

	MinTemp	MaxTemp	Rainfall	Evaporation	WindSpeed9am	Humidity9am
0	9.4	30.6	3.4	8.0	25.9	63.4
1	23.8	29.4	4.8	7.1	6.9	86.6
2	18.3	15.8	0.9	4.9	34.9	30.0
3	15.0	25.2	2.9	2.1	24.5	30.4
4	3.9	26.4	2.5	7.0	6.3	64.5

EDA Steps

In [81]:

```
df.shape
```

Out[81]:

```
(1500, 8)
```

In [82]:

```
df.columns
```

Out[82]:

```
Index(['MinTemp', 'MaxTemp', 'Rainfall', 'Evaporation', 'WindSpeed9am',
       'Humidity9am', 'Pressure9am', 'RainToday'],
      dtype='object')
```

In [83]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1500 entries, 0 to 1499
Data columns (total 8 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   MinTemp       1500 non-null   float64
 1   MaxTemp       1500 non-null   float64
 2   Rainfall      1500 non-null   float64
 3   Evaporation   1500 non-null   float64
 4   WindSpeed9am  1500 non-null   float64
 5   Humidity9am   1500 non-null   float64
 6   Pressure9am   1500 non-null   float64
 7   RainToday     1500 non-null   object 
dtypes: float64(7), object(1)
memory usage: 93.9+ KB
```

In [84]:

```
df.describe()
```

Out[84]:

	MinTemp	MaxTemp	Rainfall	Evaporation	WindSpeed9am	H
count	1500.000000	1500.000000	1500.000000	1500.000000	1500.000000	
mean	12.483533	30.012933	2.875733	6.995067	19.616400	
std	7.351179	8.680484	2.911895	2.898034	11.473366	
min	0.100000	15.000000	0.000000	2.000000	0.000000	
25%	5.900000	22.700000	0.800000	4.500000	9.700000	
50%	12.650000	30.150000	2.000000	6.900000	19.400000	
75%	18.825000	37.625000	3.900000	9.500000	29.700000	
max	25.000000	45.000000	23.200000	12.000000	40.000000	

In [85]:

```
df.describe(include = 'object')
```

Out[85]:

	RainToday
count	1500
unique	2
top	No
freq	1062

Pre-processing Steps

Let’s see how many of each class is in our data set

In [86]:

```
df['RainToday'].value_counts()
```

Out[86]:

```
RainToday
No     1062
Yes     438
Name: count, dtype: int64
```

Pre-processing: Feature selection/extraction

Convert Categorical features to numerical values

Features before One Hot Encoding

In [87]:

```
df[['MinTemp','MaxTemp','Rainfall','Evaporation','WindSpeed9am','Humidity9am
```

Out[87]:

	MinTemp	MaxTemp	Rainfall	Evaporation	WindSpeed9am	Humidity9am
0	9.4	30.6	3.4	8.0	25.9	63.4
1	23.8	29.4	4.8	7.1	6.9	86.6
2	18.3	15.8	0.9	4.9	34.9	30.0
3	15.0	25.2	2.9	2.1	24.5	30.4
4	3.9	26.4	2.5	7.0	6.3	64.5

Use one hot encoding technique to cover categorical varables to binary variables and append them to the feature Data Frame

In [88]:

```
Feature = df[['MinTemp','MaxTemp','Rainfall','Evaporation','WindSpeed9am','H
Feature.head()
Feature.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1500 entries, 0 to 1499
Data columns (total 7 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   MinTemp       1500 non-null   float64
 1   MaxTemp       1500 non-null   float64
 2   Rainfall      1500 non-null   float64
 3   Evaporation   1500 non-null   float64
 4   WindSpeed9am  1500 non-null   float64
 5   Humidity9am   1500 non-null   float64
 6   Pressure9am   1500 non-null   float64
dtypes: float64(7)
memory usage: 82.2 KB
```

Feature Selection

Let's define feature sets, X:

In [89]:

```
X = Feature
X[:]
```

Out[89]:

	MinTemp	MaxTemp	Rainfall	Evaporation	WindSpeed9am	Humidity9a
0	9.4	30.6	3.4	8.0	25.9	63
1	23.8	29.4	4.8	7.1	6.9	86
2	18.3	15.8	0.9	4.9	34.9	30
3	15.0	25.2	2.9	2.1	24.5	30
4	3.9	26.4	2.5	7.0	6.3	64
...	...	...	...	...	...	
1495	16.7	41.0	2.8	8.8	3.1	61
1496	15.5	19.7	2.0	7.0	2.9	33
1497	11.6	24.3	0.4	9.7	34.0	98
1498	9.5	23.7	0.9	6.9	8.5	28
1499	21.6	41.1	1.6	3.5	26.8	94

1500 rows × 7 columns

What are our lables? Create Output Variable

In [90]:

```
y = df['RainToday']
y[:]
d = {'No':0,'Yes' : 1}
y = y.map(d)
```

Normalize Data

Data Standardization give data zero mean and unit variance (technically should be done after train test split)

In [91]:

```
X= preprocessing.StandardScaler().fit(X).transform(X)
X[:]
```

Out[91]:

```
array([[-0.41960097,  0.06765319,  0.18010319, ...,  0.54785107,
         0.20441611,  1.45735385],
       [ 1.53992184, -0.07063405,  0.66105015, ..., -1.10871051,
         1.22432788,  0.09275376],
       [ 0.79149299, -1.6378895 , -0.67873068, ...,  1.33253813,
        -1.26390515,  0.79555209],
       ...,
       [-0.12022942, -0.65835484, -0.85049745, ...,  1.25406943,
         1.73428377,  0.32116322],
       [-0.40599317, -0.72749847, -0.67873068, ..., -0.96921059,
        -1.32545155, -0.70375101],
       [ 1.2405503 ,  1.27766659, -0.4382572 , ...,  0.62631978,
         1.5760216 , -1.62910214]])
```

Split the Data into Training and Testing Set

In [92]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split( X, y, test_size=0.2, ra
print ('Train set:', X_train.shape,  y_train.shape)
print ('Test set:', X_test.shape,  y_test.shape)
```

```
Train set: (1200, 7) (1200,)
Test set: (300, 7) (300,)
```

Classification

Now, it is your turn, use the training set to build an accurate model. Then use the test set to report the accuracy of the model You should use the following algorithm:

- K Nearest Neighbor(KNN)
- Decision Tree
- Support Vector Machine
- Logistic Regression

__ Notice:__

- You can go above and change the pre-processing, feature selection, feature-extraction, and so on, to make a better model.
- You should use either scikit-learn, Scipy or Numpy libraries for developing the classification algorithms.
- You should include the code of the algorithm in the following cells.

K Nearest Neighbor(KNN)

Notice: You should find the best k to build the model with the best accuracy.\

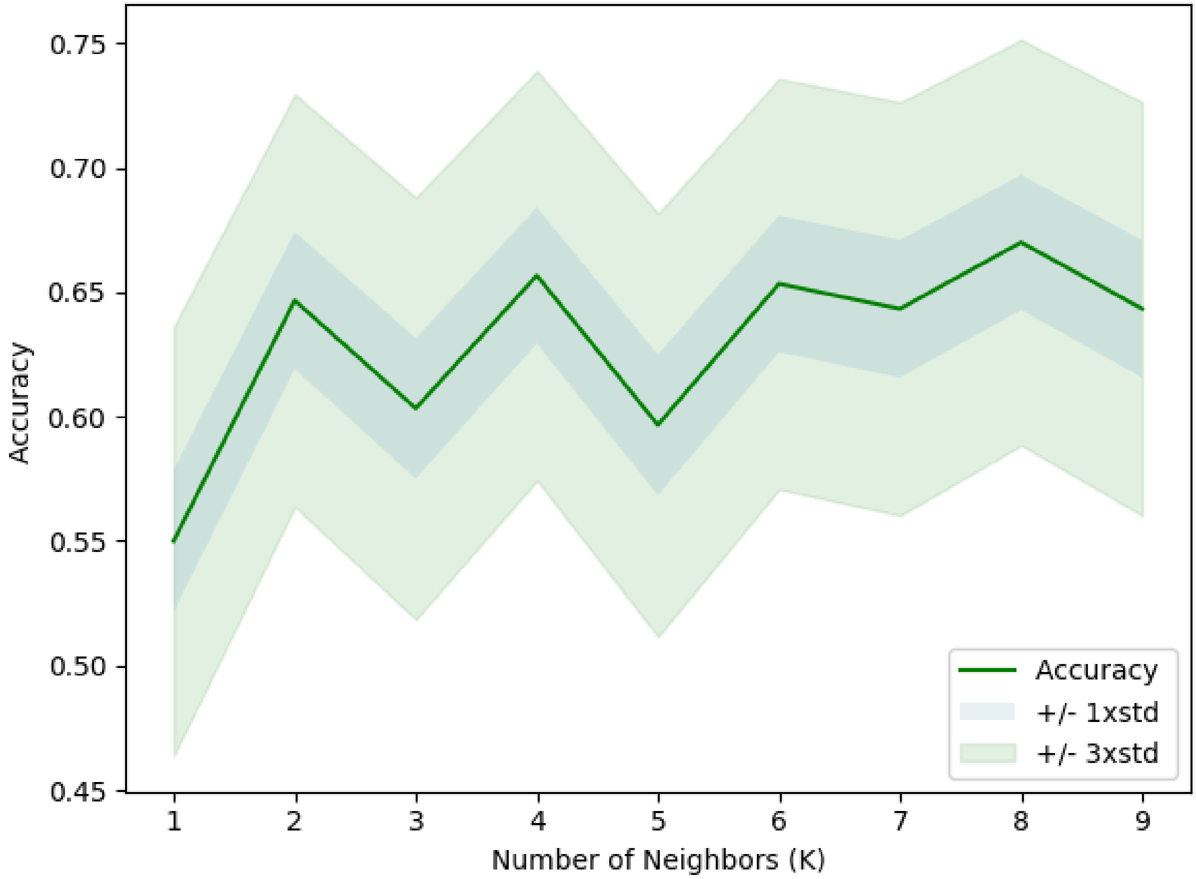
In [93]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn import metrics
Ks = 10
mean_acc = np.zeros((Ks-1))
std_acc = np.zeros((Ks-1))

for n in range(1,Ks):
    knn1 = KNeighborsClassifier(n_neighbors = n).fit(X_train,y_train)
    yhat=knn1.predict(X_test)
    mean_acc[n-1] = metrics.accuracy_score(y_test, yhat)

    std_acc[n-1]=np.std(yhat==y_test)/np.sqrt(yhat.shape[0])

mean_acc
```

```
plt.plot(range(1,Ks),mean_acc,'g')
plt.fill_between(range(1,Ks),mean_acc - 1 * std_acc,mean_acc + 1 * std_acc,
plt.fill_between(range(1,Ks),mean_acc - 3 * std_acc,mean_acc + 3 * std_acc,
plt.legend(('Accuracy ', '+/- 1xstd','+/- 3xstd'))
plt.ylabel('Accuracy ')
plt.xlabel('Number of Neighbors (K)')
plt.tight_layout()
plt.show()
print( "The best accuracy was with", mean_acc.max(), "with k=", mean_acc.arg
```



