Name : Suyash Pratap Singh

Reg ID : GO_STP_6412

Importing the required libraries

In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scikitplot as skplt
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
from sklearn.datasets import load_digits
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, recall_score, precision_score, f1_score
from sklearn.metrics import confusion_matrix, classification_report
```

In [3]:

```
digits = load_digits()
```

Shape of the Datasets

In [4]:

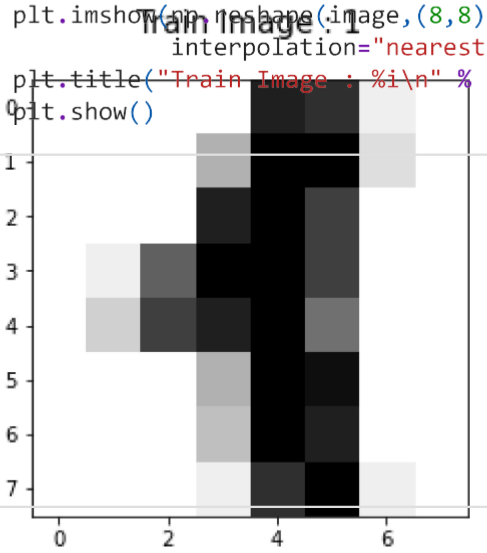
```
print("Images Data Shape : ",digits.data.shape)
print("Labels Data Shape : ",digits.target.shape)
```

```
Images Data Shape :  (1797, 64)
Labels Data Shape :  (1797,)
```

Displaying some of the Images of the dataset

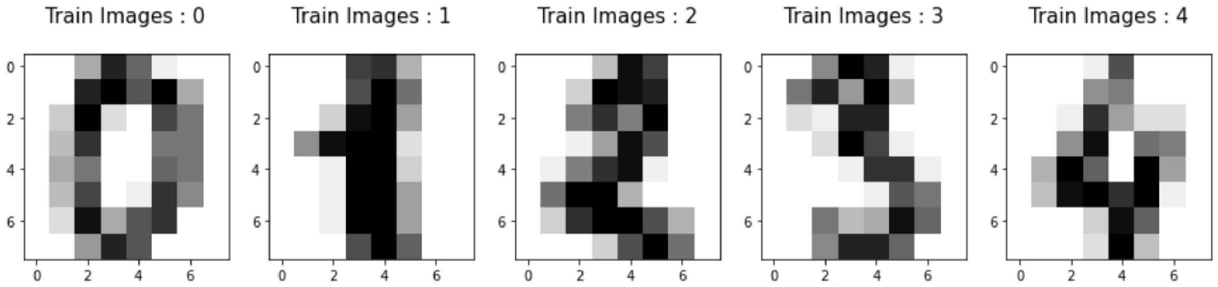
In [5]:

```
image = digits.data[11]
plt.imshow(np.reshape(image,(8,8)),cmap = plt.cm.binary,
           interpolation="nearest")
plt.title("Train Image : %i\n" % digits.target[11], fontsize = 15)
plt.show()
```



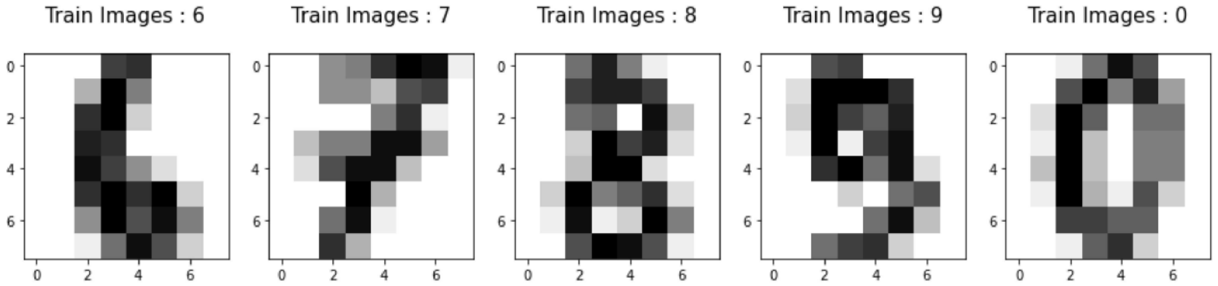
In [6]:

```
plt.figure(figsize=(16,6))
for i,(image,label) in enumerate(zip(digits.data[:5],digits.target[:5])):
    plt.subplot(1,5, i+1)
    plt.imshow(np.reshape(image,(8,8)),cmap=plt.cm.binary,interpolation='nearest')
    plt.title("Train Images : %i\n" % label, fontsize = 15)
```


Train Images : 0 Train Images : 1 Train Images : 2 Train Images : 3 Train Images : 4

In [7]:

```
plt.figure(figsize=(16,6))
for i,(image,label) in enumerate(zip(digits.data[6:11],digits.target[6:11])):
    plt.subplot(1,5, i+1)
    plt.imshow(np.reshape(image,(8,8)),cmap=plt.cm.binary,interpolation='nearest')
    plt.title("Train Images : %i\n" % label, fontsize = 15)
```


Train Images : 6 Train Images : 7 Train Images : 8 Train Images : 9 Train Images : 0

Spliting the dataset into Training and Test set

In [8]:

```
x_train,x_test,y_train,y_test = train_test_split(digits.data, digits.target,
                                                 random_state = 12, test_size = 0.20
```

In [9]:

```
print("X Train Shape:", x_train.shape)
print("Y Train Shape:", y_train.shape)
```

```
X Train Shape: (1437, 64)
Y Train Shape: (1437,)
```

In [10]:

```
print("X Test Shape:",x_test.shape)
print("Y Test Shape:",y_test.shape)
```

```
X Test Shape: (360, 64)
Y Test Shape: (360,)
```

In [11]:

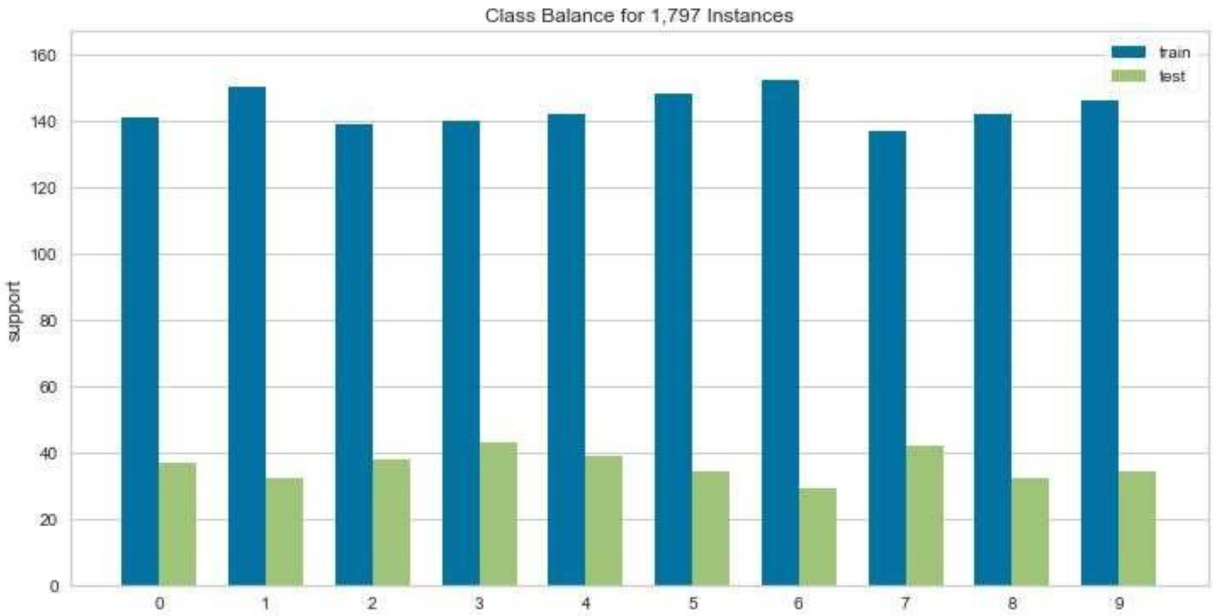
```
classes = digits.target_names
classes
```

Out[11]:

```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

In [12]:

```
from yellowbrick.target import ClassBalance
plt.figure(figsize=(12,6))
viz = ClassBalance(labels=classes)
viz.fit(y_train, y_test)
viz.show()
plt.show()
```



Support Vector Classifier

In [13]:

```
from sklearn.svm import SVC
svm_clf = SVC(kernel='poly',random_state=42, probability=True)
svm_clf.fit(x_train,y_train)
```

Out[13]:

```
SVC(kernel='poly', probability=True, random_state=42)
```

In [14]:

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

Classification Accuracy:

In [15]:

```
clf_accuracy = accuracy_score(y_test,y_pred)
print("Classification Accuracy of the Model is ",clf_accuracy)
```

```
Classification Accuracy of the Model is  0.9944444444444445
```

Classification Error:

In [16]:

```
clf_error = 1 - clf_accuracy
print("Classification Error of the Model is ",clf_error)
```

```
Classification Error of the Model is  0.005555555555555536
```

Sensitivity/True Positive Rate/Recall Score

In [17]:

```
recall_list = recall_score(y_test, y_pred, average=None)
for itr in range(len(recall_list)):
    print(f'class {classes[itr]} : {recall_list[itr]}')
```

```
class 0 : 1.0
class 1 : 1.0
class 2 : 1.0
class 3 : 1.0
class 4 : 1.0
class 5 : 0.9411764705882353
class 6 : 1.0
class 7 : 1.0
class 8 : 1.0
class 9 : 1.0
```

Precision Score:

In [18]:

```
precision_list = precision_score(y_test, y_pred, average=None)
for itr in range(len(precision_list)):
    print(f'class {classes[itr]} : {precision_list[itr]}')
```

```
class 0 : 1.0
class 1 : 1.0
class 2 : 1.0
class 3 : 1.0
class 4 : 1.0
class 5 : 1.0
class 6 : 1.0
class 7 : 1.0
class 8 : 1.0
class 9 : 0.9444444444444444
```

F1 Score

In [19]:

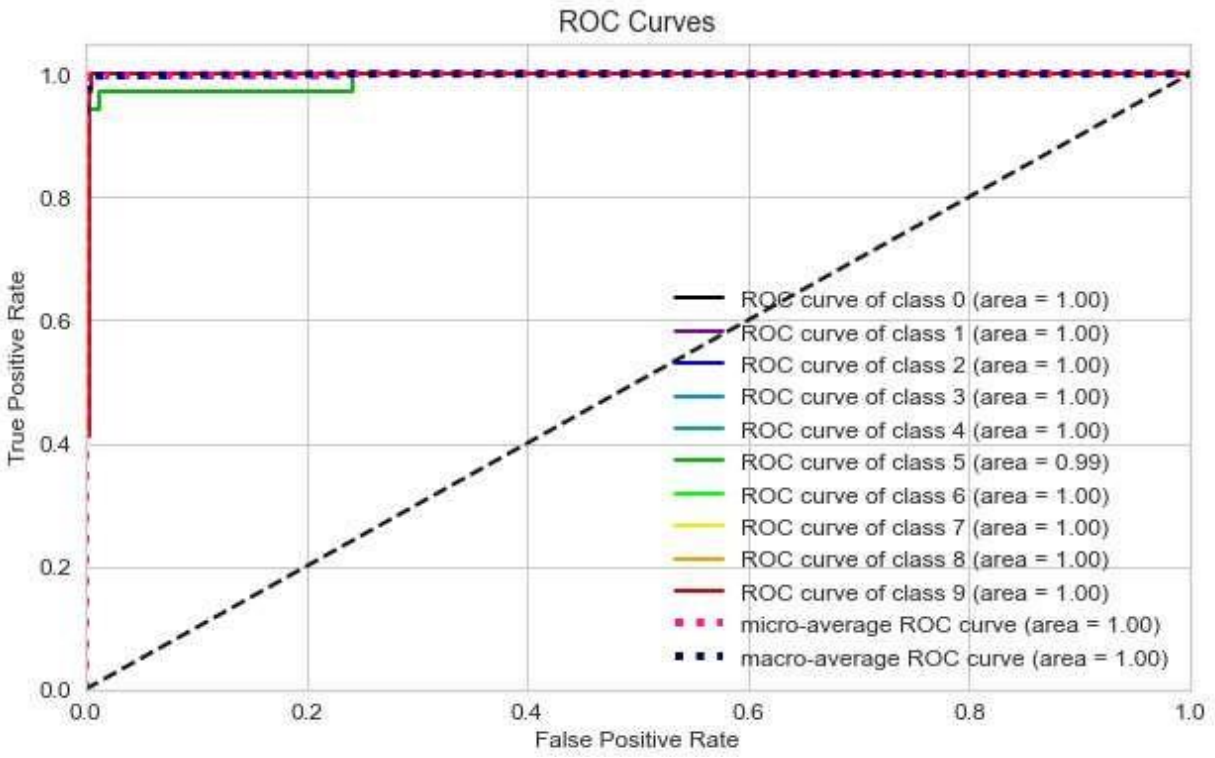
```
f1_list = f1_score(y_test, y_pred, average=None)
for itr in range(len(f1_list)):
    print(f'class {classes[itr]} : {f1_list[itr]}')
```

```
class 0 : 1.0
class 1 : 1.0
class 2 : 1.0
class 3 : 1.0
class 4 : 1.0
class 5 : 0.9696969696969697
class 6 : 1.0
class 7 : 1.0
class 8 : 1.0
class 9 : 0.9714285714285714
```

