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

```
# Import libraries

import pandas as pd
import numpy as np

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

from sklearn.model_selection import train_test_split

from sklearn.svm import SVC
from sklearn.preprocessing import LabelEncoder
from mlxtend.plotting import plot_decision_regions

from sklearn.inspection import DecisionBoundaryDisplay

from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import accuracy_score, balanced_accuracy_score, classification_report

import warnings
warnings.filterwarnings('ignore')
```

Load all the data from the three given csv files for ODI, T20 and test match types

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

```
Shape = (262, 13)
```

	Runs	Mins	BF	4s	6s	SR	Pos	Dismissal	Inns	Opposition	Ground	Start Date	Odi No
0	12	33	22	1	0	54.54	2	lbw	1	v Sri Lanka	Dambulla	18/08/08	ODI # 2742
1	37	82	67	6	0	55.22	2	caught	2	v Sri Lanka	Dambulla	20/08/08	ODI # 2745
2	25	40	38	4	0	65.78	1	run out	1	v Sri Lanka	Colombo (RPS)	24/08/08	ODI # 2750
3	54	87	66	7	0	81.81	1	bowled	1	v Sri Lanka	Colombo (RPS)	27/08/08	ODI # 2755
4	31	45	46	3	1	67.39	1	lbw	2	v Sri Lanka	Colombo (RPS)	29/08/08	ODI # 2756

```
t20i_df = pd.read_csv('virat_kohli_t20i_innings_data.csv')
print(f'Shape = {t20i_df.shape} \n')
t20i_df.head()
```

```
Shape = (114, 13)
```

	Runs	Mins	BF	4s	6s	SR	Pos	Dismissal	Inns	Opposition	Ground	Start Date	T20I No
0	26	30	21	3	1	123.8	5	not out	2	v Zimbabwe	Harare	12/06/10	T20I # 182
1	DNB	-	-	-	-	-	-	-	2	v Zimbabwe	Harare	13/06/10	T20I # 183
2	28	28	19	5	0	147.36	1	bowled	1	v South Africa	Durban	09/01/11	T20I # 196
3	14	15	12	2	0	116.66	3	caught	1	v West Indies	Port of Spain	04/06/11	T20I # 200
4	4	5	5	0	0	80	4	caught	1	v England	Manchester	31/08/11	T20I # 204

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

```
Shape = (180, 13)
```

	Runs	Mins	BF	4s	6s	SR	Pos	Dismissal	Inns	Opposition	Ground	Start Date	Test No
0	4	13	10	1	0	40	5	caught	1	v West Indies	Kingston	20/06/11	Test # 1997
1	15	72	54	2	0	27.77	5	caught	3	v West Indies	Kingston	20/06/11	Test # 1997
2	0	1	2	0	0	0	5	caught	1	v West Indies	Bridgetown	28/06/11	Test # 1998
3	27	118	107	1	1	25.23	5	caught	3	v West Indies	Bridgetown	28/06/11	Test # 1998
4	30	62	53	2	0	56.6	5	caught	2	v West Indies	Roseau	06/07/11	Test # 1999

Concatenate runs from all the match type and store in Runs. Similarly do for strike rate and store in SR and Grounds in ground.

```
def generate_matchtype_column(m_type, entry_count):
  mtype_df = pd.DataFrame([m_type] * entry_count, columns = ['match_type'])
  return mtype_df
```

```
runs_combined = odi_df['Runs'].append(t20i_df['Runs'], ignore_index = True)
runs_combined = runs_combined.append(test_inn_df['Runs'], ignore_index = True)
runs_combined
```

```
0      12
1      37
2      25
3      54
4      31
       ..
551    45
552    23
553    13
554    11
555    20
Name: Runs, Length: 556, dtype: object
```

```
SR_combined = pd.concat([odi_df['SR'], t20i_df['SR'], test_inn_df['SR']], axis = 0, ignore_index = True)
SR_combined
```

```
0      54.54
1      55.22
2      65.78
3      81.81
4      67.39
       ...
551    59.21
552    47.91
553    81.25
554    57.89
555       50
Name: SR, Length: 556, dtype: object
```

```
ground_combined = pd.concat([odi_df['Ground'], t20i_df['Ground'], test_inn_df['Ground']], axis = 0, ignore_index = True)
ground_combined
```

```
0           Dambulla
1           Dambulla
2      Colombo (RPS)
3      Colombo (RPS)
4      Colombo (RPS)
           ...
551          Mohali
552       Bengaluru
553       Bengaluru
554      Birmingham
555      Birmingham
Name: Ground, Length: 556, dtype: object
```