```
The best accuracy was with 0.67 with k= 8
```

Parameter Tunning using Grid Search Cv

```
In [94]: from sklearn.model_selection import GridSearchCV
k_range = list(range(1, 31))
weight_options = ['uniform', 'distance']
pow = [1,2]
param_grid = dict(n_neighbors=k_range,
                  weights=weight_options,
                  p = pow)
knn_gs = KNeighborsClassifier()
grid_k = GridSearchCV(knn_gs,
                    param_grid,
                    cv=10,
                    scoring='accuracy')
grid_k.fit(X_train, y_train)
```

Out[94]:

```
▸ GridSearchCV

▸ best_estimator_:
  KNeighborsClassifier

  ▸ KNeighborsClassifier
```

In [95]:

```
print("Tuned Hyperparameters :", grid_k.best_params_)
print("Accuracy :",grid_k.best_score_)
```

```
Tuned Hyperparameters : {'n_neighbors': 30, 'p': 1, 'weights': 'uniform'}
Accuracy : 0.7133333333333334
```

In [96]:

```
knn1 = KNeighborsClassifier(n_neighbors= 16, p = 1, weights = 'uniform')
```

In [97]:

```
knn1.fit(X_train,y_train)
```

Out[97]:

```
▾ KNeighborsClassifier
KNeighborsClassifier(n_neighbors=16, p=1)
```

In [98]:

```
yhat = knn1.predict(X_test)
```

In [99]:

```
from sklearn.metrics import jaccard_score
from sklearn.metrics import f1_score
from sklearn.metrics import log_loss
from sklearn.metrics import accuracy_score
a1 = jaccard_score(y_test,yhat,pos_label=1)
b1 = f1_score(y_test, yhat, average='weighted')
c1 = accuracy_score(y_test, yhat)
print('The jaccard_score of the KNN for k = 7 classifier on train data is {:
print('The F1-score of the KNN for k = 7 classifier on train data is {:.2f}'
print('The Accuracy_score of the KNN for k = 7 classifier on train data is {
```

```
The jaccard_score of the KNN for k = 7 classifier on train data is 0.04
The F1-score of the KNN for k = 7 classifier on train data is 0.59
The Accuracy_score of the KNN for k = 7 classifier on train data is 0.69
```

Decision Tree

Parameter Tuning For Decision tree to find best tree

In [100…

```
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
param_grid = {'criterion' :['gini', 'entropy'],
              'max_features': ['auto', 'sqrt', 'log2'],
              'ccp_alpha': [0.1, .01, .001],
              'max_depth' : [5, 6, 7, 8, 9],
             }
tree_clas = DecisionTreeClassifier(random_state=1)
grid_search = GridSearchCV(estimator=tree_clas, param_grid=param_grid, cv=5,
grid_search.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 90 candidates, totalling 450 fits
```

```
C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-packages\skl
earn\model_selection\_validation.py:528: FitFailedWarning:
150 fits failed out of a total of 450.
The score on these train-test partitions for these parameters will be set to
nan.
If these failures are not expected, you can try to debug them by setting err
or_score='raise'.

Below are more details about the failures:
----------------------------------------------------------------------------
----
150 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\model_selection\_validation.py", line 866, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\base.py", line 1382, in wrapper
    estimator._validate_params()
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\base.py", line 436, in _validate_params
    validate_parameter_constraints(
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\utils\_param_validation.py", line 98, in validate_parameter_con
straints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_features' pa
rameter of DecisionTreeClassifier must be an int in the range [1, inf), a fl
oat in the range (0.0, 1.0], a str among {'log2', 'sqrt'} or None. Got 'aut
o' instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-packages\skl
earn\model_selection\_search.py:1108: UserWarning: One or more of the test s
cores are non-finite: [       nan 0.7125     0.7125            nan 0.7125
0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.7125     0.7125            nan 0.7125     0.7125
        nan 0.68833333 0.68833333        nan 0.6925     0.6925
        nan 0.67916667 0.67916667        nan 0.68333333 0.68333333
        nan 0.64166667 0.64166667        nan 0.705      0.705
        nan 0.70166667 0.70166667        nan 0.69166667 0.69166667
        nan 0.685      0.685             nan 0.67583333 0.67583333]
  warnings.warn(
```

Out[100…

```
▸ GridSearchCV

▸ best_estimator_:
  DecisionTreeClassifier

  ▸ DecisionTreeClassifier
```

Find the best parameters

In [101…

```
print("Tuned Hyperparameters :", grid_search.best_params_)
print("Accuracy :",grid_search.best_score_)
```

```
Tuned Hyperparameters : {'ccp_alpha': 0.1, 'criterion': 'gini', 'max_depth':
5, 'max_features': 'sqrt'}
Accuracy : 0.7125
```

In [102…

