# Week7_4_SVM_mnist1

May 21, 2021

Support Vector Machine (SVM)

Importing libraries

[1]:
```python
import sys
import numpy as np
import pandas as pd
import pickle
from sklearn import model_selection, svm, preprocessing
from sklearn.metrics import accuracy_score,confusion_matrix
import matplotlib.pyplot as plt
from matplotlib import style
style.use('ggplot')
import seaborn as sns
from collections import Counter

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

Load train and test data

[2]:
```python
train = pd.read_csv("~/Desktop/Analysis/Work/ML_EIT/Data/MNIST_train.csv")
test = pd.read_csv("~/Desktop/Analysis/Work/ML_EIT/Data/MNIST_test.csv")
```

[3]:
```python
test
```

[3]:
```
      Unnamed: 0  index  labels  0  1  2  3  4  5  6  …  774  775  776  777  \
0              0      0       7  0  0  0  0  0  0  0  …    0    0    0    0
1              1      1       2  0  0  0  0  0  0  0  …    0    0    0    0
2              2      2       1  0  0  0  0  0  0  0  …    0    0    0    0
3              3      3       0  0  0  0  0  0  0  0  …    0    0    0    0
4              4      4       4  0  0  0  0  0  0  0  …    0    0    0    0
…            …      …       …  .. .. .. .. .. .. ..  …    …    …    …    …
9995        9995   9995       2  0  0  0  0  0  0  0  …    0    0    0    0
9996        9996   9996       3  0  0  0  0  0  0  0  …    0    0    0    0
9997        9997   9997       4  0  0  0  0  0  0  0  …    0    0    0    0
9998        9998   9998       5  0  0  0  0  0  0  0  …    0    0    0    0
9999        9999   9999       6  0  0  0  0  0  0  0  …    0    0    0    0
```

```
      778  779  780  781  782  783
0       0    0    0    0    0    0
1       0    0    0    0    0    0
2       0    0    0    0    0    0
3       0    0    0    0    0    0
4       0    0    0    0    0    0
…    …   …   …   …   …   …
9995    0    0    0    0    0    0
9996    0    0    0    0    0    0
9997    0    0    0    0    0    0
9998    0    0    0    0    0    0
9999    0    0    0    0    0    0

[10000 rows x 787 columns]
```

Train and Test data shape

[4]:

```
print(train.shape,test.shape)
```

```
(60000, 787) (10000, 787)
```

[5]:

```
print(train.labels,test['labels'])
```

```
0        5
1        0
2        4
3        1
4        9
        ..
59995    8
59996    3
59997    5
59998    6
59999    8
Name: labels, Length: 60000, dtype: int64 0       7
1       2
2       1
3       0
4       4
       ..
9995    2
9996    3
9997    4
9998    5
9999    6
Name: labels, Length: 10000, dtype: int64
```

Train and Test data shape

[6]:

```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 60000 entries, 0 to 59999
Columns: 787 entries, Unnamed: 0 to 783
dtypes: int64(787)
memory usage: 360.3 MB
```

Each labels count

[7]:

```
test_cnt = Counter(test.labels)
train_cnt = Counter(train['labels'])
print(test_cnt)
print(train_cnt)
```

```
Counter({1: 1135, 2: 1032, 7: 1028, 3: 1010, 9: 1009, 4: 982, 0: 980, 8: 974, 6:
958, 5: 892})
Counter({1: 6742, 7: 6265, 3: 6131, 2: 5958, 9: 5949, 0: 5923, 6: 5918, 8: 5851,
4: 5842, 5: 5421})
```

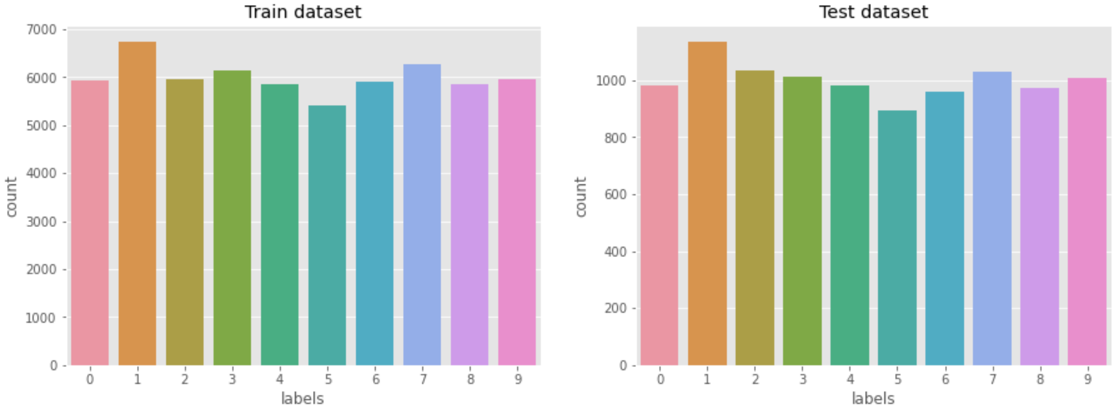
Visualization

[8]:

```
f, axes = plt.subplots(ncols=2, figsize=(15, 5))

sns.countplot(train.labels,ax=axes[0])
axes[0].set_title('Train dataset')

sns.countplot(test.labels,ax=axes[1])
axes[1].set_title('Test dataset')
```

[8]:

```
Text(0.5, 1.0, 'Test dataset')
```



Each label count

[9]:

```
lbls = train['labels'].unique()
cnts = train['labels'].value_counts()
lbls,cnts
```

[9]:

```
(array([5, 0, 4, 1, 9, 2, 3, 6, 7, 8]),
 1    6742
 7    6265
 3    6131
 2    5958
 9    5949
 0    5923
 6    5918
 8    5851
 4    5842
 5    5421
 Name: labels, dtype: int64)
```

[10]:

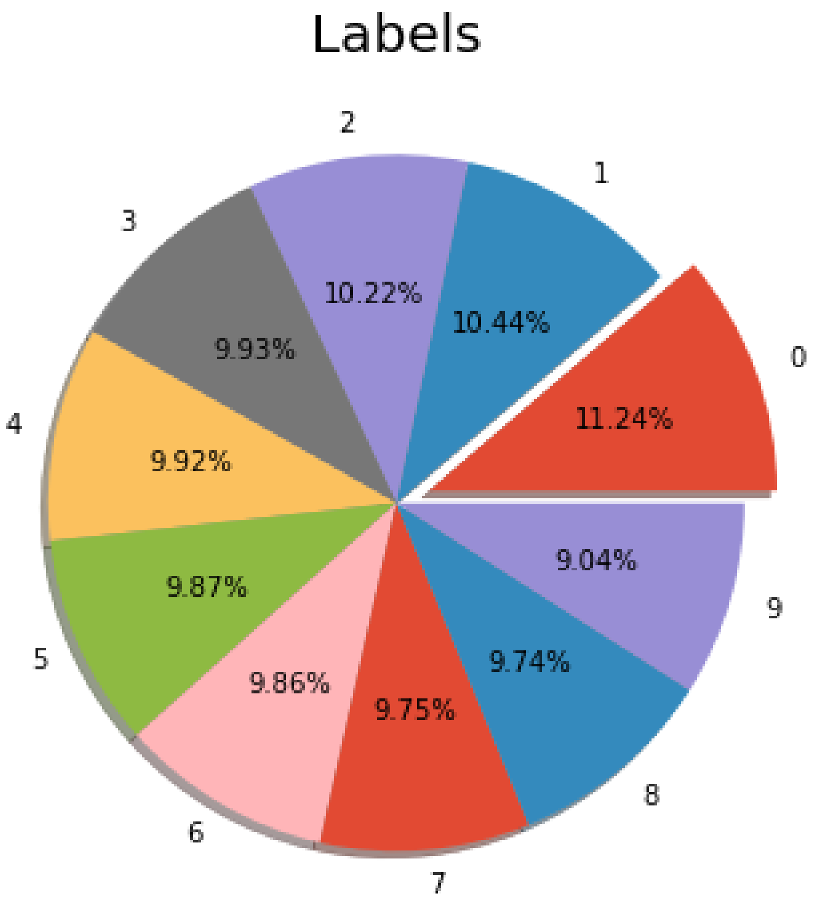
```
lbls
```

[10]:

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

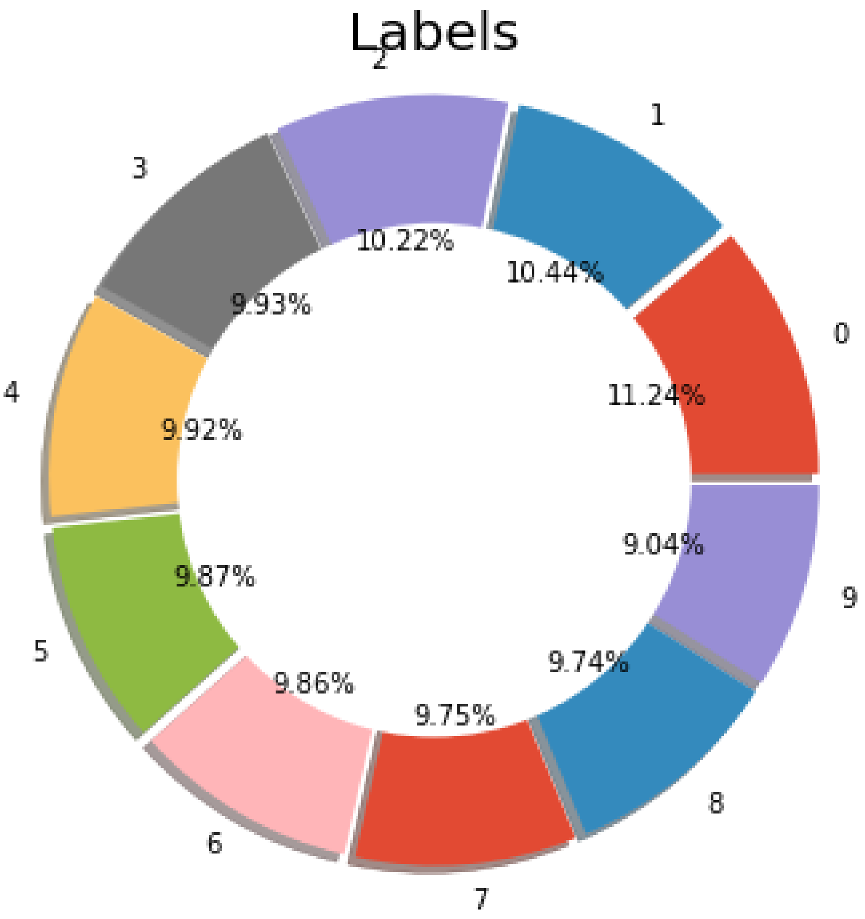
[11]:

```
labls = ['0', '1','2','3','4','5','6','7','8','9']
size = train['labels'].value_counts()
explode = [0.1,0,0,0,0,0,0,0,0,0]

plt.rcParams['figure.figsize'] = (6, 6)
plt.pie(size, explode = explode, labels = labls, shadow = True, autopct = '%.
 ↪2f%%')
plt.title('Labels', fontsize = 20)
plt.axis('off')
# plt.legend()
plt.show()
```



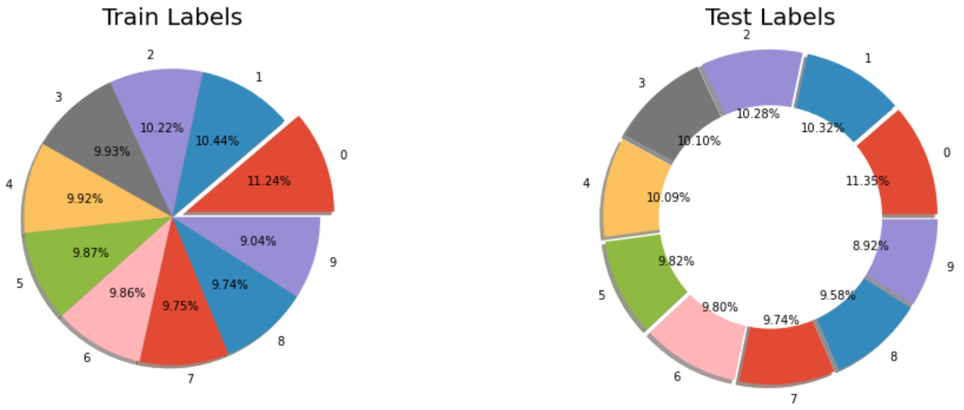
[12]:

```
labls = ['0', '1','2','3','4','5','6','7','8','9']
size = train['labels'].value_counts()
explode = [0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05]

plt.rcParams['figure.figsize'] = (5, 5)
plt.pie(size, explode = explode, labels = labls, shadow = True, autopct = '%.
 ↪2f%%')
#        startangle=90, pctdistance=0.85)
plt.title('Labels', fontsize = 20)
#draw circle
centre_circle = plt.Circle((0,0),0.70,fc='white')
fig=plt.gcf()
fig.gca().add_artist(centre_circle)

#equal aspect ratio ensures that pie is drawn as a circle
plt.axis('equal')
plt.tight_layout()
plt.show()
```



[13]:
```
f, (ax1,ax2) = plt.subplots(ncols=2, figsize=(15, 5))

#first plot
labls = ['0', '1','2','3','4','5','6','7','8','9']
size = train['labels'].value_counts()
explode = [0.1,0,0,0,0,0,0,0,0,0]

ax1.pie(size, explode = explode, labels = labls, shadow = True, autopct = '%.
 ↪2f%%')
ax1.set_title('Train Labels', fontsize = 20)
plt.axis('off')