Create a new **match_type** variable by storing info on the type of match for each datapoint. This can be extracted from the csv filename for each type of match. The 3 categories will be: **ODI, T20, TEST.**

```
ODI_match_type_df = generate_matchtype_column('ODI', len(odi_df))
print(f'Length = {len(ODI_match_type_df)}\n')
ODI_match_type_df.head()
```

```
Length = 262
```

	match_type
0	ODI
1	ODI
2	ODI
3	ODI
4	ODI

```
T20_match_type_df = generate_matchtype_column('T20', len(t20i_df))
print(f'Length = {len(T20_match_type_df)}\n')
T20_match_type_df.head()
```

```
Length = 114
```

	match_type
0	T20
1	T20
2	T20
3	T20
4	T20

```
TEST_match_type_df = generate_matchtype_column('TEST', len(test_inn_df))
print(f'Length = {len(TEST_match_type_df)}\n')
TEST_match_type_df.head()
```

```
Length = 180
```

```
match_type
```

```
match_type_combined = pd.concat([ODI_match_type_df, T20_match_type_df, TEST_match_type_df], axis = 0, ignore_index = True)
match_type_combined
```

	match_type
0	ODI
1	ODI
2	ODI
3	ODI
4	ODI
...	...
551	TEST
552	TEST
553	TEST
554	TEST
555	TEST

556 rows × 1 columns

Create a data frame data_cricketer and store Runs, SR, match_type and grounds in it.

```
data_cricketer = pd.concat([runs_combined, SR_combined, ground_combined, match_type_combined], axis = 1)
data_cricketer
```

	Runs	SR	Ground	match_type
0	12	54.54	Dambulla	ODI
1	37	55.22	Dambulla	ODI
2	25	65.78	Colombo (RPS)	ODI
3	54	81.81	Colombo (RPS)	ODI
4	31	67.39	Colombo (RPS)	ODI
...	...	...	...	...
551	45	59.21	Mohali	TEST
552	23	47.91	Bengaluru	TEST
553	13	81.25	Bengaluru	TEST
554	11	57.89	Birmingham	TEST
555	20	50	Birmingham	TEST

556 rows × 4 columns

```
data_cricketer.describe()
```

	Runs	SR	Ground	match_type
count	556	556	556	556
unique	144	377	75	3
top	0	0	Mirpur	ODI
freq	33	32	25	262

```
data_cricketer.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 556 entries, 0 to 555
Data columns (total 4 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   Runs        556 non-null    object
 1   SR          556 non-null    object
 2   Ground      556 non-null    object
 3   match_type  556 non-null    object
dtypes: object(4)
memory usage: 17.5+ KB
```

```
# Dropping those innings where Virat Kohli did not bat
        # invalid literal for int() with base 10: 'TDNB'
        # invalid literal for int() with base 10: 'DNB'

data_cricketer = data_cricketer.loc[(data_cricketer['Runs'] != 'TDNB') & (data_cricketer['Runs'] != 'DNB'), :]
data_cricketer.replace('-', np.NaN, inplace = True)
data_cricketer.dropna(axis = 0, inplace = True)
print(f'Shape = {data_cricketer.shape} \n')
data_cricketer.head()
```

```
Shape = (531, 4)
```

	Runs	SR	Ground	match_type
0	12	54.54	Dambulla	ODI
1	37	55.22	Dambulla	ODI
2	25	65.78	Colombo (RPS)	ODI

```
data_cricketer['Runs'] = data_cricketer['Runs'].astype('int64')
data_cricketer['SR'] = data_cricketer['SR'].astype('float64')
```

```
data_cricketer.dtypes
```

```
Runs            int64
SR            float64
Ground         object
match_type     object
dtype: object
```

```
data_cricketer.isna().sum()
```

```
Runs          0
SR            0
Ground        0
match_type    0
dtype: int64
```

From data_cricketer, store Runs and SR in X and match_type in Y.

```
X = data_cricketer[['Runs', 'SR']]
print(f'Shape = {X.shape} \n')
X.head()
```

```
Shape = (531, 2)
```

