Support Vector Machine (SVM) Classifier

```
## Importing Libraries

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split

%matplotlib inline


## Loading the dataset

from sklearn.datasets import load_iris
iris = load_iris()
```

```
## Displaying Input Variables

iris.feature_names
```

```
['sepal length (cm)',
 'sepal width (cm)',
 'petal length (cm)',
 'petal width (cm)']
```

```
## Displaying the Output Variable

iris.target_names
```

```
array(['setosa', 'versicolor', 'virginica'], dtype='<U10')
```

```
## Creating a Dataframe out of the dataset loaded

df = pd.DataFrame(iris.data,columns=iris.feature_names)
df.head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2

```
df['target'] = iris.target
df.head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
0	5.1	3.5	1.4	0.2	0
1	4.9	3.0	1.4	0.2	0
2	4.7	3.2	1.3	0.2	0
3	4.6	3.1	1.5	0.2	0
4	5.0	3.6	1.4	0.2	0

```
df[df.target==1].head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
50	7.0	3.2	4.7	1.4	1
51	6.4	3.2	4.5	1.5	1
52	6.9	3.1	4.9	1.5	1
53	5.5	2.3	4.0	1.3	1
54	6.5	2.8	4.6	1.5	1

```
df[df.target==2].head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
100	6.3	3.3	6.0	2.5	2
101	5.8	2.7	5.1	1.9	2
102	7.1	3.0	5.9	2.1	2
103	6.3	2.9	5.6	1.8	2
104	6.5	3.0	5.8	2.2	2

```
df['flower_name'] =df.target.apply(lambda x: iris.target_names[x])
df.head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target	flower_name
0	5.1	3.5	1.4	0.2	0	setosa
1	4.9	3.0	1.4	0.2	0	setosa
2	4.7	3.2	1.3	0.2	0	setosa
3	4.6	3.1	1.5	0.2	0	setosa
4	5.0	3.6	1.4	0.2	0	setosa

```
df[45:55]
```

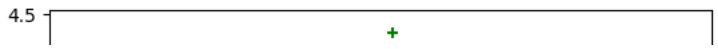
	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target	flower_name
45	4.8	3.0	1.4	0.3	0	setosa
46	5.1	3.8	1.6	0.2	0	setosa
47	4.6	3.2	1.4	0.2	0	setosa
48	5.3	3.7	1.5	0.2	0	setosa
49	5.0	3.3	1.4	0.2	0	setosa
50	7.0	3.2	4.7	1.4	1	versicolor
51	6.4	3.2	4.5	1.5	1	versicolor
52	6.9	3.1	4.9	1.5	1	versicolor
53	5.5	2.3	4.0	1.3	1	versicolor
54	6.5	2.8	4.6	1.5	1	versicolor

```
df0 = df[:50]
df1 = df[50:100]
df2 = df[100:]
```

Sepal length vs Sepal Width (Setosa vs Versicolor)

```
plt.xlabel('Sepal Length')
plt.ylabel('Sepal Width')
plt.scatter(df0['sepal length (cm)'], df0['sepal width (cm)'],color="green",marker='+')
plt.scatter(df1['sepal length (cm)'], df1['sepal width (cm)'],color="blue",marker='.')
```

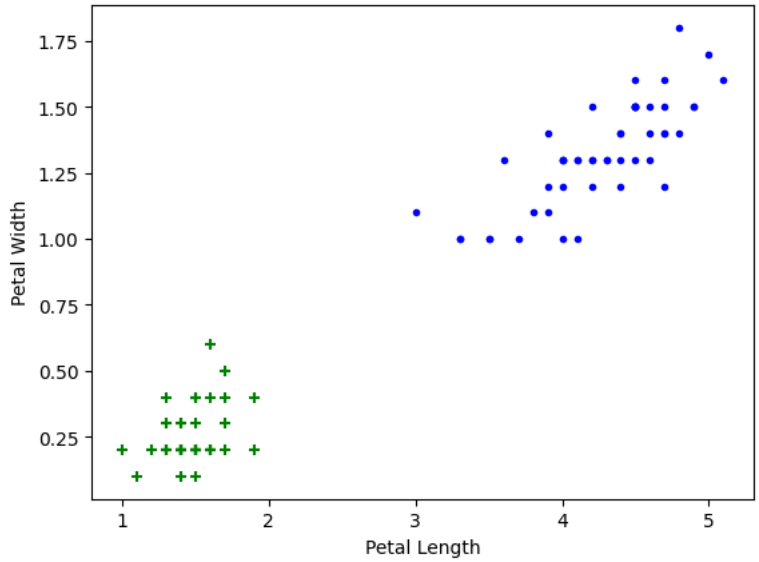
```
<matplotlib.collections.PathCollection at 0x7caa8701b790>
```



Petal length vs Pepal Width (Setosa vs Versicolor)