#second plot
labls = ['0', '1','2','3','4','5','6','7','8','9']
size1 = test['labels'].value_counts()
explode1 = [0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05,0.05]
```

```
ax2.pie(size1, explode = explode1, labels = labls, shadow = True, autopct = '%.
 ↪2f%%')
ax2.set_title('Test Labels', fontsize = 20)
#draw circle
centre_circle = plt.Circle((0,0),0.70,fc='white')
fig=plt.gcf()
fig.gca().add_artist(centre_circle)

#equal aspect ratio ensures that pie is drawn as a circle
plt.axis('equal')
plt.tight_layout()
plt.show()
```



Change to numpy

```
[14]: # Change data set to numpy
test= test.to_numpy()
train = train.to_numpy()
print(train.shape,test.shape)
```

```
(60000, 787) (10000, 787)
```

Support Vector Machine (SVM)

```
[15]: Xtrain_imgs = np.asfarray(train[:,3:]) *(1/255)
Ytrain_labls = np.array(train[:,2])

test_imgs = np.asfarray(test[:,3:]) *(1/255)
test_lbls = np.asarray(test[:,2])
print(test_lbls[0:20])

# Prepare Classifier Training and Testing Data
# print('\nPreparing Classifier Training and Validation Data...')
X_train, X_test, y_train, y_test = model_selection.
 ↪train_test_split(Xtrain_imgs,Ytrain_labls,test_size=0.2)
```

```
[7 2 1 0 4 1 4 9 5 9 0 6 9 0 1 5 9 7 3 4]
```

```
[16]: ## Pickle the Classifier for Future Use
      ## Support Vector Machine (SVM)
```

```
[17]: clf = svm.SVC(gamma=0.1, kernel='poly')
      clf.fit(X_train,y_train)

      #Save the model using pickle
      # with open('MNIST_SVM.pickle','wb') as f:
      #         pickle.dump(clf, f)

      #load the model pickle file
      # pickle_in = open('MNIST_SVM.pickle','rb')
      # clf = pickle.load(pickle_in)
```

```
[17]: SVC(gamma=0.1, kernel='poly')
```

```
[18]: print('\nCalculating Accuracy of trained Classifier...')
      acc = clf.score(X_test,y_test)
      print("SVM test data Accuracy: %0.4f" %(acc))
```

```

Calculating Accuracy of trained Classifier…
SVM test data Accuracy: 0.9788
```

Support Vector Machine (SVM) Metric

```
[19]: from sklearn.model_selection import train_test_split
      from sklearn.metrics import confusion_matrix, accuracy_score
      from sklearn import metrics

      y_pred = clf.predict(X_test)
      # con_res = confusion_matrix(y_test,y_pred, labels=[0, 1])
      con_res = metrics.confusion_matrix(y_test,y_pred)

      print("Confusion matrix:")
      print(confusion_matrix(y_test,y_pred))
      print("Accuracy: {:.2f}%".format(accuracy_score(y_test, y_pred)*100))
```

```
Confusion matrix:
[[1139    0    2    2    0    1    3    0    0    1]
 [   0 1320    4    2    1    0    0    2    1    1]
 [   6    4 1163    3    2    3    1    5    5    1]
 [   2    0    7 1221    0    6    0    4    8    5]
 [   3    6    6    1 1149    0    1    4    0    4]
 [   2    1    1    7    2 1020    5    2    5    4]
 [   3    0    1    0    3    4 1152    0    3    0]
 [   3    3    6    0    4    1    0 1255    0    9]
 [   4    9    1   11    4    6    2    1 1132    4]
 [   2    2    0   10   12    2    0    4    4 1195]]
Accuracy: 97.88%
```

Predict test images

[20]:

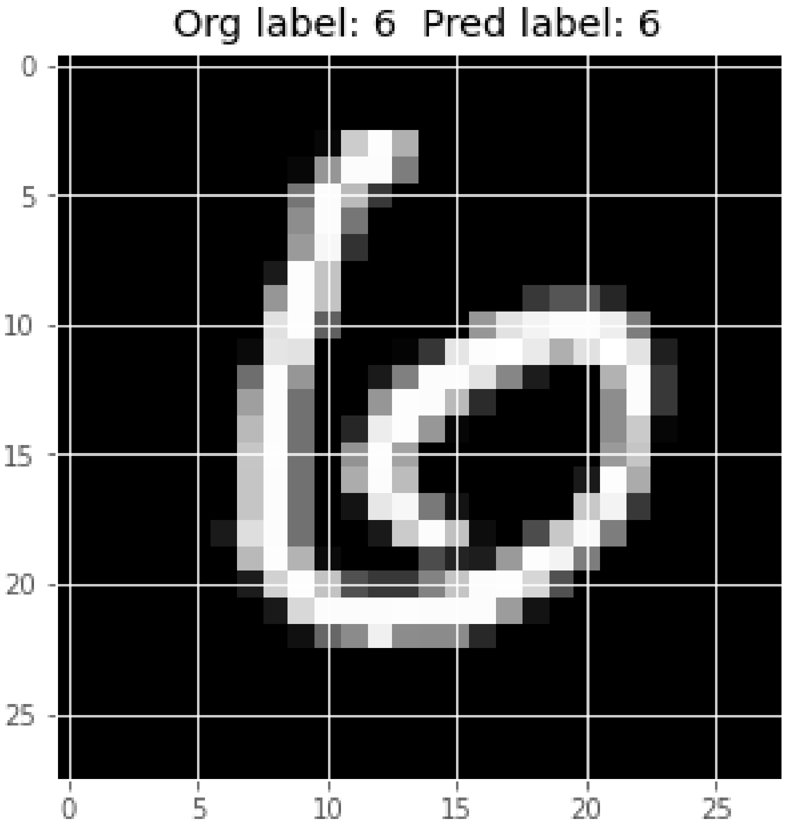
```
test_labels_pred = clf.predict(test_imgs)
confmat_test = metrics.confusion_matrix(test_lbls,test_labels_pred)