```
Rain_Tree = grid_search.best_estimator_
print(Rain_Tree)
```

```
DecisionTreeClassifier(ccp_alpha=0.1, max_depth=5, max_features='sqrt',
                       random_state=1)
```

Train the best model using Training Data

In [103…

```
Rain_Tree.fit(X_train,y_train)
```

Out[103…

```
▾ DecisionTreeClassifier

DecisionTreeClassifier(ccp_alpha=0.1, max_depth=5, max_features='sq
rt',
                       random_state=1)
```

In [104…

```
predTree = Rain_Tree.predict(X_test)
```

In [105…

```
a2 = jaccard_score(y_test, predTree,pos_label=1)
b2 = f1_score(y_test, predTree, average='weighted')
c2 = accuracy_score(y_test, predTree)
print("The accuraccy of (Rain_tree) DecisionTrees's {:.2f} ".format(c2))
print('The jaccard_score of the (Rain_tree) DecisionTrees classifier on trai
print('The F1-score of the (Rain_tree) DecisionTrees classifier on train dat
```

```
The accuraccy of (Rain_tree) DecisionTrees's 0.69
The jaccard_score of the (Rain_tree) DecisionTrees classifier on train data
is 0.00
The F1-score of the (Rain_tree) DecisionTrees classifier on train data is 0.
56
```

Support Vector Machine

Parameter Tunning For SVM using GridSerachCV

In [106…

```
from sklearn.svm import SVC
param_grid = {'C': [0.1,1, 10, 100],
              'gamma': [1,0.1,0.01,0.001],
              'kernel': ['rbf','sigmoid']}
grid_s = GridSearchCV(SVC(),param_grid,refit=True,verbose=2)
grid_s.fit(X_train,y_train)
```

