Support Vector Machine

import dataset

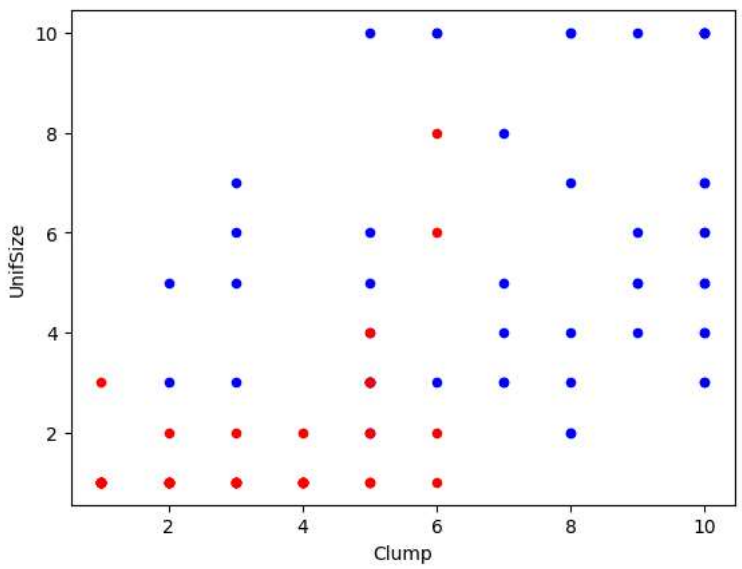
```
import pandas as pd
df = pd.read_csv("cell_samples.csv")
df.head()
```

	ID	Clump	UnifSize	UnifShape	MargAdh	SingEpiSize	BareNuc	BlandChrom	NormNucl	Mit	Class
0	1000025	5	1	1	1	2	1	3	1	1	2
1	1002945	5	4	4	5	7	10	3	2	1	2
2	1015425	3	1	1	1	2	2	3	1	1	2
3	1016277	6	8	8	1	3	4	3	7	1	2
4	1017023	4	1	1	3	2	1	3	1	1	2

```
# cell_df['Class'].value_counts()
df['Class'].unique()
```

```
array([2, 4])
```

```
import matplotlib.pyplot as plt
ax = df[df['Class'] == 4][0:50].plot(kind='scatter', x='Clump', y='UnifSize', color='b');
df[df['Class'] == 2][0:50].plot(kind='scatter', x='Clump', y='UnifSize', color='r', ax=ax)
plt.show()
```



cleaning

```
# df.dtypes
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 699 entries, 0 to 698
Data columns (total 11 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   ID           699 non-null    int64
 1   Clump        699 non-null    int64
 2   UnifSize     699 non-null    int64
 3   UnifShape    699 non-null    int64
 4   MargAdh      699 non-null    int64
 5   SingEpiSize  699 non-null    int64
 6   BareNuc      699 non-null    object
 7   BlandChrom   699 non-null    int64
 8   NormNucl     699 non-null    int64
 9   Mit          699 non-null    int64
```

```
 10  Class        699 non-null    int64
dtypes: int64(10), object(1)
memory usage: 60.2+ KB
```

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

```
BareNuc
1     402
10    132
2      30
5      30
3      28
8      21
4      19
?      16
9       9
7       8
6       4
Name: count, dtype: int64
```

```
df[df['BareNuc'] == '?'][:2]
```

	ID	Clump	UnifSize	UnifShape	MargAdh	SingEpiSize	BareNuc	BlandChrom	NormNucl	Mit	Class
23	1057013	8	4	5	1	2	?	7	3	1	4
40	1096800	6	6	6	9	6	?	7	8	1	2

```
import numpy as np
# df['BareNuc'] = df['BareNuc'].apply(pd.to_numeric, errors='coerce')
# df = df[pd.to_numeric(df['BareNuc'], errors='coerce').notnull()]
df['BareNuc'].replace({'?': np.nan}, inplace=True)
```

```
C:\Users\javad\AppData\Local\Temp\ipykernel_9280\44521018.py:4: FutureWarning: A value is trying to be set on a copy of a DataFrame
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col

  df['BareNuc'].replace({'?': np.nan}, inplace=True)
```

```
df[df['BareNuc'] == '?']
```

	ID	Clump	UnifSize	UnifShape	MargAdh	SingEpiSize	BareNuc	BlandChrom	NormNucl	Mit	Class

```
df.dropna(subset=['BareNuc'], inplace=True)
```

```
df[22:25]
```