```
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')
plt.scatter(df0['petal length (cm)'], df0['petal width (cm)'],color="green",marker='+')
plt.scatter(df1['petal length (cm)'], df1['petal width (cm)'],color="blue",marker='.')
```

```
<matplotlib.collections.PathCollection at 0x7caa870efa90>
```



Train Using Support Vector Machine (SVM)

```
## Separating Input/Output Varaiables and Creating Training-Testing Sets

X = df.drop(['target','flower_name'], axis='columns')
y = df.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2)


from sklearn.svm import SVC
model = SVC()


model.fit(X_train, y_train)
```

```
▾ SVC
SVC()
```

```
model.score(X_test, y_test)
```

```
0.9333333333333333
```

```
model.predict([[4.8,3.0,1.5,0.3]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but SVC was fitted wi
  warnings.warn(
array([0])
```

Parameter Tuning

Double-click (or enter) to edit

```
## 1. Regularization (C)

model_C = SVC(C=1)
model_C.fit(X_train, y_train)
model_C.score(X_test, y_test)
```

```
0.9333333333333333
```

```
model_C = SVC(C=10)
model_C.fit(X_train, y_train)
model_C.score(X_test, y_test)
```

```
0.9333333333333333
```

```
## 2. Gamma
```

```
model_g = SVC(gamma=10)
model_g.fit(X_train, y_train)
model_g.score(X_test, y_test)
```

```
0.9666666666666667
```

```
## 3. Kernel
```

```
model_linear_kernal = SVC(kernel='linear')
model_linear_kernal.fit(X_train, y_train)
```

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

```
model_linear_kernal.score(X_test, y_test)
```

```
0.9333333333333333
```

```
y_pred = model_linear_kernal.predict(X_test)
```

```
## Model Performance - Confusion Matrix
```

```
from sklearn.metrics import confusion_matrix

print("Confusion Matrix: ")
print(confusion_matrix(y_test, y_pred))
```

```
Confusion Matrix:
[[11  0  0]
 [ 0 11  1]
 [ 0  1  6]]
```

```
## Model Performance - Classification Report
```

```
from sklearn import metrics
#  accuracy
print("acuracy:", metrics.accuracy_score(y_test,y_pred))
#  precision score
print("precision:", metrics.precision_score(y_test,y_pred, average='macro'))
#  recall score
print("recall" , metrics.recall_score(y_test,y_pred, average='macro'))
print(metrics.classification_report(y_test, y_pred))
```

```
acuracy: 0.9333333333333333
precision: 0.9246031746031745
recall 0.9246031746031745
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        11
           1       0.92      0.92      0.92        12
           2       0.86      0.86      0.86         7

    accuracy                           0.93        30
   macro avg       0.92      0.92      0.92        30
weighted avg       0.93      0.93      0.93        30
```