ROC Curve

In [20]:

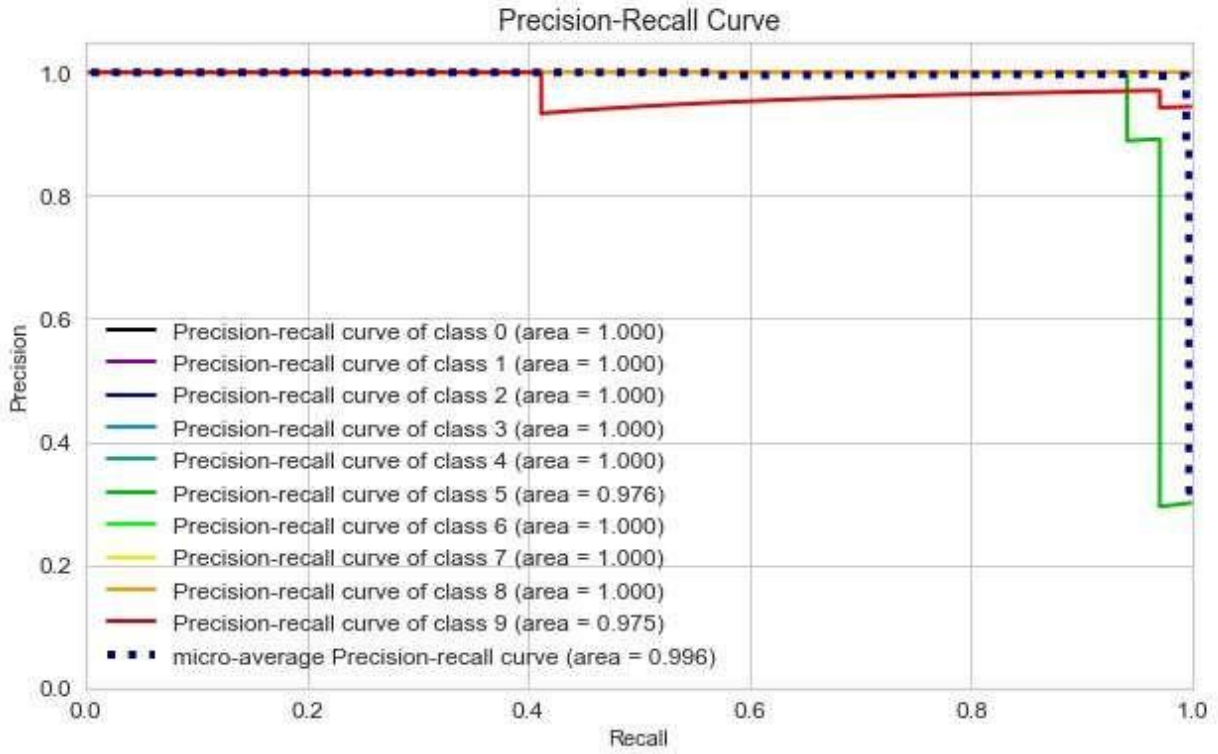
```
y_probas = svm_clf.predict_proba(x_test)
skplt.metrics.plot_roc(y_test, y_probas,figsize=(10,6),title_fontsize=14,text_fontsi
plt.show()
```



