```
# pip install -U kaleido
```

```
Collecting kaleido
  Downloading kaleido-0.2.1-py2.py3-none-manylinux1_x86_64.whl (79.9 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 79.9/79.9 MB 6.6 MB/s eta 0:00:00
Installing collected packages: kaleido
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of the following dependency conflicts.
lida 0.0.10 requires fastapi, which is not installed.
lida 0.0.10 requires python-multipart, which is not installed.
lida 0.0.10 requires uvicorn, which is not installed.
Successfully installed kaleido-0.2.1
```

```
# Import libraries

import pandas as pd
import numpy as np

import matplotlib.pyplot as plt
import plotly.express as px

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import precision_score, recall_score, f1_score
```

Import the training and test datasets

```
training_df = pd.read_csv('tblTrain.csv')
print(f'Shape = {training_df.shape} \n')
training_df.head()
```

```
Shape = (2797, 4)
```

	Name	Duration	Genre	Rating
0	#Gadhvi (He thought he was Gandhi)	99	Drama	7.0
1	@Andheri	126	Action	4.0
2	1:1.6 An Ode to Lost Love	86	Drama	6.2
3	13B: Fear Has a New Address	136	Drama	7.3
4	15th August	158	Drama	5.6

```
test_df = pd.read_csv('tblTest.csv')
print(test_df.shape, '\n')
test_df.head()
```

```
(699, 4)
```

	Name	Duration	Genre	Rating
0	...Yahaan	132	Drama	7.4
1	15 Park Avenue	106	Drama	7.1
2	1971	146	Action	8.1
3	5ters: Castle of Dark Master	120	Action	4.6
4	7 Bijliyaan	136	Action	5.0

```
training_df.isna().sum()
```

```
Name        0
Duration    0
Genre       0
Rating      0
dtype: int64
```

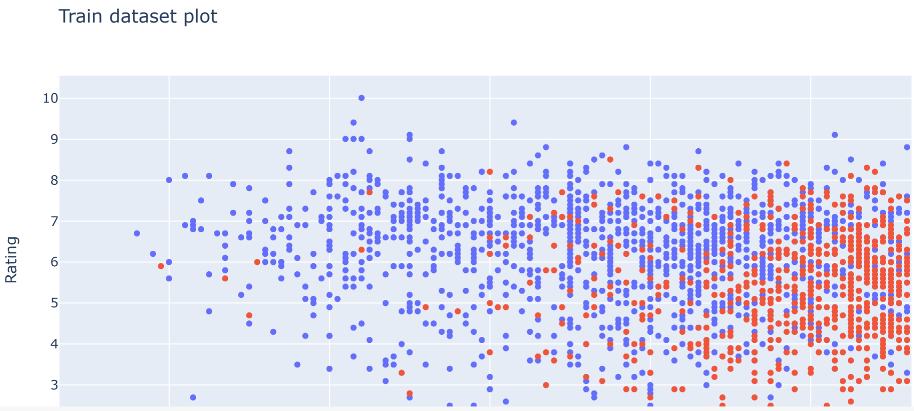
```
test_df.isna().sum()
```

```
Name        0
Duration    0
Genre       0
Rating      0
dtype: int64
```

