Train SVM classifier using sklearn digits dataset (i.e. from sklearn.datasets import load_digits) and then

1. Measure the accuracy of your model using different kernels such as RBF, poly, and linear. ¶

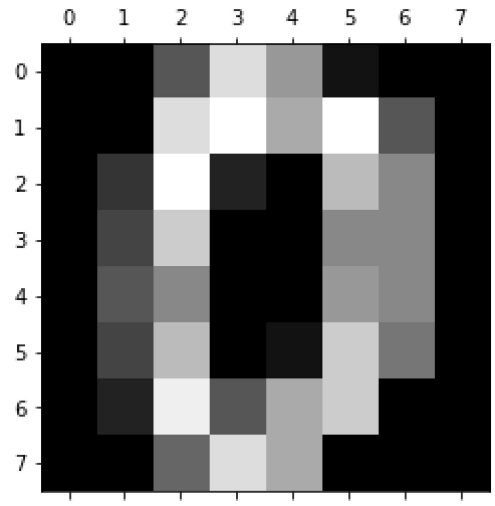
In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
from sklearn.datasets import load_digits
digits = load_digits()
digits.data.shape
```

Out[2]:
```
(1797, 64)
```

In [3]:
```
plt.gray()
plt.matshow(digits.images[0])
plt.show()
```

```
<Figure size 432x288 with 0 Axes>
```



In [4]:
```
dir(digits)
```

Out[4]:
```
['DESCR', 'data', 'feature_names', 'frame', 'images', 'target', 'target_names']
```

In [5]:
```
digits.feature_names
```

Out[5]:
```
['pixel_0_0',
 'pixel_0_1',
 'pixel_0_2',
 'pixel_0_3',
 'pixel_0_4',
 'pixel_0_5',
 'pixel_0_6',
 'pixel_0_7',
 'pixel_1_0',
 'pixel_1_1',
 'pixel_1_2',
 'pixel_1_3',
 'pixel_1_4',
 'pixel_1_5',
 'pixel_1_6',
 'pixel_1_7',
 'pixel_2_0',
 'pixel_2_1',
 'pixel_2_2',
 'pixel_2_3',
 'pixel_2_4',
 'pixel_2_5',
 'pixel_2_6',
 'pixel_2_7',
 'pixel_3_0',
 'pixel_3_1',
 'pixel_3_2',
 'pixel_3_3',
 'pixel_3_4',
 'pixel_3_5',
 'pixel_3_6',
 'pixel_3_7',
 'pixel_4_0',
 'pixel_4_1',
 'pixel_4_2',
 'pixel_4_3',
 'pixel_4_4',
 'pixel_4_5',
 'pixel_4_6',
 'pixel_4_7',
 'pixel_5_0',
 'pixel_5_1',
 'pixel_5_2',
 'pixel_5_3',
 'pixel_5_4',
 'pixel_5_5',
 'pixel_5_6',
 'pixel_5_7',
 'pixel_6_0',
 'pixel_6_1',
 'pixel_6_2',
 'pixel_6_3',
 'pixel_6_4',
 'pixel_6_5',
```

```
 'pixel_6_6',
 'pixel_6_7',
 'pixel_7_0',
 'pixel_7_1',
 'pixel_7_2',
 'pixel_7_3',
 'pixel_7_4',
 'pixel_7_5',
 'pixel_7_6',
 'pixel_7_7']
```

In [6]:
```
digits.target_names
```

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

In [7]:
```
digits.target
```

Out[7]:
```
array([0, 1, 2, ..., 8, 9, 8])
```

In [9]:
```
df=pd.DataFrame(digits.data,digits.target)
df.head()
```

Out[9]:

	0	1	2	3	4	5	6	7	8	9	...	54	55	56	57	58	59	60	61	6
0	0.0	0.0	5.0	13.0	9.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	6.0	13.0	10.0	0.0	0
1	0.0	0.0	0.0	12.0	13.0	5.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	11.0	16.0	10.0	0
2	0.0	0.0	0.0	4.0	15.0	12.0	0.0	0.0	0.0	0.0	...	5.0	0.0	0.0	0.0	0.0	3.0	11.0	16.0	9
3	0.0	0.0	7.0	15.0	13.0	1.0	0.0	0.0	0.0	8.0	...	9.0	0.0	0.0	0.0	7.0	13.0	13.0	9.0	0
4	0.0	0.0	0.0	1.0	11.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	2.0	16.0	4.0	0

5 rows × 64 columns

In [10]:
```
df['target']=digits.target
df.head(15)
```

Out[10]:

	0	1	2	3	4	5	6	7	8	9	...	55	56	57	58	59	60	61	6
0	0.0	0.0	5.0	13.0	9.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	6.0	13.0	10.0	0.0	0.