Precision Recall Curve

In [21]:

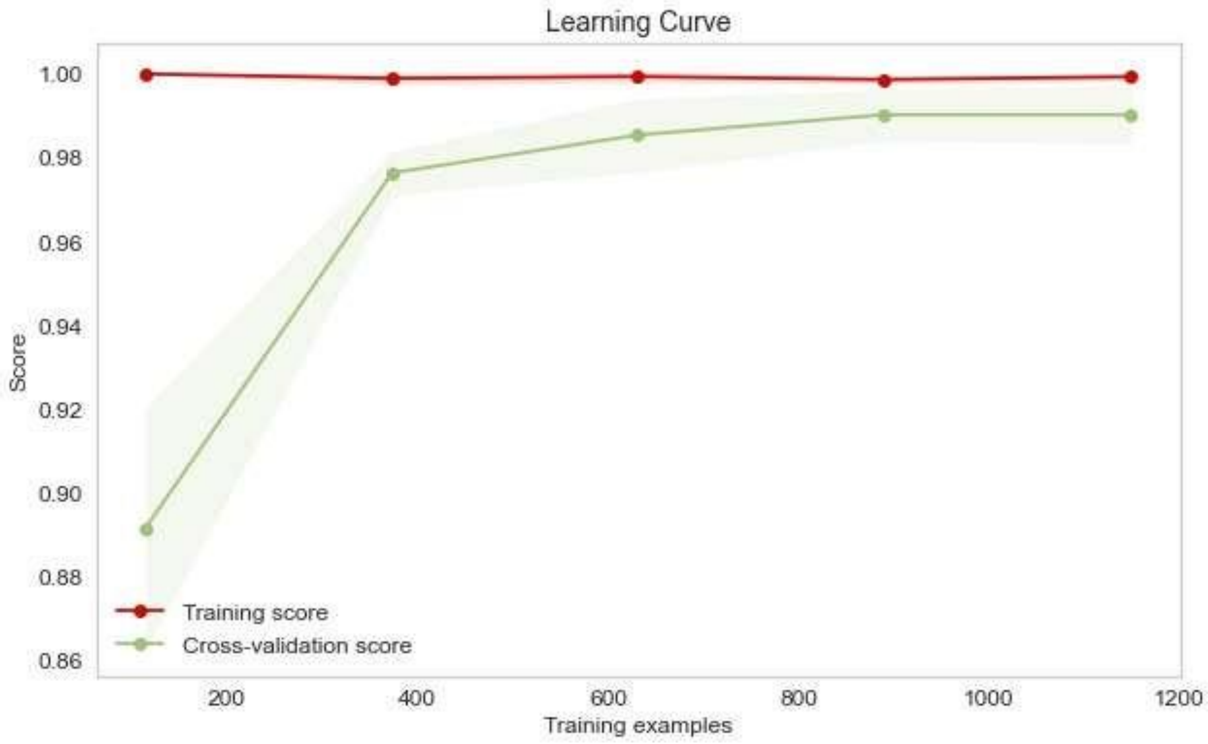
```
skplt.metrics.plot_precision_recall(y_test, y_probas,figsize=(10,6),title_fontsize=1
plt.show()
```