	Runs	SR
0	12	54.54
1	37	55.22
2	25	65.78
3	54	81.81
4	31	67.39

```
Y = data_cricketer[['match_type']]
Y.head()
```

	match_type
0	ODI
1	ODI
2	ODI
3	ODI
4	ODI

```
X.describe()
```

	Runs	SR
count	531.000000	531.000000
mean	45.905838	78.083013
std	44.287638	44.826650
min	0.000000	0.000000
25%	11.000000	48.615000
50%	33.000000	73.070000
75%	69.000000	103.560000
max	254.000000	241.370000

Split the data X and Y in x_train, x_test, y_train , y_test.

```
x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size = 0.3, random_state = 0)
```

```
x_train.shape
```

```
(371, 2)
```

```
x_train.index
```

```
Int64Index([487, 551, 215, 331,  59, 413, 260, 181,  38, 363,
            ...
```

```
            91, 509, 329, 416, 494,  74, 289,  10, 377, 201],
           dtype='int64', length=371)
```

```
y_train.value_counts()
```

```
match_type
ODI           179
TEST          119
T20            73
dtype: int64
```

```
y_train.shape
```

```
(371, 1)
```

```
x_test.shape
```

```
(160, 2)
```

```
x_test.index
```

```
Int64Index([429, 460, 280, 205, 472, 295, 293,  17, 398, 234,
            ...
            214, 519, 245, 174, 132, 163, 496,  63, 428, 463],
           dtype='int64', length=160)
```

```
y_test.value_counts()
```

```
match_type
ODI           73
TEST          54
T20           33
dtype: int64
```

Perform SVM classification with different kernels

```
# SVM with Linear Kernel

svc_linear = SVC(kernel = 'linear')
svc_linear.fit(x_train, y_train)
```

```
SVC(kernel='linear')
```

```
# SVM with Polynomial Kernel

svc_poly = SVC(kernel = 'poly', degree = 3)
svc_poly.fit(x_train, y_train)
```

```
SVC(kernel='poly')
```

```
# SVM with Radial Basis Function (RBF) Kernel

svc_rbf = SVC(kernel = 'rbf')
svc_rbf.fit(x_train, y_train)
```

```
SVC()
```

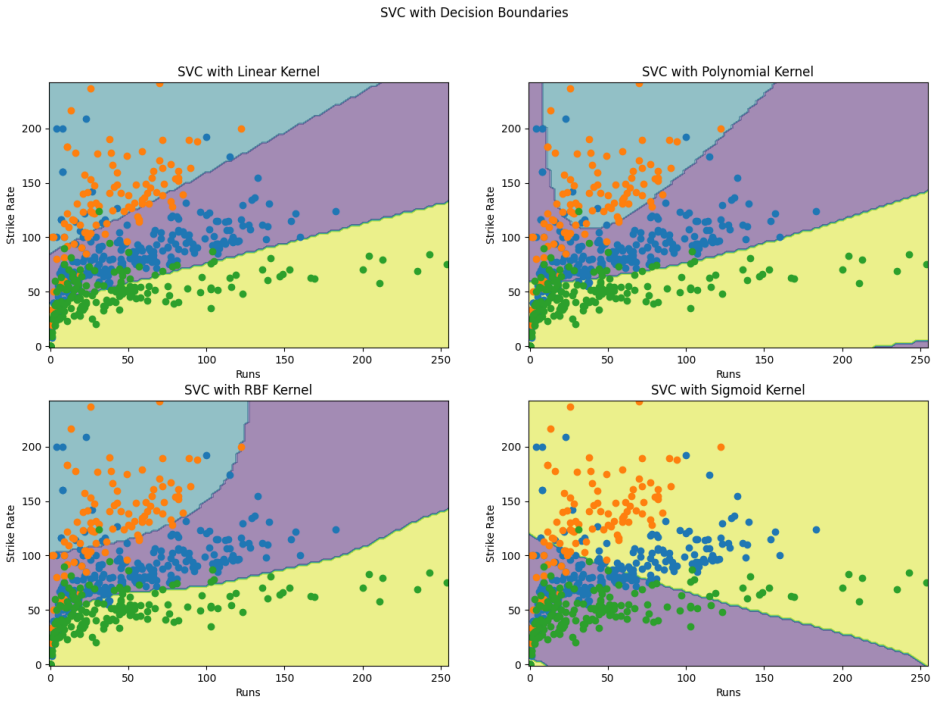
```
# SVM with Sigmoid Kernel

svc_sig = SVC(kernel = 'sigmoid')
svc_sig.fit(x_train, y_train)
```

```
SVC(kernel='sigmoid')
```

```
svc_clfs = {'Linear': svc_linear, 'Polynomial': svc_poly, 'RBF': svc_rbf, 'Sigmoid': svc_sig}
svc_clfs
```

```
{'Linear': SVC(kernel='linear'),
 'Polynomial': SVC(kernel='poly'),
 'RBF': SVC(),
 'Sigmoid': SVC(kernel='sigmoid')}
```

```
# Plot decision boundaries

fig, axes = plt.subplots(2, 2, figsize=(15, 10))

svc_clf_list = list(svc_clfs.items())

k = 0
for r in range(2):
  for c in range(2):
    name, svc_clf = svc_clf_list[k]
    disp = DecisionBoundaryDisplay.from_estimator(svc_clf, x_train, response_method= 'predict', xlabel = 'Runs', ylabel = 'Strike Rate', alpha=0.5, ax = axes[r][c])
    for match_type in data_cricketer['match_type'].unique():
        subset_type = data_cricketer[data_cricketer['match_type'] == match_type]
        axes[r][c].scatter(subset_type['Runs'], subset_type['SR'], label = match_type)
    axes[r][c].set_title(f'SVC with {name} Kernel')
    k += 1

#fig.set_xlabel('Runs')
#fig.set_ylabel('Score Rate')
plt.suptitle('SVC with Decision Boundaries')
plt.show()
```