```
Fitting 5 folds for each of 32 candidates, totalling 160 fits
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=
0.0s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END .........................C=0.1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END .....................C=0.1, gamma=1, kernel=sigmoid; total time=
0.0s
[CV] END .....................C=0.1, gamma=1, kernel=sigmoid; total time=
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[CV] END .....................C=0.1, gamma=1, kernel=sigmoid; total time=
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[CV] END .....................C=0.1, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=
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[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=
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[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=
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[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=
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[CV] END .......................C=0.1, gamma=0.1, kernel=rbf; total time=
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[CV] END ...................C=0.1, gamma=0.1, kernel=sigmoid; total time=
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[CV] END ...................C=0.1, gamma=0.1, kernel=sigmoid; total time=
0.0s
[CV] END ......................C=0.1, gamma=0.01, kernel=rbf; total time=
0.0s
[CV] END ......................C=0.1, gamma=0.01, kernel=rbf; total time=
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[CV] END ......................C=0.1, gamma=0.01, kernel=rbf; total time=
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[CV] END ......................C=0.1, gamma=0.01, kernel=rbf; total time=
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[CV] END ..................C=0.1, gamma=0.01, kernel=sigmoid; total time=
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[CV] END ..................C=0.1, gamma=0.01, kernel=sigmoid; total time=
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[CV] END ..................C=0.1, gamma=0.01, kernel=sigmoid; total time=
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[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time=
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[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time=
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[CV] END .................C=0.1, gamma=0.001, kernel=sigmoid; total time=
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[CV] END .................C=0.1, gamma=0.001, kernel=sigmoid; total time=
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[CV] END .................C=0.1, gamma=0.001, kernel=sigmoid; total time=
0.0s
[CV] END .................C=0.1, gamma=0.001, kernel=sigmoid; total time=
0.0s
[CV] END .................C=0.1, gamma=0.001, kernel=sigmoid; total time=
0.0s
[CV] END ...........................C=1, gamma=1, kernel=rbf; total time=
0.0s
[CV] END ...........................C=1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END ...........................C=1, gamma=1, kernel=rbf; total time=
0.1s
[CV] END ...........................C=1, gamma=1, kernel=rbf; total time=
0.0s
[CV] END ...........................C=1, gamma=1, kernel=rbf; total time=
0.0s
[CV] END .......................C=1, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=1, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=1, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=1, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=1, gamma=1, kernel=sigmoid; total time=
0.0s
[CV] END .........................C=1, gamma=0.1, kernel=rbf; total time=
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[CV] END .........................C=1, gamma=0.1, kernel=rbf; total time=
0.0s
[CV] END .........................C=1, gamma=0.1, kernel=rbf; total time=
0.0s
[CV] END .........................C=1, gamma=0.1, kernel=rbf; total time=
0.1s
[CV] END .........................C=1, gamma=0.1, kernel=rbf; total time=
0.1s
[CV] END .....................C=1, gamma=0.1, kernel=sigmoid; total time=
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[CV] END .....................C=1, gamma=0.1, kernel=sigmoid; total time=
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[CV] END .....................C=1, gamma=0.1, kernel=sigmoid; total time=
0.0s
[CV] END .....................C=1, gamma=0.1, kernel=sigmoid; total time=
0.0s
[CV] END .....................C=1, gamma=0.1, kernel=sigmoid; total time=
0.0s
[CV] END ........................C=1, gamma=0.01, kernel=rbf; total time=
0.0s
[CV] END ........................C=1, gamma=0.01, kernel=rbf; total time=
0.0s
[CV] END ........................C=1, gamma=0.01, kernel=rbf; total time=
0.0s
[CV] END ........................C=1, gamma=0.01, kernel=rbf; total time=
0.1s
[CV] END ........................C=1, gamma=0.01, kernel=rbf; total time=
0.0s
[CV] END ....................C=1, gamma=0.01, kernel=sigmoid; total time=
0.0s
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[CV] END ....................C=1, gamma=0.01, kernel=sigmoid; total time=
0.0s
[CV] END .......................C=1, gamma=0.001, kernel=rbf; total time=
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[CV] END ...................C=1, gamma=0.001, kernel=sigmoid; total time=
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[CV] END ...................C=1, gamma=0.001, kernel=sigmoid; total time=
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0.0s
[CV] END ..........................C=10, gamma=1, kernel=rbf; total time=
0.1s
[CV] END ..........................C=10, gamma=1, kernel=rbf; total time=
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[CV] END ..........................C=10, gamma=1, kernel=rbf; total time=
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[CV] END ......................C=10, gamma=1, kernel=sigmoid; total time=
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[CV] END ........................C=10, gamma=0.1, kernel=rbf; total time=
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[CV] END ....................C=10, gamma=0.1, kernel=sigmoid; total time=
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[CV] END .......................C=10, gamma=0.01, kernel=rbf; total time=
0.2s
[CV] END .......................C=10, gamma=0.01, kernel=rbf; total time=
0.3s
[CV] END .......................C=10, gamma=0.01, kernel=rbf; total time=
0.2s
[CV] END .......................C=10, gamma=0.01, kernel=rbf; total time=
0.2s
[CV] END ...................C=10, gamma=0.01, kernel=sigmoid; total time=
0.1s
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[CV] END ...................C=10, gamma=0.01, kernel=sigmoid; total time=
0.1s
[CV] END ...................C=10, gamma=0.01, kernel=sigmoid; total time=
0.0s
[CV] END ......................C=10, gamma=0.001, kernel=rbf; total time=
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[CV] END .........................C=100, gamma=1, kernel=rbf; total time=
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[CV] END .........................C=100, gamma=1, kernel=rbf; total time=
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[CV] END .....................C=100, gamma=1, kernel=sigmoid; total time=
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[CV] END .......................C=100, gamma=0.1, kernel=rbf; total time=
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[CV] END ...................C=100, gamma=0.1, kernel=sigmoid; total time=
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[CV] END ...................C=100, gamma=0.1, kernel=sigmoid; total time=
0.0s
[CV] END ......................C=100, gamma=0.01, kernel=rbf; total time=
0.5s
[CV] END ......................C=100, gamma=0.01, kernel=rbf; total time=
0.6s
[CV] END ......................C=100, gamma=0.01, kernel=rbf; total time=
0.7s
[CV] END ......................C=100, gamma=0.01, kernel=rbf; total time=
0.4s
[CV] END ......................C=100, gamma=0.01, kernel=rbf; total time=
0.5s
[CV] END ..................C=100, gamma=0.01, kernel=sigmoid; total time=
0.1s
[CV] END ..................C=100, gamma=0.01, kernel=sigmoid; total time=
0.1s
[CV] END ..................C=100, gamma=0.01, kernel=sigmoid; total time=
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0.1s
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[CV] END .....................C=100, gamma=0.001, kernel=rbf; total time=
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[CV] END .................C=100, gamma=0.001, kernel=sigmoid; total time=
0.0s
[CV] END .................C=100, gamma=0.001, kernel=sigmoid; total time=
0.0s
[CV] END .................C=100, gamma=0.001, kernel=sigmoid; total time=
0.0s
```
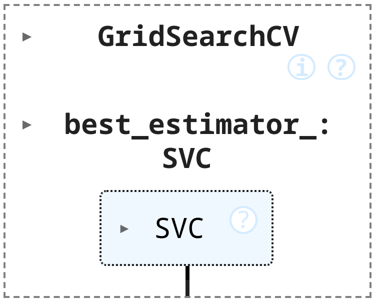

Out[106…



In [107…

```
print("Tuned Hyperparameters :", grid_s.best_params_)
print("Accuracy :",grid_s.best_score_)
```

```
Tuned Hyperparameters : {'C': 0.1, 'gamma': 1, 'kernel': 'rbf'}
Accuracy : 0.7125
```

In [108…

```
svm = SVC(probability=True,C=0.1, gamma=1, kernel='sigmoid')
print(svm)
```

```
SVC(C=0.1, gamma=1, kernel='sigmoid', probability=True)
```

In [109…

```
svm.fit(X_train, y_train)
```

Out[109…

```
▾                              SVC
SVC(C=0.1, gamma=1, kernel='sigmoid', probability=True)
```

In [110…

```
yhat_s = svm.predict(X_test)
```

In [111…

```
a3 = jaccard_score(y_test, yhat_s,pos_label=1)
b3 = f1_score(y_test, yhat_s, average='weighted')
c3 = accuracy_score(y_test, yhat_s)
print('The accuracy of the svm classifier on training data is {:.2f} out of 
print('The accuracy of the svm classifier on test data is {:.2f} out of 1'.f
print('The jaccard_score of the SVM classifier on train data is {:.2f}'.form
print('The F1-score of the SVM classifier on train data is {:.2f}'.format(b3
print('The accuracy-score of the SVM classifier on train data is {:.2f}'.for
```

```
The accuracy of the svm classifier on training data is 0.57 out of 1
The accuracy of the svm classifier on test data is 0.61 out of 1
The jaccard_score of the SVM classifier on train data is 0.09
The F1-score of the SVM classifier on train data is 0.57
The accuracy-score of the SVM classifier on train data is 0.61
```

Logistic Regression

Parameter Tunning using Grid Serch CV

In [112…