```
## Visulaizing the Results
```

```
from matplotlib.colors import ListedColormap

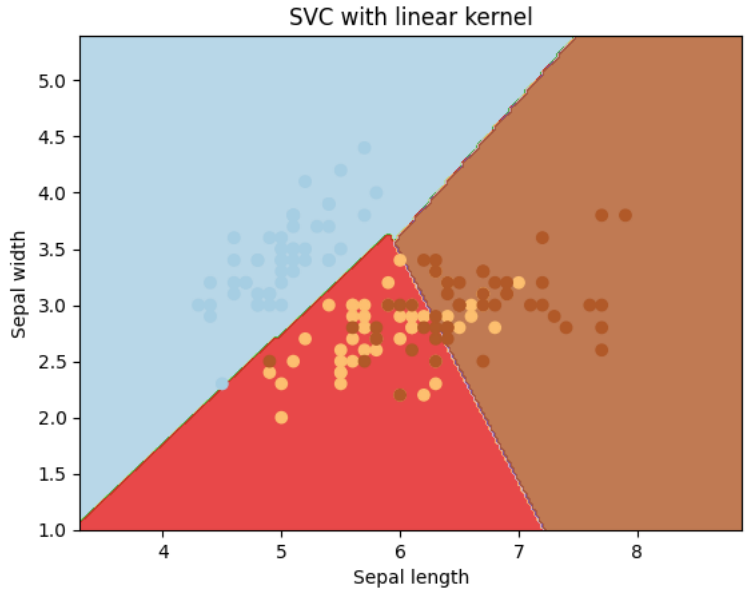
X = iris.data[:, :2]
y = iris.target

C = 1.0 # SVM regularization parameter
svc = SVC(kernel='linear', C=1).fit(X, y)
```

```
# create a mesh to plot in
x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
h = (x_max / x_min)/100
xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))

plt.subplot(1, 1, 1)
Z = svc.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)
plt.contourf(xx, yy, Z, cmap=plt.cm.Paired, alpha=0.8)

plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Paired)
plt.xlabel('Sepal length')
plt.ylabel('Sepal width')
plt.xlim(xx.min(), xx.max())
plt.title('SVC with linear kernel')
plt.show()
```

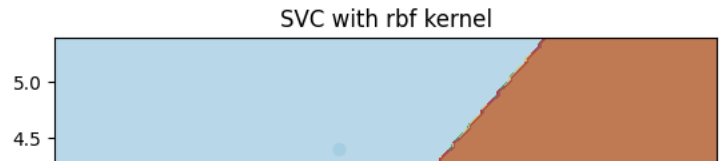



```
C = 1.0 # SVM regularization parameter
svc = SVC(kernel='rbf', C=100, gamma=0.01).fit(X, y)

# create a mesh to plot in
x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
h = (x_max / x_min)/100
xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))

plt.subplot(1, 1, 1)
Z = svc.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)
plt.contourf(xx, yy, Z, cmap=plt.cm.Paired, alpha=0.8)

plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Paired)
plt.xlabel('Sepal length')
plt.ylabel('Sepal width')
plt.xlim(xx.min(), xx.max())
plt.title('SVC with rbf kernel')
plt.show()
```

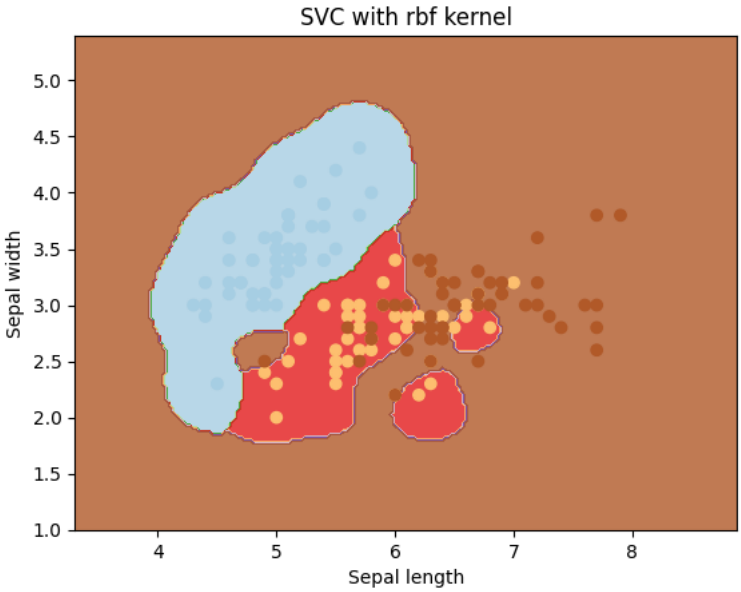