Learning Curve

In [22]:

```
skplt.estimators.plot_learning_curve(svm_clf, x_train, y_train,figsize=(10,6),title_
plt.show()
```



Classification Report

In [23]:

```
print(classification_report(y_test,y_pred))
```

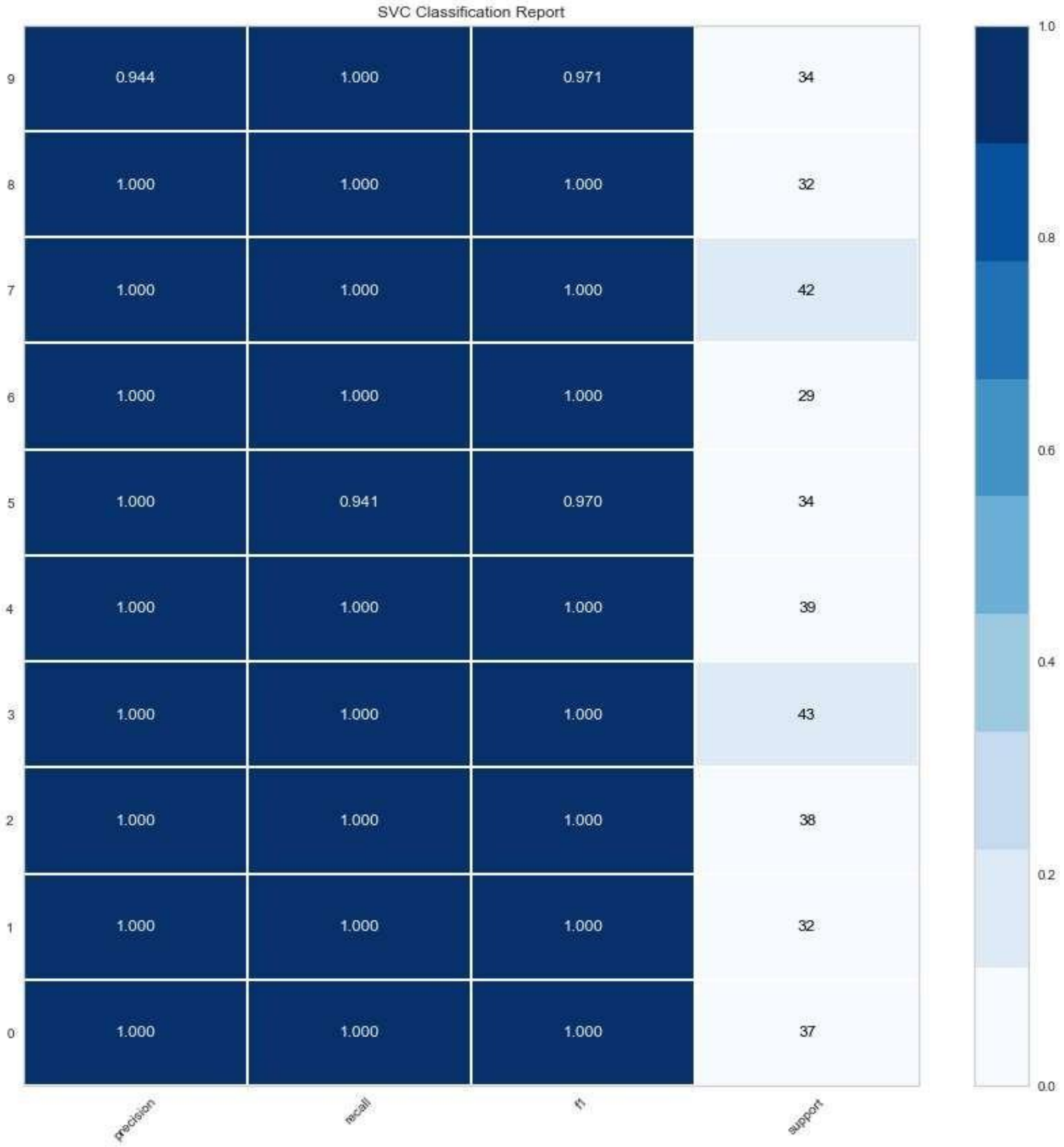
```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        37
           1       1.00      1.00      1.00        32
           2       1.00      1.00      1.00        38
           3       1.00      1.00      1.00        43
           4       1.00      1.00      1.00        39
           5       1.00      0.94      0.97        34
           6       1.00      1.00      1.00        29
           7       1.00      1.00      1.00        42
           8       1.00      1.00      1.00        32
           9       0.94      1.00      0.97        34

    accuracy                           0.99       360
   macro avg       0.99      0.99      0.99       360
weighted avg       0.99      0.99      0.99       360
```