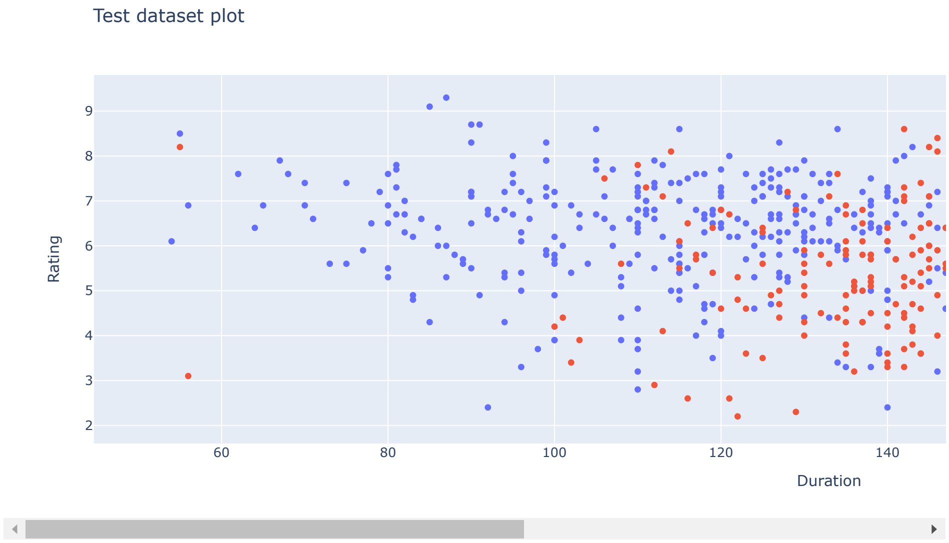
Plot the training and test data

```
def plot_dataset(df, title, annot):
  plt.plot(x = df['Duration'], y = df['Rating'])
```

```
fig = px.scatter(training_df, x = 'Duration', y = 'Rating', color = 'Genre', title = 'Train dataset plot')
fig.show()
fig.write_image('Train dataset plot.png')
```

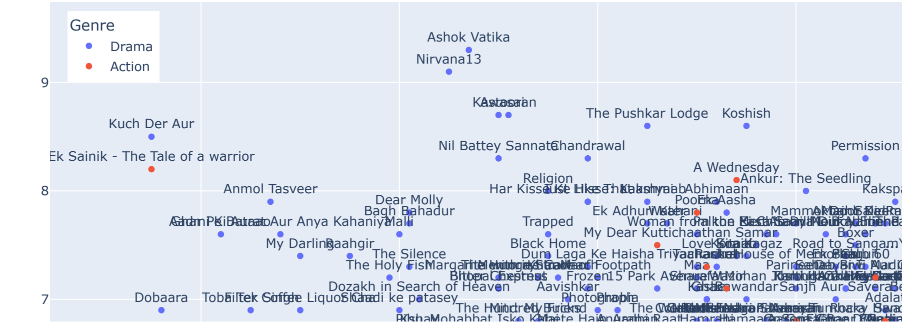


```
fig = px.scatter(test_df, x = 'Duration', y = 'Rating', color = 'Genre', title = 'Test dataset plot')
fig.show()
fig.write_image('Test dataset plot.png')
```



```
fig = px.scatter(test_df, x = 'Duration', y = 'Rating', color = 'Genre', text = 'Name', width = 1800, height = 1000, title = 'Test dataset plot annotated with movie names')
fig.update_traces(textposition='top center')
fig.update_layout(legend=dict(
    yanchor='top',
    y=0.99,
    xanchor='left',
    x=0.01
))
fig.show()
fig.write_image('Test dataset plot annotated with movie names.png')
```

Test dataset plot annotated with movie names



Model Development and Evaluation

```
knn_neighbors = list(range(1, 500))
```

```
train_X = training_df.drop(['Name', 'Genre'], axis = 1)
print(f'Shape = {train_X.shape} \n')
train_X.head()
```

```
Shape = (2797, 2)
```

	Duration	Rating
0	99	7.0
1	126	4.0
2	86	6.2
3	136	7.3
4	158	5.6

```
train_y = training_df['Genre']
train_y.head()
```

```
0     Drama
1    Action
2     Drama
3     Drama
4     Drama
Name: Genre, dtype: object
```

```
test_X = test_df.drop(['Name', 'Genre'], axis = 1)
print(f'Shape = {test_X.shape} \n')
test_X.head()
```

```
Shape = (699, 2)
```