1	0.0	0.0	0.0	12.0	13.0	5.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	11.0	16.0	10.0	0.
2	0.0	0.0	0.0	4.0	15.0	12.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	3.0	11.0	16.0	9.
3	0.0	0.0	7.0	15.0	13.0	1.0	0.0	0.0	0.0	8.0	...	0.0	0.0	0.0	7.0	13.0	13.0	9.0	0.
4	0.0	0.0	0.0	1.0	11.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	2.0	16.0	4.0	0.
5	0.0	0.0	12.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	9.0	16.0	16.0	10.0	0.
6	0.0	0.0	0.0	12.0	13.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	1.0	9.0	15.0	11.0	3.
7	0.0	0.0	7.0	8.0	13.0	16.0	15.0	1.0	0.0	0.0	...	0.0	0.0	0.0	13.0	5.0	0.0	0.0	0.
8	0.0	0.0	9.0	14.0	8.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	11.0	16.0	15.0	11.0	1.
9	0.0	0.0	11.0	12.0	0.0	0.0	0.0	0.0	0.0	2.0	...	0.0	0.0	0.0	9.0	12.0	13.0	3.0	0.
0	0.0	0.0	1.0	9.0	15.0	11.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	1.0	10.0	13.0	3.0	0.
1	0.0	0.0	0.0	0.0	14.0	13.0	1.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	1.0	13.0	16.0	1.
2	0.0	0.0	5.0	12.0	1.0	0.0	0.0	0.0	0.0	0.0	...	2.0	0.0	0.0	3.0	11.0	8.0	13.0	12.
3	0.0	2.0	9.0	15.0	14.0	9.0	3.0	0.0	0.0	4.0	...	0.0	0.0	2.0	12.0	12.0	13.0	11.0	0.
4	0.0	0.0	0.0	8.0	15.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	10.0	15.0	4.0	0.

15 rows × 65 columns

In [11]:
```
df.describe()
```

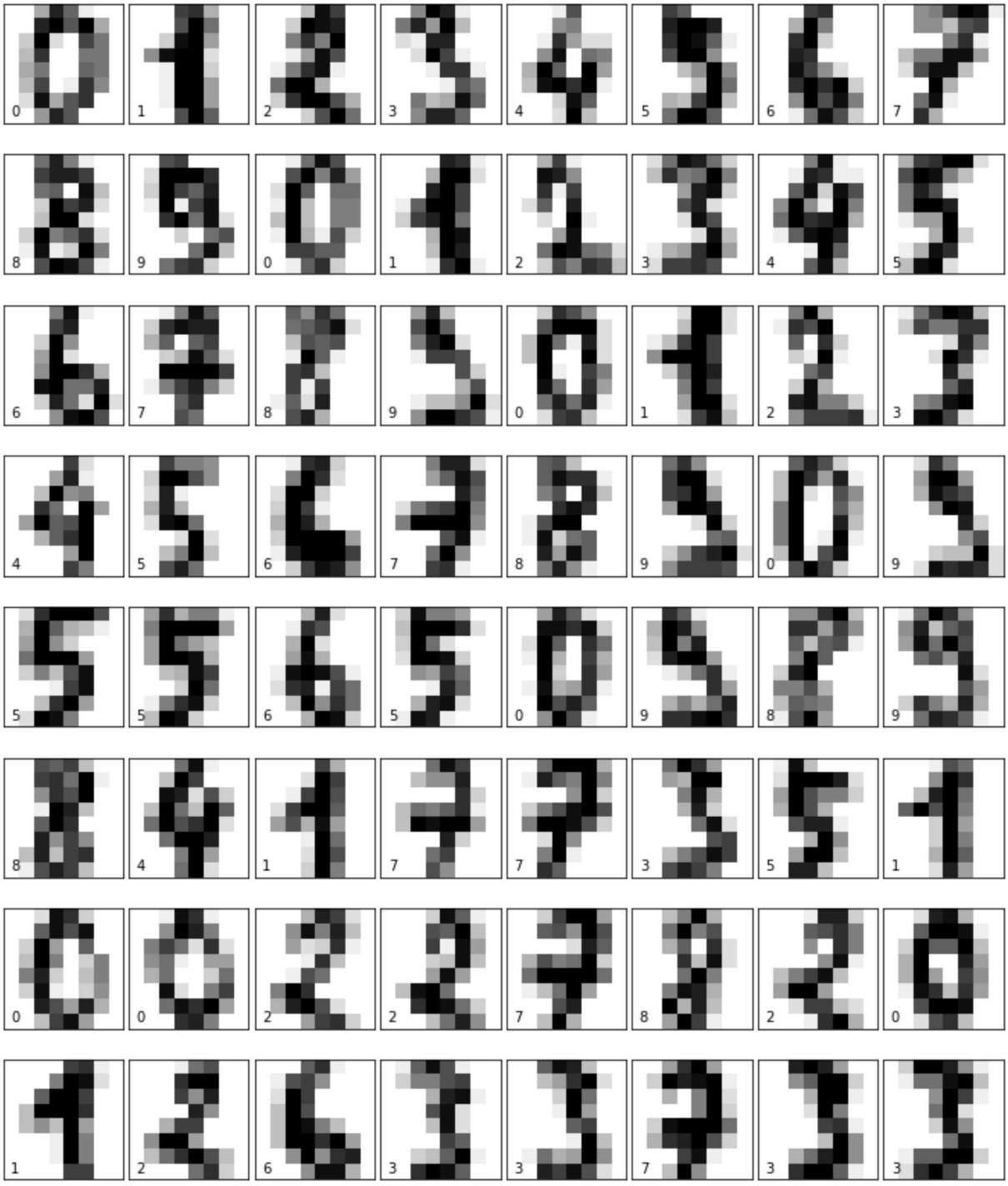
Out[11]:

	0	1	2	3	4	5	6	
count	1797.0	1797.000000	1797.000000	1797.000000	1797.000000	1797.000000	1797.000000	179
mean	0.0	0.303840	5.204786	11.835838	11.848080	5.781859	1.362270	