```
C = 1.0 # SVM regularization parameter
svc = SVC(kernel='rbf', C=10, gamma=10).fit(X, y)

# create a mesh to plot in
x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
h = (x_max / x_min)/100
xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))

plt.subplot(1, 1, 1)
Z = svc.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)
plt.contourf(xx, yy, Z, cmap=plt.cm.Paired, alpha=0.8)

plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.Paired)
plt.xlabel('Sepal length')
plt.ylabel('Sepal width')
plt.xlim(xx.min(), xx.max())
plt.title('SVC with rbf kernel')
plt.show()
```



Prameter Finetuning through GridSearch

```
from sklearn.model_selection import GridSearchCV

param_grid = {'C':(1, 10, 100, 1000), 'gamma':(0.1, 0.01, 0.001, 0.0001)}

grid_search = GridSearchCV(svc, param_grid, cv=10, verbose=10)

grid_search.fit(X_train, y_train)
```

```
Fitting 10 folds for each of 16 candidates, totalling 160 fits
[CV 1/10; 1/16] START C=1, gamma=0.1.....................................
[CV 1/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 2/10; 1/16] START C=1, gamma=0.1.....................................
[CV 2/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 3/10; 1/16] START C=1, gamma=0.1.....................................
[CV 3/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 4/10; 1/16] START C=1, gamma=0.1.....................................
[CV 4/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 5/10; 1/16] START C=1, gamma=0.1.....................................
[CV 5/10; 1/16] END .............C=1, gamma=0.1;, score=0.917 total time=   0.0s
[CV 6/10; 1/16] START C=1, gamma=0.1.....................................
[CV 6/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 7/10; 1/16] START C=1, gamma=0.1.....................................
[CV 7/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 8/10; 1/16] START C=1, gamma=0.1.....................................
[CV 8/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 9/10; 1/16] START C=1, gamma=0.1.....................................
[CV 9/10; 1/16] END .............C=1, gamma=0.1;, score=1.000 total time=   0.0s
[CV 10/10; 1/16] START C=1, gamma=0.1....................................
[CV 10/10; 1/16] END ............C=1, gamma=0.1;, score=0.917 total time=   0.0s
[CV 1/10; 2/16] START C=1, gamma=0.01....................................
[CV 1/10; 2/16] END ............C=1, gamma=0.01;, score=1.000 total time=   0.0s
[CV 2/10; 2/16] START C=1, gamma=0.01....................................
[CV 2/10; 2/16] END ............C=1, gamma=0.01;, score=1.000 total time=   0.0s
[CV 3/10; 2/16] START C=1, gamma=0.01....................................
[CV 3/10; 2/16] END ............C=1, gamma=0.01;, score=1.000 total time=   0.0s
[CV 4/10; 2/16] START C=1, gamma=0.01....................................
[CV 4/10; 2/16] END ............C=1, gamma=0.01;, score=0.917 total time=   0.0s
[CV 5/10; 2/16] START C=1, gamma=0.01....................................
[CV 5/10; 2/16] END ............C=1, gamma=0.01;, score=0.917 total time=   0.0s
[CV 6/10; 2/16] START C=1, gamma=0.01....................................
[CV 6/10; 2/16] END ............C=1, gamma=0.01;, score=0.917 total time=   0.0s
[CV 7/10; 2/16] START C=1, gamma=0.01....................................
[CV 7/10; 2/16] END ............C=1, gamma=0.01;, score=0.917 total time=   0.0s
[CV 8/10; 2/16] START C=1, gamma=0.01....................................
[CV 8/10; 2/16] END ............C=1, gamma=0.01;, score=0.917 total time=   0.0s
[CV 9/10; 2/16] START C=1, gamma=0.01....................................
[CV 9/10; 2/16] END ............C=1, gamma=0.01;, score=1.000 total time=   0.0s