Fit a SVM classification model with a Polynomial kernel with degree 6.

```
clf = SVC(kernel = 'poly', degree = 6)
```

```
clf.fit(x_train, y_train)
```

```
SVC(degree=6, kernel='poly')
```

```
y_pred = clf.predict(x_test)
```

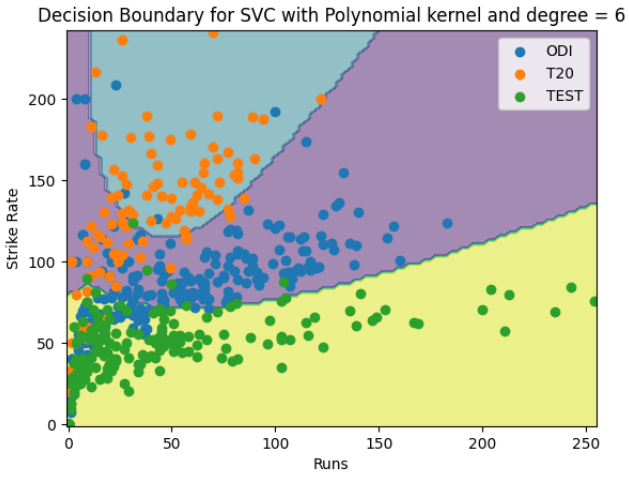
```
y_pred
```

```
array(['TEST', 'TEST', 'TEST', 'ODI', 'TEST', 'TEST', 'T20', 'ODI',
       'TEST', 'ODI', 'ODI', 'T20', 'TEST', 'T20', 'TEST', 'TEST', 'ODI',
       'ODI', 'TEST', 'TEST', 'T20', 'ODI', 'ODI', 'ODI', 'ODI', 'ODI',
       'ODI', 'TEST', 'TEST', 'ODI', 'T20', 'ODI', 'TEST', 'ODI', 'TEST',
       'ODI', 'TEST', 'TEST', 'ODI', 'ODI', 'TEST', 'TEST', 'ODI', 'T20',
       'ODI', 'ODI', 'ODI', 'TEST', 'ODI', 'ODI', 'ODI', 'TEST', 'T20',
       'ODI', 'TEST', 'ODI', 'ODI', 'ODI', 'ODI', 'TEST', 'TEST', 'TEST',
       'TEST', 'T20', 'TEST', 'ODI', 'TEST', 'TEST', 'T20', 'TEST', 'ODI',
       'TEST', 'TEST', 'ODI', 'TEST', 'ODI', 'ODI', 'T20', 'TEST', 'TEST',
       'TEST', 'ODI', 'TEST', 'TEST', 'ODI', 'TEST', 'TEST', 'T20', 'ODI',
```

```
'TEST', 'TEST', 'TEST', 'TEST', 'TEST', 'TEST', 'TEST', 'TEST',
'ODI', 'T20', 'TEST', 'T20', 'TEST', 'T20', 'ODI', 'TEST', 'TEST',
'TEST', 'ODI', 'ODI', 'T20', 'ODI', 'ODI', 'TEST', 'TEST', 'ODI',
'TEST', 'ODI', 'T20', 'TEST', 'TEST', 'ODI', 'TEST', 'T20', 'TEST',
'ODI', 'TEST', 'TEST', 'ODI', 'ODI', 'TEST', 'ODI', 'ODI', 'ODI',
'TEST', 'TEST', 'ODI', 'TEST', 'TEST', 'ODI', 'TEST', 'TEST',
'TEST', 'T20', 'ODI', 'TEST', 'TEST', 'TEST', 'TEST', 'ODI', 'T20',
'ODI', 'TEST', 'ODI', 'ODI', 'TEST', 'ODI', 'TEST', 'ODI', 'TEST',
'TEST'], dtype=object)
```

```
plt.figure(figsize=(10, 6))
disp = DecisionBoundaryDisplay.from_estimator(clf, x_train, response_method= 'predict', xlabel = 'Runs', ylabel = 'Strike Rate', alpha=0.5,)
for match_type in data_cricketer['match_type'].unique():
    subset_type = data_cricketer[data_cricketer['match_type'] == match_type]
    plt.scatter(subset_type['Runs'], subset_type['SR'], label = match_type)
plt.xlabel('Runs')
plt.ylabel('Strike Rate')
plt.title('Decision Boundary for SVC with Polynomial kernel and degree = 6')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7d22dd102c50>
<Figure size 1000x600 with 0 Axes>
```