```
from sklearn.linear_model import LogisticRegression
parameters = {
    'penalty' : ['l1','l2'],
    'C'       : np.logspace(-3,3,7),
    'solver'  : ['newton-cg', 'lbfgs', 'liblinear'],
}
logreg = LogisticRegression()
clf = GridSearchCV(logreg,                    # model
                   param_grid = parameters,   # hyperparameters
                   scoring='accuracy',        # metric for scoring
                   cv=10)                     # number of folds
clf.fit(X_train,y_train)
```

```
C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-packages\skl
earn\model_selection\_validation.py:528: FitFailedWarning:
140 fits failed out of a total of 420.
The score on these train-test partitions for these parameters will be set to
nan.
If these failures are not expected, you can try to debug them by setting err
or_score='raise'.

Below are more details about the failures:
----------------------------------------------------------------------------
----
70 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\model_selection\_validation.py", line 866, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\base.py", line 1389, in wrapper
    return fit_method(estimator, *args, **kwargs)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\linear_model\_logistic.py", line 1193, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
             ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\linear_model\_logistic.py", line 63, in _check_solver
    raise ValueError(
ValueError: Solver newton-cg supports only 'l2' or None penalties, got l1 pe
nalty.

----------------------------------------------------------------------------
----
70 fits failed with the following error:
Traceback (most recent call last):
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\model_selection\_validation.py", line 866, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\base.py", line 1389, in wrapper
    return fit_method(estimator, *args, **kwargs)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\linear_model\_logistic.py", line 1193, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
             ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-pack
ages\sklearn\linear_model\_logistic.py", line 63, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or None penalties, got l1 penalt
y.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
C:\Users\Admin\AppData\Local\Programs\Python\Python312\Lib\site-packages\skl
earn\model_selection\_search.py:1108: UserWarning: One or more of the test s
cores are non-finite: [   nan    nan 0.7125 0.7125 0.7125 0.7125    nan    n
an 0.7125 0.7125
```

```
 0.7125 0.7125    nan    nan 0.7125 0.7125 0.7125 0.7125    nan    nan
 0.7125 0.7125 0.7125 0.7125    nan    nan 0.7125 0.7125 0.7125 0.7125
    nan    nan 0.7125 0.7125 0.7125 0.7125    nan    nan 0.7125 0.7125
 0.7125 0.7125]
  warnings.warn(
```

Out[112…

```
▸ GridSearchCV
▸ best_estimator_: LogisticRegression
  ▸ LogisticRegression
```

In [113…

```
print("Tuned Hyperparameters :", clf.best_params_)
print("Accuracy :",clf.best_score_)
```

```
Tuned Hyperparameters : {'C': np.float64(0.001), 'penalty': 'l1', 'solver':
'liblinear'}
Accuracy : 0.7125
```

In [114…

```
log_reg = clf.best_estimator_
log_reg.fit(X_train,y_train)
```

Out[114…

```
▾ LogisticRegression
LogisticRegression(C=np.float64(0.001), penalty='l1', solver='libli
near')
```

In [115…

```
yhat_l = log_reg.predict(X_test)
```

In [116…

```
a4 = jaccard_score(y_test, yhat_l,pos_label=1)
b4 = f1_score(y_test, yhat_l, average='weighted')
c4 = accuracy_score(y_test, yhat_l)

print('The jaccard_score of the logistic regression classifier on train data
print('The F1-score of the logistic regression classifier on train data is {
print('The accuracy_score of the logistic regression classifier on train dat
```

```
The jaccard_score of the logistic regression classifier on train data is 0.0
0
The F1-score of the logistic regression classifier on train data is 0.56
The accuracy_score of the logistic regression classifier on train data is 0.
69
```

Model Evaluation

In [117…

```
result_df=pd.DataFrame({'Model':['KNN','Decision Tree','SVM','Logistic Regre
                    'Jaccard Score' : [a1,a2,a3,a4],
                    'F1 Score' : [b1,b2,b3,b4],
                    'Accuracy Score':[c1,c2,c3,c4]})
```

In [118…