	ID	Clump	UnifSize	UnifShape	MargAdh	SingEpiSize	BareNuc	BlandChrom	NormNucl	Mit	Class
22	1056784	3	1	1	1	2	1	2	1	1	2
24	1059552	1	1	1	1	2	1	3	1	1	2
25	1065726	5	2	3	4	2	7	3	6	1	4

```
# df = df[pd.to_numeric(df['BareNuc'], errors='coerce').notnull()]
# --------------------------------------------------------------------------------
df['BareNuc'] = df['BareNuc'].astype('int')
df.dtypes
```

```
ID             int64
Clump          int64
UnifSize       int64
UnifShape      int64
MargAdh        int64
SingEpiSize    int64
BareNuc        int64
BlandChrom     int64
NormNucl       int64
Mit            int64
Class          int64
dtype: object
```

encoding

```
# encode the data
```

define x , y

```
import numpy as np
x = df.loc[: , 'Clump':'Mit'].values
x[0:5]
```

```
array([[ 5,  1,  1,  1,  2,  1,  3,  1,  1],
       [ 5,  4,  4,  5,  7, 10,  3,  2,  1],
       [ 3,  1,  1,  1,  2,  2,  3,  1,  1],
       [ 6,  8,  8,  1,  3,  4,  3,  7,  1],
       [ 4,  1,  1,  3,  2,  1,  3,  1,  1]])
```

```
df['Class'] = df['Class'].astype('int')
y = df['Class'].values
y[0:5]
```

```
array([2, 2, 2, 2, 2])
```

spliting

```
### finding best random state

# from sklearn.model_selection import train_test_split
# from sklearn.svm import SVC
# from sklearn.preprocessing import StandardScaler
# from sklearn.metrics import accuracy_score

# import time
# t1 = time.time()
# lst = []
# for i in range(1,10):
#     x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25, random_state=i)
#     sc = StandardScaler().fit(x_train)
#     x_train = sc.transform(x_train)
#     x_test = sc.transform(x_test)
#     svc = SVC(kernel='rbf', random_state=1)
#     svc.fit(x_train, y_train)
#     yhat_test = svc.predict(x_test)
#     acc = accuracy_score(y_test, yhat_test)
#     lst.append(acc)
# t2 = time.time()
# print(f"run time: {round((t2 - t1) / 60 , 0)} min")
# print(f"accuracy_score = {round(max(lst),2)}")
# print(f"random_state = {np.argmax(lst) + 1}")

from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25, random_state=2)
```

scaling

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler().fit(x_train)
x_train = sc.transform(x_train)
x_test = sc.transform(x_test)
```

fit train data

```
from sklearn.svm import SVC
svc = SVC(kernel='rbf', random_state=1) # default kernel='rbf'
svc.fit(x_train, y_train)
```

```
SVC(random_state=1)
```

predict test data

```
yhat_test = svc.predict(x_test)
print(yhat_test [0:5])
```

```
[4 4 2 4 2]
```

evaluating

```
from sklearn.metrics import accuracy_score
print("Accuracy_score (train data): ", accuracy_score(y_train, svc.predict(x_train)))
print("Accuracy_score (test data): ", accuracy_score(y_test, yhat_test))
```

```
Accuracy_score (train data):  0.984375
Accuracy_score (test data):  0.935672514619883
```

```
from sklearn.metrics import confusion_matrix
print(confusion_matrix(y_test, yhat_test))
```

```
[[98  6]
 [ 5 62]]
```

```
from sklearn.metrics import f1_score
print(f1_score(y_test, yhat_test, average='weighted') )
```

```
0.9357553841662664
```

```
from sklearn.metrics import jaccard_score
print(jaccard_score(y_test, yhat_test,pos_label=2))
```

```
0.8990825688073395
```

```
from sklearn.metrics import classification_report
print(classification_report(y_test, yhat_test))
```

```
              precision    recall  f1-score   support

           2       0.95      0.94      0.95       104
           4       0.91      0.93      0.92        67

    accuracy                           0.94       171
   macro avg       0.93      0.93      0.93       171
weighted avg       0.94      0.94      0.94       171
```

save the model

```
# import joblib
# joblib.dump(svc, 'svc_model.pkl')
```

load the model

```
# import joblib
# svc = joblib.load('svc_model.pkl')
```