std	0.0	0.907192	4.754826	4.248842	4.287388	5.666418	3.325775	
min	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	0.0	0.000000	1.000000	10.000000	10.000000	0.000000	0.000000	
50%	0.0	0.000000	4.000000	13.000000	13.000000	4.000000	0.000000	
75%	0.0	0.000000	9.000000	15.000000	15.000000	11.000000	0.000000	
max	0.0	8.000000	16.000000	16.000000	16.000000	16.000000	16.000000	1

8 rows × 65 columns

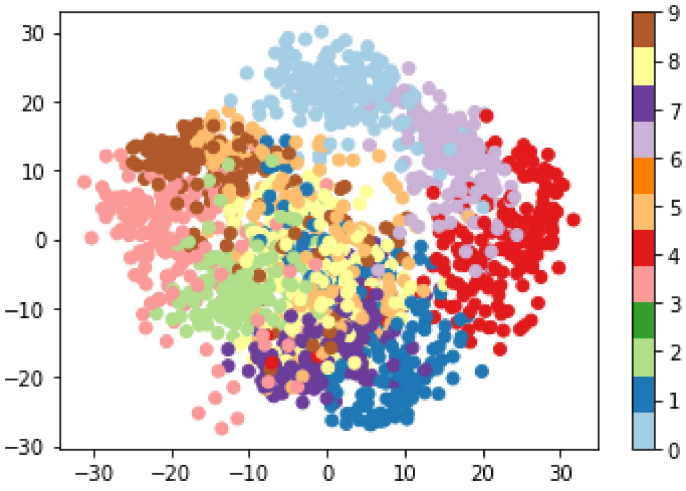
DATA VISUALIZATION

In [12]:
```
from matplotlib import pyplot as plt
fig = plt.figure(figsize=(10, 12))  # figure size in inches
fig.subplots_adjust(left=0, right=1, bottom=0, top=1, hspace=0.05, wspace=0.05)

for i in range(64):
    ax = fig.add_subplot(8, 8, i + 1, xticks=[], yticks=[])
    ax.imshow(digits.images[i], cmap=plt.cm.binary, interpolation='nearest')
    # label the image with the target value
    ax.text(0, 7, str(digits.target[i]))
```



In [14]:
```
plt.figure()

from sklearn.decomposition import PCA
pca = PCA(n_components=2)
proj = pca.fit_transform(digits.data)
plt.scatter(proj[:, 0], proj[:, 1], c=digits.target, cmap="Paired")
plt.colorbar()
```

Out[14]:
```
<matplotlib.colorbar.Colorbar at 0x2527ab4e910>
```



In [15]:
```
sns.set(rc={'figure.figsize':(20,20)})
correlation_matrix = df.corr().round(1)
sns.heatmap(data=correlation_matrix, annot=True,cmap='Pastel1')
```

Out[15]: <AxesSubplot:>

DATA PREPROCESSING

In [16]:
```
df.isna().sum()
```

Out[16]:
```
0         0
1         0
2         0
3         0
4         0
         ..