```
print(result_df)
```

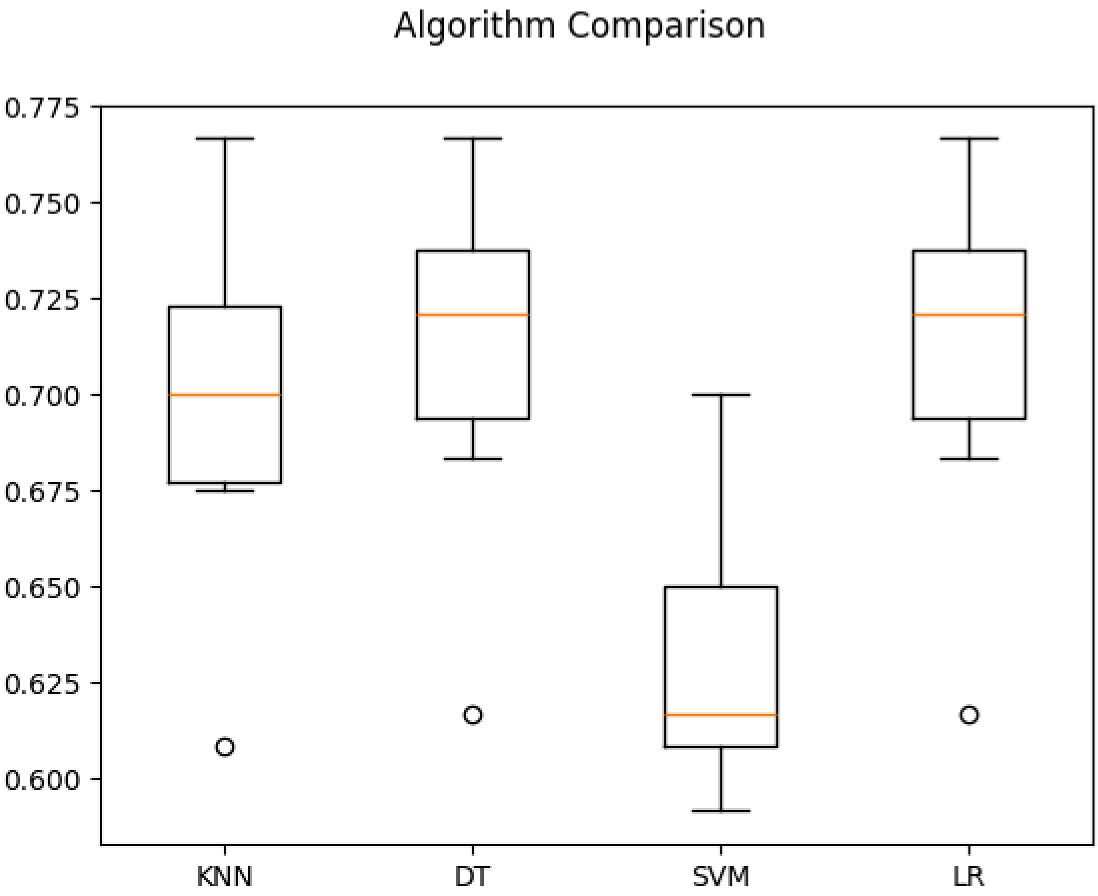
```
                 Model  Jaccard Score  F1 Score  Accuracy Score
0                  KNN       0.041237  0.585957            0.69
1        Decision Tree       0.000000  0.563432            0.69
2                  SVM       0.093023  0.566884            0.61
3  Logistic Regression       0.000000  0.563432            0.69
```

using K-fold cross validation

In [119…

```
from sklearn import model_selection
# prepare configuration for cross validation test harness
seed = 7
# prepare models
models = []
models.append(('KNN', knn1))
models.append(('DT', Rain_Tree ))
models.append(('SVM', svm))
models.append(('LR', log_reg))
# evaluate each model in turn
results = []
names = []
scoring = 'accuracy'
for name,model in models:
  kfold = model_selection.KFold(n_splits=10,
                               random_state=seed,
                               shuffle=True)
  cv_results = model_selection.cross_val_score(model,
                                               X_train,
                                               y_train,
                                               cv=kfold,
                                               scoring=scoring)
  results.append(cv_results)
  names.append(name)
for name,model in models:
  msg = "%s: %f (%f)" % (name, cv_results.mean(), cv_results.std())
  print(msg)
# boxplot algorithm comparison
fig = plt.figure()
fig.suptitle('Algorithm Comparison')
ax = fig.add_subplot(111)
plt.boxplot(results)
ax.set_xticklabels(names)
plt.show()
```

```
KNN: 0.712500 (0.041037)
DT: 0.712500 (0.041037)
SVM: 0.712500 (0.041037)
LR: 0.712500 (0.041037)
```



Ploting ROC_AUC Curce

In [120…

```
#d = {'No':0,'Yes' : 1}
#y_test = y_test.map(d)
```

In [121…

```
from sklearn.metrics import roc_curve, roc_auc_score
from sklearn.metrics import roc_curve, roc_auc_score

# Instantiate the classfiers and make a list
classifiers = [knn1,
               Rain_Tree,
               svm,
               log_reg]
model = ['KNN',
         'Decision Tree',
         'SVM',
         'Logistic Regression','Naive Bayes']
# Define a result table as a DataFrame
result_table = pd.DataFrame(columns=['model', 'fpr','tpr','auc'])

for cls in classifiers:
    model = cls.fit(X_train, y_train)
    yproba = model.predict_proba(X_test)[:, 1]

    fpr, tpr, _ = roc_curve(y_test, yproba)
    auc = roc_auc_score(y_test, yproba)
    new_row = pd.DataFrame({
        'model': [cls.__class__.__name__],
        'fpr': [fpr],
        'tpr': [tpr],
        'auc': [auc]
    })

    result_table = pd.concat([result_table, new_row], ignore_index=True)