In [24]:

```
import yellowbrick as yb
plt.figure(figsize=(12,12))
visualizer = yb.classifier.classification_report(svm_clf, x_train, y_train, x_test,
                                                 classes=classes, support=True,cmap
plt.show()
```



Confusion Matrix

In [25]:

```
cm = confusion_matrix(y_test,y_pred)
```

In [26]:

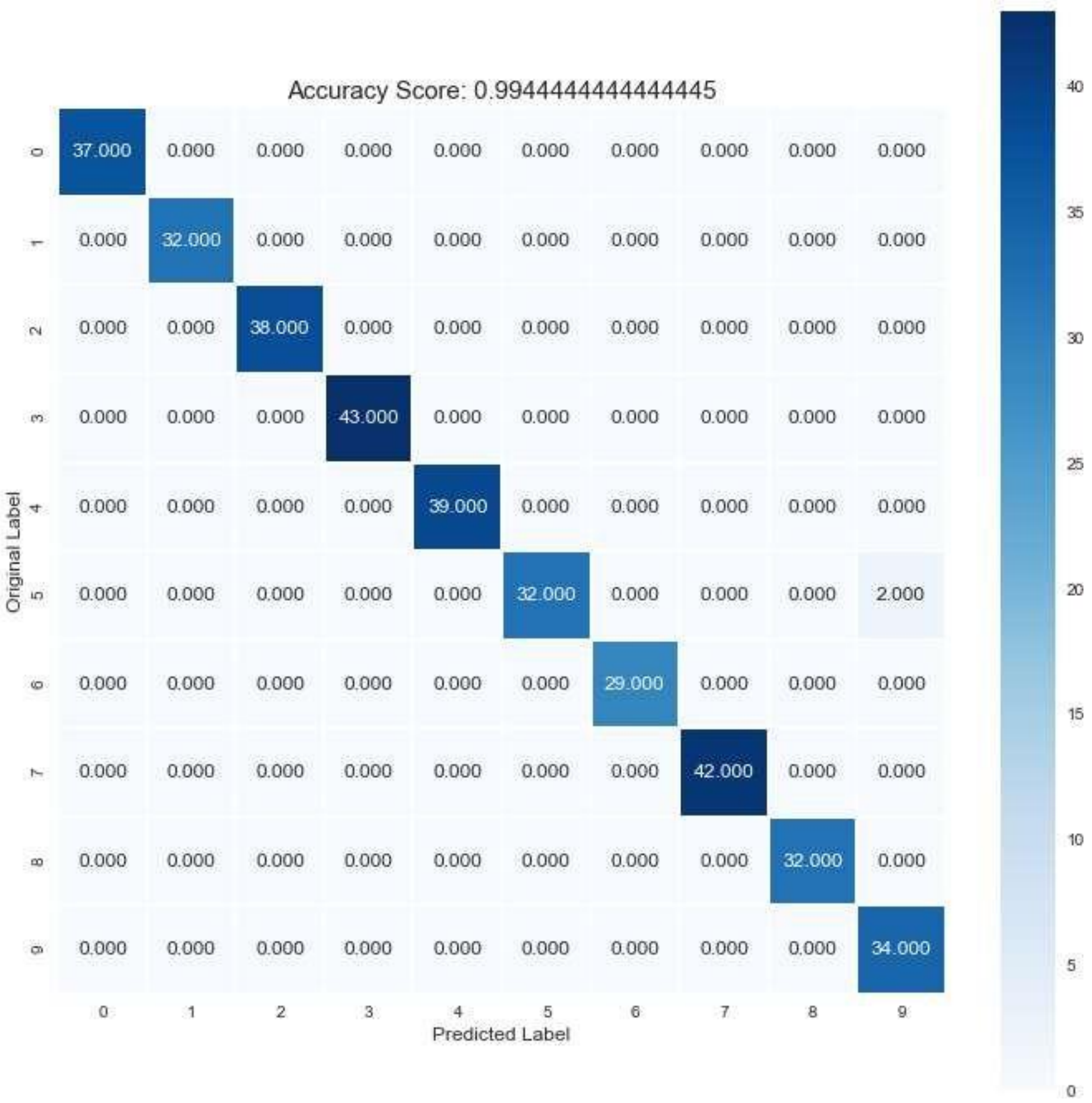
```
print(cm)
```

```
[[37  0  0  0  0  0  0  0  0  0]
 [ 0 32  0  0  0  0  0  0  0  0]
 [ 0  0 38  0  0  0  0  0  0  0]
 [ 0  0  0 43  0  0  0  0  0  0]
 [ 0  0  0  0 39  0  0  0  0  0]
 [ 0  0  0  0  0 32  0  0  0  2]
 [ 0  0  0  0  0  0 29  0  0  0]
 [ 0  0  0  0  0  0  0 42  0  0]
 [ 0  0  0  0  0  0  0  0 32  0]
 [ 0  0  0  0  0  0  0  0  0 34]]
```