60        0
61        0
62        0
63        0
target    0
Length: 65, dtype: int64
```

In [21]:
```
import missingno as msno
msno.bar(df,color="pink")
plt.show()
```

MODELING WITH SVM

In [23]:
```
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split
```

In [24]:
```
X=df.drop('target',axis='columns')
y=df.target
```

In [25]:
```
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_stat
```

RBF KERNEL

In [26]:
```
rbf_model = SVC(kernel='rbf',gamma=0.002,probability=True)
rbf_model.fit(X_train,y_train)
```

Out[26]:
```
SVC(gamma=0.002, probability=True)
```

In [28]:
```
rbf_model.score(X_test,y_test)
```

Out[28]:
```
0.9861111111111112
```

In [29]:
```
y_pred=rbf_model.predict(X_test)
```

In [33]:
```
import scikitplot as skplt
from sklearn.metrics import confusion_matrix, classification_report,accuracy_scor
from sklearn.metrics import recall_score, precision_score, f1_score
from sklearn.pipeline import Pipeline

print(accuracy_score(y_test, y_pred))
```

```
0.9861111111111112
```

In [34]:
```
print(recall_score(y_test, y_pred,average=None))
```

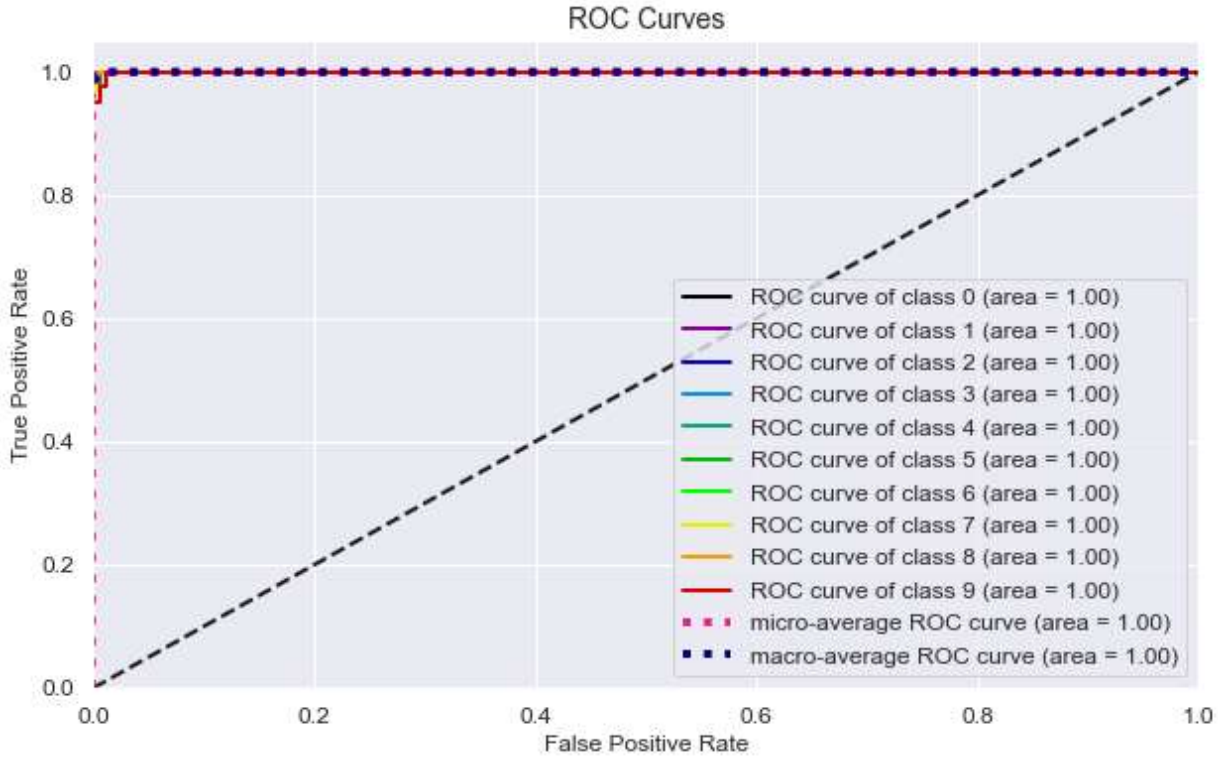
```
[1.         1.         1.         0.97058824 1.         0.9787234
 1.         0.97058824 1.         0.95       ]
```

In [35]:
```
print(precision_score(y_test, y_pred,average=None))
```

```
[1.         1.         1.         1.         1.         0.95833333
 0.97222222 0.97058824 1.         0.97435897]
```

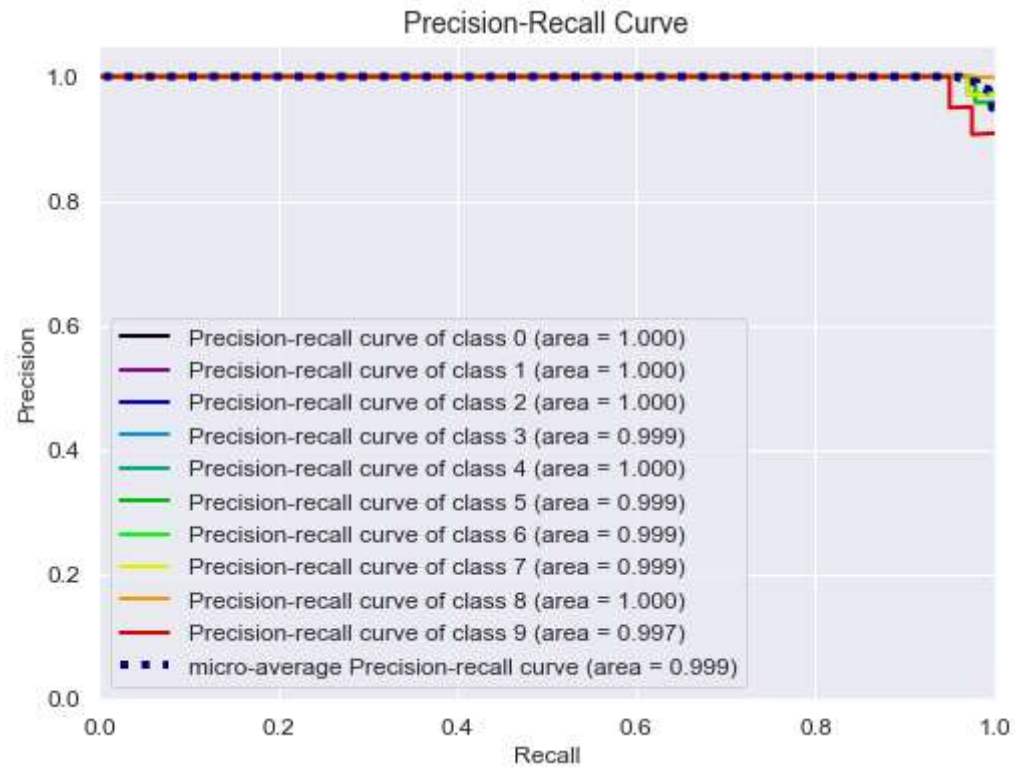
ROC CURVE

In [36]:
```
y_probas = rbf_model.predict_proba(X_test)