# Set name of the classifiers as index labels
result_table.set_index('model', inplace=True)
```

```
C:\Users\Admin\AppData\Local\Temp\ipykernel_76704\3286901965.py:30: FutureWa
rning: The behavior of DataFrame concatenation with empty or all-NA entries
is deprecated. In a future version, this will no longer exclude empty or all
-NA columns when determining the result dtypes. To retain the old behavior,
exclude the relevant entries before the concat operation.
  result_table = pd.concat([result_table, new_row], ignore_index=True)
```

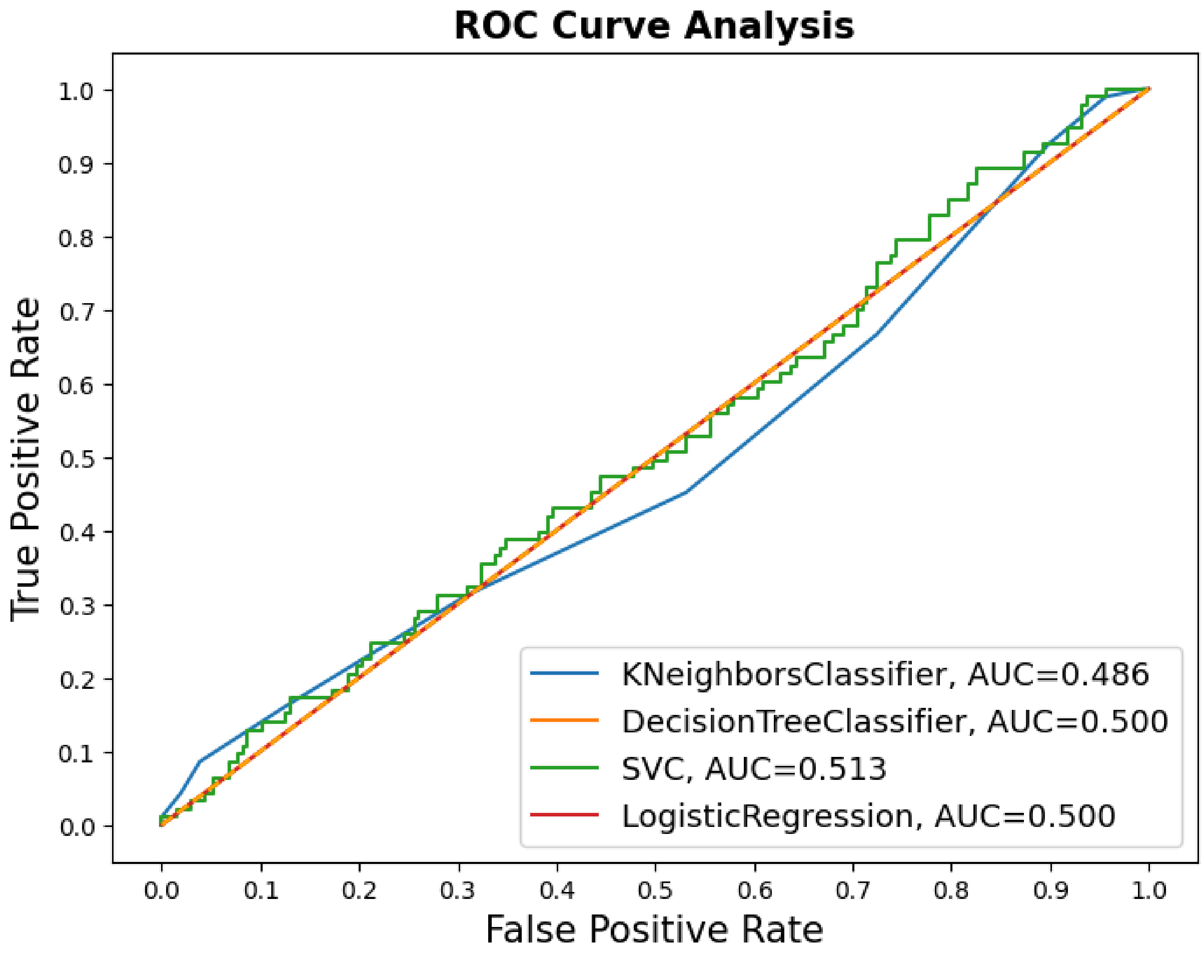
In [122…

```
print(result_table)
```

```
                                                                      fpr  \
model                                                                      
KNeighborsClassifier    [0.0, 0.0, 0.01932367149758454, 0.038647342995...   
DecisionTreeClassifier                                         [0.0, 1.0]   
SVC                     [0.0, 0.0, 0.014492753623188406, 0.01449275362...   
LogisticRegression                                             [0.0, 1.0]   

                                                                      tpr  \
model                                                                      
KNeighborsClassifier    [0.0, 0.010752688172043012, 0.0430107526881720...   
DecisionTreeClassifier                                         [0.0, 1.0]   
SVC                     [0.0, 0.010752688172043012, 0.0107526881720430...   
LogisticRegression                                             [0.0, 1.0]   

                             auc  
model                             
KNeighborsClassifier    0.485949  
DecisionTreeClassifier  0.500000  
SVC                     0.513168  
LogisticRegression      0.500000  
```

In [123…

```
fig = plt.figure(figsize=(8,6))

for i in result_table.index:
    plt.plot(result_table.loc[i]['fpr'],
             result_table.loc[i]['tpr'],
             label="{}, AUC={:.3f}".format(i, result_table.loc[i]['auc']))

plt.plot([0,1], [0,1], color='orange', linestyle='--')

plt.xticks(np.arange(0.0, 1.1, step=0.1))
plt.xlabel("False Positive Rate", fontsize=15)

plt.yticks(np.arange(0.0, 1.1, step=0.1))
plt.ylabel("True Positive Rate", fontsize=15)
plt.title('ROC Curve Analysis', fontweight='bold', fontsize=15)
plt.legend(prop={'size':13}, loc='lower right')

plt.show()
```


ROC Curve Analysis
True Positive Rate
False Positive Rate
KNeighborsClassifier, AUC=0.486
DecisionTreeClassifier, AUC=0.500
SVC, AUC=0.513
LogisticRegression, AUC=0.500