[CV 10/10; 2/16] START C=1, gamma=0.01...................................
[CV 10/10; 2/16] END ...........C=1, gamma=0.01;, score=0.833 total time=   0.0s
[CV 1/10; 3/16] START C=1, gamma=0.001...................................
[CV 1/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 2/10; 3/16] START C=1, gamma=0.001...................................
[CV 2/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 3/10; 3/16] START C=1, gamma=0.001...................................
[CV 3/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 4/10; 3/16] START C=1, gamma=0.001...................................
[CV 4/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 5/10; 3/16] START C=1, gamma=0.001...................................
[CV 5/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 6/10; 3/16] START C=1, gamma=0.001...................................
[CV 6/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 7/10; 3/16] START C=1, gamma=0.001...................................
[CV 7/10; 3/16] END ...........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 8/10; 3/16] START C=1, gamma=0.001...................................
[CV 8/10; 3/16] END ...........C=1, gamma=0.001;, score=0.750 total time=   0.0s
[CV 9/10; 3/16] START C=1, gamma=0.001...................................
[CV 9/10; 3/16] END ...........C=1, gamma=0.001;, score=0.750 total time=   0.0s
[CV 10/10; 3/16] START C=1, gamma=0.001..................................
[CV 10/10; 3/16] END ..........C=1, gamma=0.001;, score=0.667 total time=   0.0s
[CV 1/10; 4/16] START C=1, gamma=0.0001..................................
[CV 1/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 2/10; 4/16] START C=1, gamma=0.0001..................................
[CV 2/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 3/10; 4/16] START C=1, gamma=0.0001..................................
[CV 3/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 4/10; 4/16] START C=1, gamma=0.0001..................................
[CV 4/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 5/10; 4/16] START C=1, gamma=0.0001..................................
[CV 5/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 6/10; 4/16] START C=1, gamma=0.0001..................................
[CV 6/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 7/10; 4/16] START C=1, gamma=0.0001..................................
[CV 7/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.333 total time=   0.0s
[CV 8/10; 4/16] START C=1, gamma=0.0001..................................
[CV 8/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.417 total time=   0.0s
[CV 9/10; 4/16] START C=1, gamma=0.0001..................................
[CV 9/10; 4/16] END ..........C=1, gamma=0.0001;, score=0.417 total time=   0.0s
[CV 10/10; 4/16] START C=1, gamma=0.0001.................................
[CV 10/10; 4/16] END .........C=1, gamma=0.0001;, score=0.417 total time=   0.0s
[CV 1/10; 5/16] START C=10, gamma=0.1....................................
[CV 1/10; 5/16] END ............C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 2/10; 5/16] START C=10, gamma=0.1....................................
[CV 2/10; 5/16] END ............C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 3/10; 5/16] START C=10, gamma=0.1....................................
[CV 3/10; 5/16] END ............C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 4/10; 5/16] START C=10, gamma=0.1....................................
[CV 4/10; 5/16] END ............C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 5/10; 5/16] START C=10, gamma=0.1....................................
```