skplt.metrics.plot_roc(y_test,y_probas,figsize=(10,6),title_fontsize=14,text_font
plt.show()
```



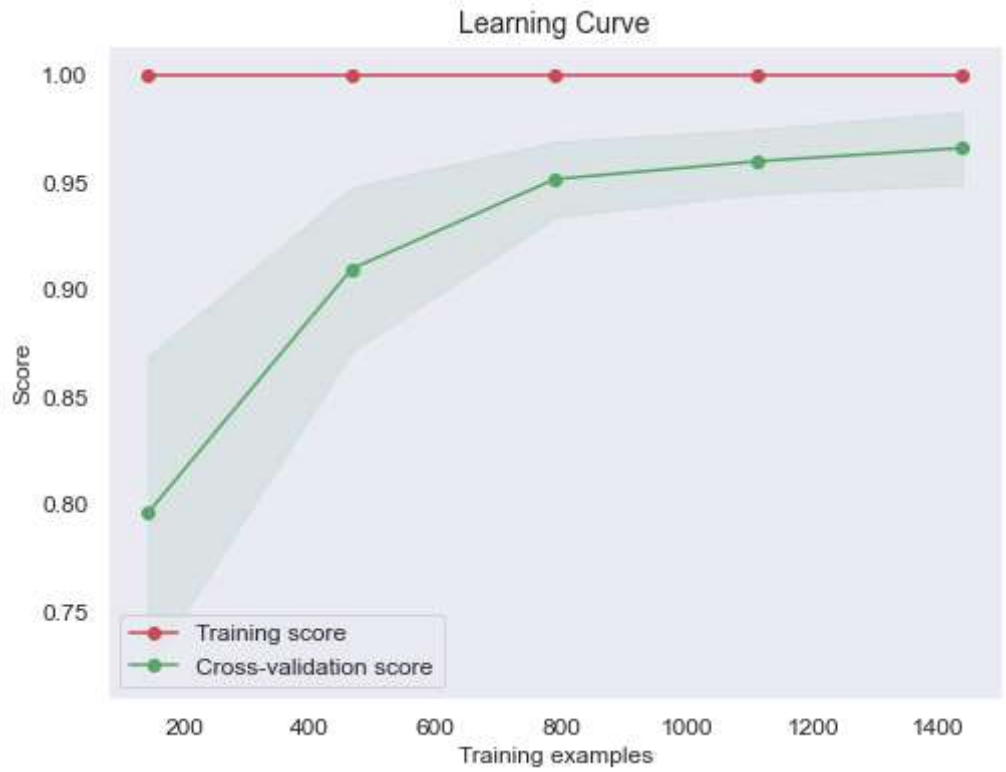
PRECISION RECALL CURVE

In [37]:
```
skplt.metrics.plot_precision_recall(y_test,y_probas,figsize=(8,6),title_fontsize=
plt.show()
```



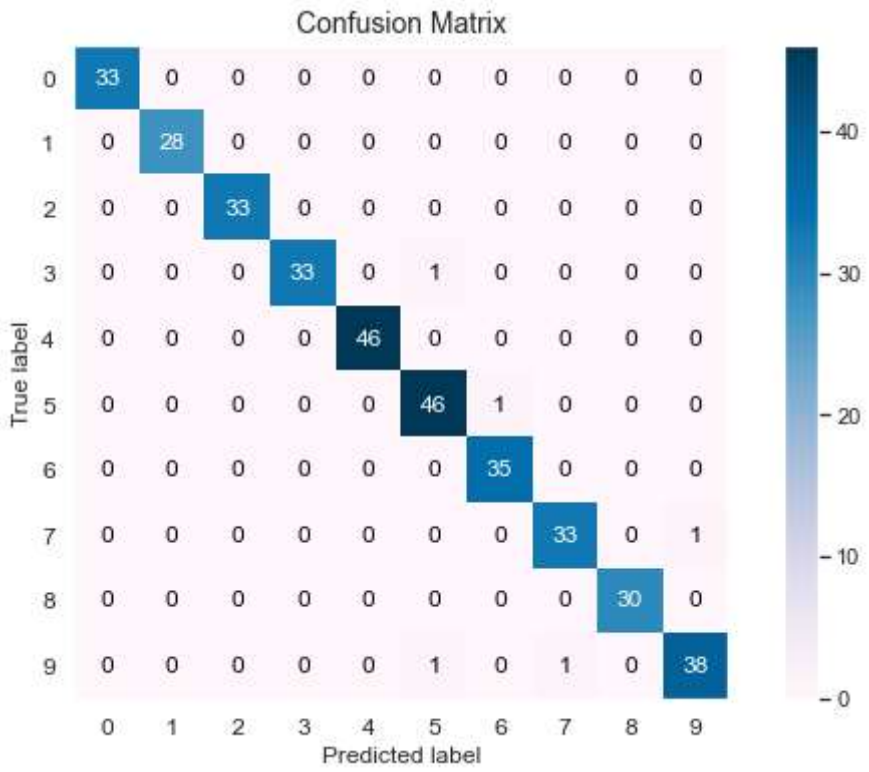
LEARNING CURVE

In [38]:
```
skplt.estimators.plot_learning_curve(rbf_model, X,y,figsize=(8,6),title_fontsize=
plt.show()
```



CONFUSION MATRIX

In [39]:
```
skplt.metrics.plot_confusion_matrix(y_test,y_pred,figsize=(10,6),title_fontsize=1
plt.show()
```



LINEAR KERNEL

In [52]:
```
linear_model = SVC(kernel='linear',C=0.001,probability=True)
linear_model.fit(X_train,y_train)
```

Out[52]:
```
SVC(C=0.001, kernel='linear', probability=True)