	Duration	Rating
0	132	7.4
1	106	7.1
2	146	8.1
3	120	4.6
4	136	5.0

```
test_y = test_df['Genre']
test_y.head()
```

```
0     Drama
1     Drama
2    Action
3    Action
4    Action
Name: Genre, dtype: object
```

```
knn_clf = KNeighborsClassifier(n_neighbors = 3)
knn_clf.fit(train_X, train_y)
y_pred = knn_clf.predict(test_X)
```

```
set(y_pred)
```

```
{'Action', 'Drama'}
```

```
pd.Series(y_pred)
```

```
0       Drama
1       Drama
2      Action
3       Drama
4      Action
```

```
        ...
694     Action
695     Action
696      Drama
697      Drama
698      Drama
Length: 699, dtype: object
```

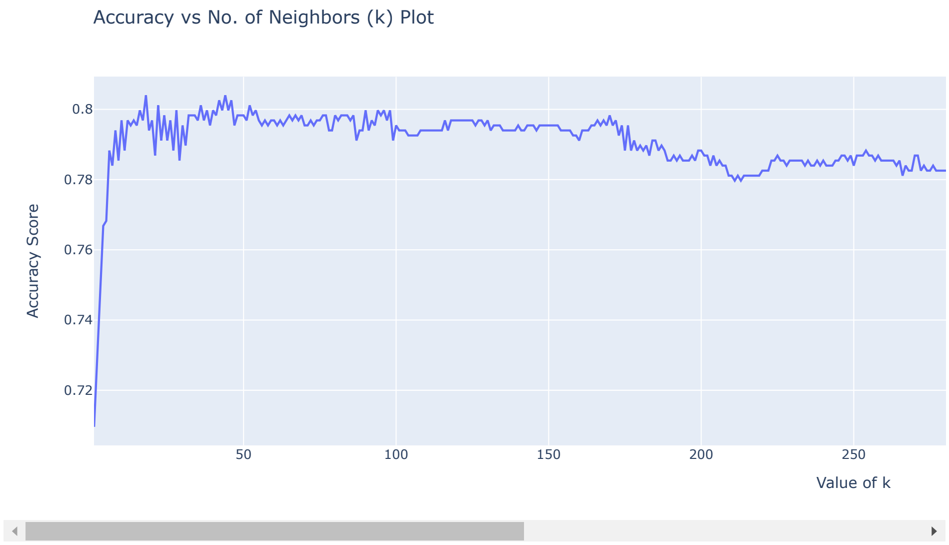
```
accuracy_list = []
```

```
for k in knn_neighbors:
  knn_clf = KNeighborsClassifier(n_neighbors = k)   # Define k-NN classifier
  knn_clf.fit(train_X, train_y)                     # Apply the k-NN algorithm on the train set
  y_pred = knn_clf.predict(test_X)                  # Use the test dataset to the find the predictions

  cf_matrix = confusion_matrix(test_y, y_pred)      # Index = Actual;  Column = Predicted

  # Accuracy = (True Negatives + True Positives) / Total no. of data points
  accuracy_score = (cf_matrix[0][0] + cf_matrix[1][1]) /sum(sum(cf_matrix))
  accuracy_list.append(accuracy_score)
```

```
fig = px.line(x = knn_neighbors, y = accuracy_list, title = 'Accuracy vs No. of Neighbors (k) Plot',
                              labels = dict(x = 'Value of k', y = 'Accuracy Score'))
fig.show()
fig.write_image('Accuracy vs No. of Neighbors (k) Plot.png')
```



Find optimal k

Find the value of k for which the accuracy is the maximum

```
max_accuracy = max(accuracy_list)
max_accuracy
```

```
0.804005722460658
```

```
corresponding_k = accuracy_list.index(max_accuracy)
corresponding_k
```

```
17
```

Print optimal k and corresponding accuracy

```
print(f'The value of optimal k and corresponding accuracy are {corresponding_k} and {max_accuracy} respectively.')
```