In [27]:

```
plt.figure(figsize=(12,12))
sns.heatmap(cm, annot=True, fmt =".3f",linewidths= 2, square=True , cmap= 'Blues')
plt.ylabel("Original Label", size = 12)
plt.xlabel("Predicted Label",size = 12)
```

```
all_title = "Accuracy Score: {0}".format(clf_accuracy)
plt.title(all_title,size = 15)
plt.show()
```

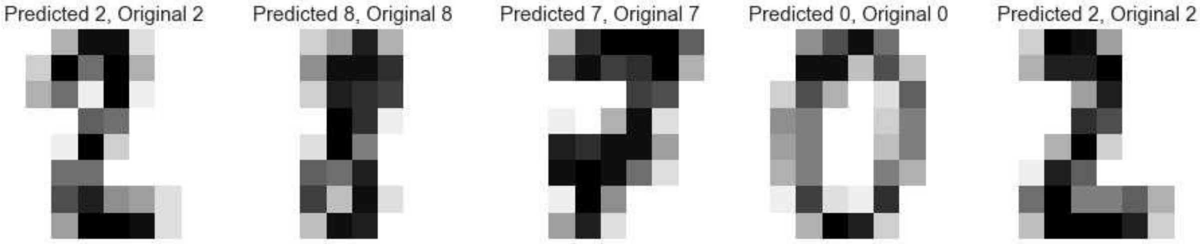


	0	1	2	3	4	5	6	7	8	9
0	37.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	32.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	38.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	43.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	39.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	32.000	0.000	0.000	0.000	2.000
6	0.000	0.000	0.000	0.000	0.000	0.000	29.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	42.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	32.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.000

Displaying some of the Predicted Images of the dataset

In [28]:

```
index = 0
classifed = []
for predict, actual in zip(y_pred,y_test):
    if predict == actual:
        classifed.append(index)
    index = index+1
plt.figure(figsize=(16,4))
for i, wrong in enumerate(classifed[:5]):
    plt.subplot(1,5, i+1)
    plt.imshow(np.reshape(x_test[wrong], (8,8)), cmap=plt.cm.gray_r)
    plt.axis('off')
    plt.title("Predicted {0}, Original {0}".format(y_pred[wrong],y_test[wrong]),font
```



Predicted 2, Original 2

Predicted 8, Original 8

Predicted 7, Original 7

Predicted 0, Original 0

Predicted 2, Original 2