```

In [53]:
```
linear_model.score(X_test,y_test)
```

Out[53]:
```
0.9805555555555555
```

In [55]:
```
y_pred=linear_model.predict(X_test)
```

In [56]:
```
import scikitplot as skplt
from sklearn.metrics import confusion_matrix, classification_report,accuracy_scor
from sklearn.metrics import recall_score, precision_score, f1_score
from sklearn.pipeline import Pipeline

print(accuracy_score(y_test, y_pred))
```

```
0.9805555555555555
```

In [57]:
```
print(recall_score(y_test, y_pred,average=None))
```

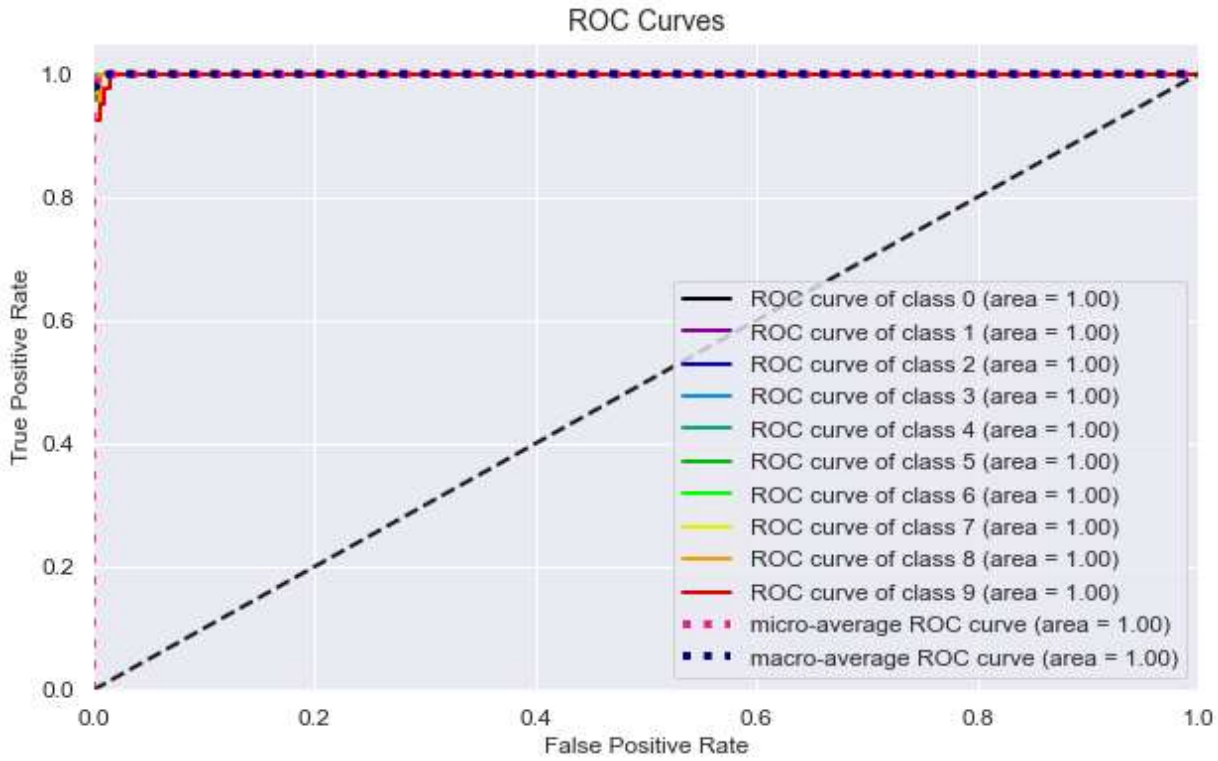
```
[1.         1.         1.         1.         1.         0.9787234
 0.97142857 0.97058824 0.93333333 0.95      ]
```

In [58]:
```
print(precision_score(y_test, y_pred,average=None))
```