For this model, compute confusion matrix, accuracy and balanced accuracy

```
unique_labels = list(set(y_pred))
unique_labels.sort()
unique_labels_ser = pd.Series(unique_labels)
unique_labels_ser
```

```
0     ODI
1     T20
2    TEST
dtype: object
```

```
# To compute the confusion matrix

confusion_mat = confusion_matrix(y_test, y_pred)                # Index = Actual;  Column = Predicted
pd.DataFrame(confusion_mat, index = unique_labels_ser, columns = unique_labels_ser)
```

	ODI	T20	TEST
ODI	48	2	23
T20	13	17	3
TEST	1	0	53

```
# To compute accuracy score

accuracy = accuracy_score(y_test, y_pred)
accuracy
```

```
0.7375
```

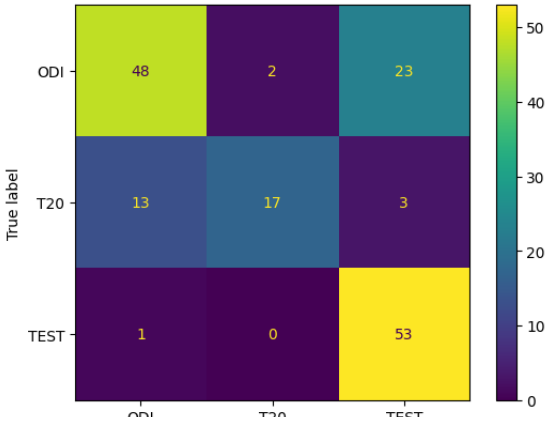
```
# To compute balanced accuracy score

balanced_accuracy = balanced_accuracy_score(y_test, y_pred)
balanced_accuracy
```

```
0.718055747736113
```

Plot confusion matrix

```
conf_disp = ConfusionMatrixDisplay(confusion_matrix = confusion_mat, display_labels = unique_labels_ser)
conf_disp.plot()
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7d22dd1b2aa0>
```



Also print classification report

```
print(classification_report(y_test, y_pred, target_names = unique_labels_ser))
```

```
              precision    recall  f1-score   support

         ODI       0.77      0.66      0.71        73
         T20       0.89      0.52      0.65        33
        TEST       0.67      0.98      0.80        54

    accuracy                           0.74       160
   macro avg       0.78      0.72      0.72       160
weighted avg       0.76      0.74      0.73       160
```

Create a scatter plot for Runs scored on x-axis and strike rate on y-axis. Group each point by match type (by assigning a different colour for each match type on the plot)

```
fig = px.scatter(data_cricketer, x = 'Runs', y = 'SR', color = 'match_type', title = 'Runs scored V/S Strike rate')
fig.show()
fig.write_image('Runs scored vs Strike rate.png')
```