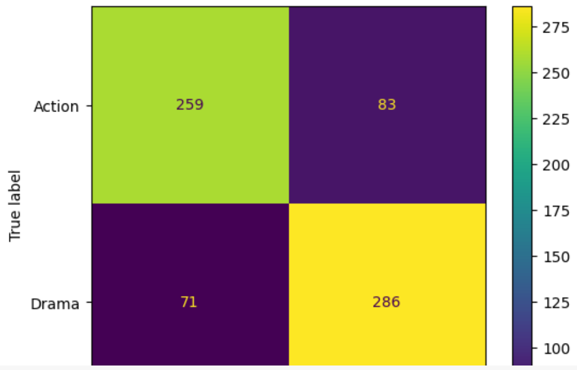
```
The value of optimal k and corresponding accuracy are 17 and 0.804005722460658 respectively.
```

Evaluate Model for Optimal k

```
knn_clf = KNeighborsClassifier(n_neighbors = corresponding_k)       # Define k-NN classifier
knn_clf.fit(train_X, train_y)                                       # Apply the k-NN algorithm on the train set
optimal_conf_mat = confusion_matrix(test_y, y_pred)                 # Index = Actual;  Column = Predicted
```

```
conf_disp = ConfusionMatrixDisplay(confusion_matrix = optimal_conf_mat, display_labels = knn_clf.classes_)
conf_disp.plot()
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x787e42933430>
```



```
# To verify the confusion matrix and labels

pd.crosstab(test_y, y_pred, rownames = ['Actual'], colnames = ['Predicted'], margins = True)
```

Predicted	Action	Drama	All
Actual			
Action	259	83	342
Drama	71	286	357
All	330	369	699

To compute Precision score

```
# To compute precision for Action class

precision_action = precision_score(test_y, y_pred, pos_label = 'Action')
precision_action
```

```
0.7848484848484848
```

```
# To compute precision for Drama class

precision_drama = precision_score(test_y, y_pred, pos_label = 'Drama')
precision_drama
```

```
0.7750677506775068
```

```
precision_score(test_y, y_pred, average=None)
```

```
array([0.78484848, 0.77506775])
```

```
# To compute overall precision

overall_precison = precision_score(test_y, y_pred, average = 'weighted')
overall_precison
```

```
0.779853174263307
```

To compute Recall score

```
# To compute recall for Action class

recall_action = recall_score(test_y, y_pred, pos_label = 'Action')
recall_action
```

```
0.7573099415204678
```

```
# To compute recall for Drama class

recall_drama = recall_score(test_y, y_pred, pos_label = 'Drama')
recall_drama
```

```
0.8011204481792717
```

```
recall_score(test_y, y_pred, average = None)
```

```
array([0.75730994, 0.80112045])
```

```
# To compute overall recall

overall_recall = recall_score(test_y, y_pred, average = 'weighted')
overall_recall
```

```
0.7796852646638054
```

To compute F-score score

```
# To compute F-score for Action class

f1_score_action = f1_score(test_y, y_pred, pos_label = 'Action')
f1_score_action
```

```
0.7708333333333333
```

```
# To compute F-score for Drama class

f1_score_drama = f1_score(test_y, y_pred, pos_label = 'Drama')
f1_score_drama
```

```
0.787878787878788
```

```
f1_score(test_y, y_pred, average = None)
```

```
array([0.77083333, 0.78787879])
```

```
# To compute overall F-score

overall_f1_score = f1_score(test_y, y_pred, average = 'weighted')
overall_f1_score
```

```
0.7795389517492521
```

```
precision_vals = [precision_action, precision_drama, overall_precison]
recall_vals = [recall_action, recall_drama, overall_recall]
f1_vals = [f1_score_action, f1_score_drama, overall_f1_score]
```

```
index_labels = ['Action class', 'Drama class', 'Overall']
column_labels = ['Precision', 'Recall', 'F1-score']

pd.DataFrame({'Precison': precision_vals, 'Recall': recall_vals, 'F1-score': f1_vals}, index = index_labels)
```

	Precison	Recall	F1-score
Action class	0.784848	0.757310	0.770833
Drama class	0.775068	0.801120	0.787879
Overall	0.779853	0.779685	0.779539