```
[0.97058824 1.         1.         1.         1.         0.9787234
 0.97142857 1.         0.93333333 0.95      ]
```

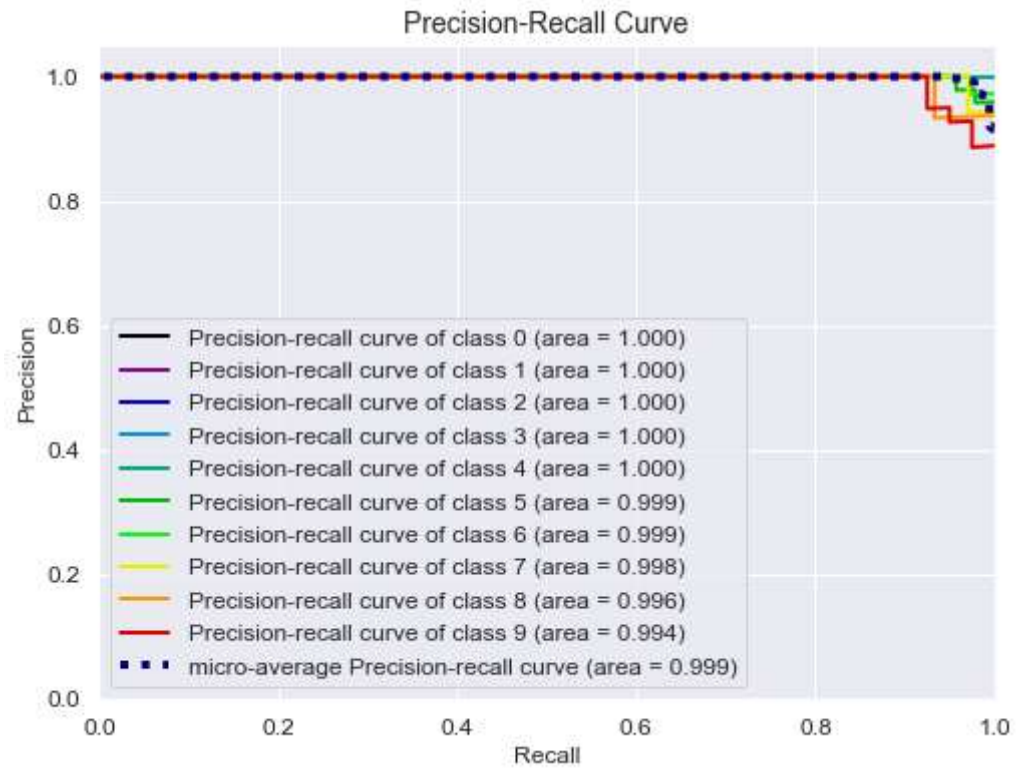
ROC CURVE

In [59]:
```
y_probas = linear_model.predict_proba(X_test)
skplt.metrics.plot_roc(y_test,y_probas,figsize=(10,6),title_fontsize=14,text_font
plt.show()
```



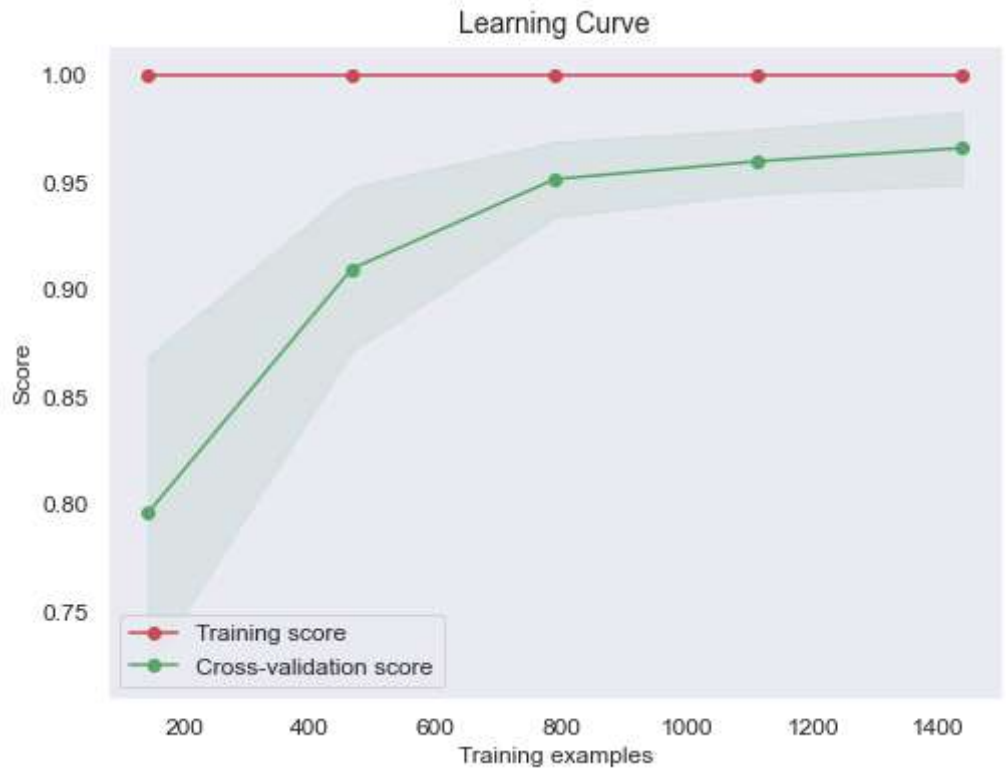
PRECISION RECALL CURVE

In [60]:
```
skplt.metrics.plot_precision_recall(y_test,y_probas,figsize=(8,6),title_fontsize=
plt.show()
```



LEARNING CURVE

In [61]:
```
skplt.estimators.plot_learning_curve(rbf_model, X,y,figsize=(8,6),title_fontsize=
plt.show()
```



CONFUSION MATRIX

In [62]:
```
skplt.metrics.plot_confusion_matrix(y_test,y_pred,figsize=(10,6),title_fontsize=1
plt.show()
```