```
[CV 5/10; 5/16] END ..........C=10, gamma=0.1;, score=0.917 total time=   0.0s
[CV 6/10; 5/16] START C=10, gamma=0.1.....................................
[CV 6/10; 5/16] END ..........C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 7/10; 5/16] START C=10, gamma=0.1.....................................
[CV 7/10; 5/16] END ..........C=10, gamma=0.1;, score=0.917 total time=   0.0s
[CV 8/10; 5/16] START C=10, gamma=0.1.....................................
[CV 8/10; 5/16] END ..........C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 9/10; 5/16] START C=10, gamma=0.1.....................................
[CV 9/10; 5/16] END ..........C=10, gamma=0.1;, score=1.000 total time=   0.0s
[CV 10/10; 5/16] START C=10, gamma=0.1....................................
[CV 10/10; 5/16] END ..........C=10, gamma=0.1;, score=0.917 total time=   0.0s
[CV 1/10; 6/16] START C=10, gamma=0.01....................................
[CV 1/10; 6/16] END ..........C=10, gamma=0.01;, score=1.000 total time=   0.0s
[CV 2/10; 6/16] START C=10, gamma=0.01....................................
[CV 2/10; 6/16] END ..........C=10, gamma=0.01;, score=1.000 total time=   0.0s
[CV 3/10; 6/16] START C=10, gamma=0.01....................................
[CV 3/10; 6/16] END ..........C=10, gamma=0.01;, score=1.000 total time=   0.0s
[CV 4/10; 6/16] START C=10, gamma=0.01....................................
[CV 4/10; 6/16] END ..........C=10, gamma=0.01;, score=1.000 total time=   0.0s
[CV 5/10; 6/16] START C=10, gamma=0.01....................................
[CV 5/10; 6/16] END ..........C=10, gamma=0.01;, score=0.917 total time=   0.0s
[CV 6/10; 6/16] START C=10, gamma=0.01....................................
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[CV 8/10; 7/16] END ..........C=10, gamma=0.001;, score=0.917 total time=   0.0s
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[CV 9/10; 7/16] END ..........C=10, gamma=0.001;, score=1.000 total time=   0.0s
[CV 10/10; 7/16] START C=10, gamma=0.001..................................
[CV 10/10; 7/16] END ..........C=10, gamma=0.001;, score=0.833 total time=   0.0s
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[CV 2/10; 8/16] START C=10, gamma=0.0001..................................
[CV 2/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
[CV 3/10; 8/16] START C=10, gamma=0.0001..................................
[CV 3/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
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[CV 4/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
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[CV 5/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
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[CV 6/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
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[CV 7/10; 8/16] END ..........C=10, gamma=0.0001;, score=0.667 total time=   0.0s
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[CV 4/10; 9/16] START C=100, gamma=0.1....................................
[CV 4/10; 9/16] END ..........C=100, gamma=0.1;, score=1.000 total time=   0.0s
[CV 5/10; 9/16] START C=100, gamma=0.1....................................
[CV 5/10; 9/16] END ..........C=100, gamma=0.1;, score=0.917 total time=   0.0s
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[CV 6/10; 9/16] END ..........C=100, gamma=0.1;, score=1.000 total time=   0.0s
[CV 7/10; 9/16] START C=100, gamma=0.1....................................
[CV 7/10; 9/16] END ..........C=100, gamma=0.1;, score=0.917 total time=   0.0s
[CV 8/10; 9/16] START C=100, gamma=0.1....................................
[CV 8/10; 9/16] END ..........C=100, gamma=0.1;, score=0.917 total time=   0.0s
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[CV 9/10; 9/16] END ..........C=100, gamma=0.1;, score=1.000 total time=   0.0s
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[CV 10/10; 9/16] END ..........C=100, gamma=0.1;, score=0.833 total time=   0.0s
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[CV 2/10; 10/16] END .........C=100, gamma=0.01;, score=1.000 total time=   0.0s
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[CV 3/10; 10/16] END .........C=100, gamma=0.01;, score=1.000 total time=   0.0s
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[CV 4/10; 10/16] END .........C=100, gamma=0.01;, score=1.000 total time=   0.0s
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[CV 5/10; 10/16] END .........C=100, gamma=0.01;, score=0.917 total time=   0.0s
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[CV 6/10; 10/16] END .........C=100, gamma=0.01;, score=1.000 total time=   0.0s
[CV 7/10; 10/16] START C=100, gamma=0.01.....................................
[CV 7/10; 10/16] END .........C=100, gamma=0.01;, score=0.917 total time=   0.0s
[CV 8/10; 10/16] START C=100, gamma=0.01.....................................
[CV 8/10; 10/16] END .........C=100, gamma=0.01;, score=0.917 total time=   0.0s
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[CV 10/10; 10/16] END ........C=100, gamma=0.01;, score=1.000 total time=   0.0s
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[CV 10/10; 11/16] END .......C=100, gamma=0.001;, score=0.917 total time=   0.0s
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