print("Confusion matrix:")
print(confusion_matrix(y_test,y_pred))
print("Accuracy: {:.2f}%".format(accuracy_score(test_lbls,␣
 ↪test_labels_pred)*100))
```

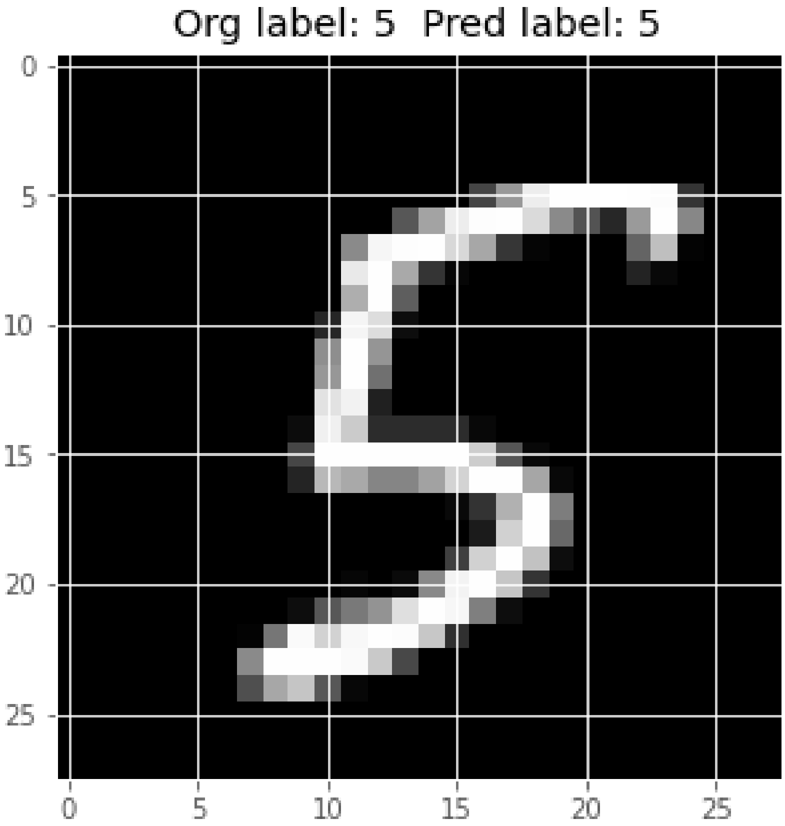
```
Confusion matrix:
[[1139    0    2    2    0    1    3    0    0    1]
 [   0 1320    4    2    1    0    0    2    1    1]
 [   6    4 1163    3    2    3    1    5    5    1]
 [   2    0    7 1221    0    6    0    4    8    5]
 [   3    6    6    1 1149    0    1    4    0    4]
 [   2    1    1    7    2 1020    5    2    5    4]
 [   3    0    1    0    3    4 1152    0    3    0]
 [   3    3    6    0    4    1    0 1255    0    9]
 [   4    9    1   11    4    6    2    1 1132    4]
 [   2    2    0   10   12    2    0    4    4 1195]]
Accuracy: 97.72%
```

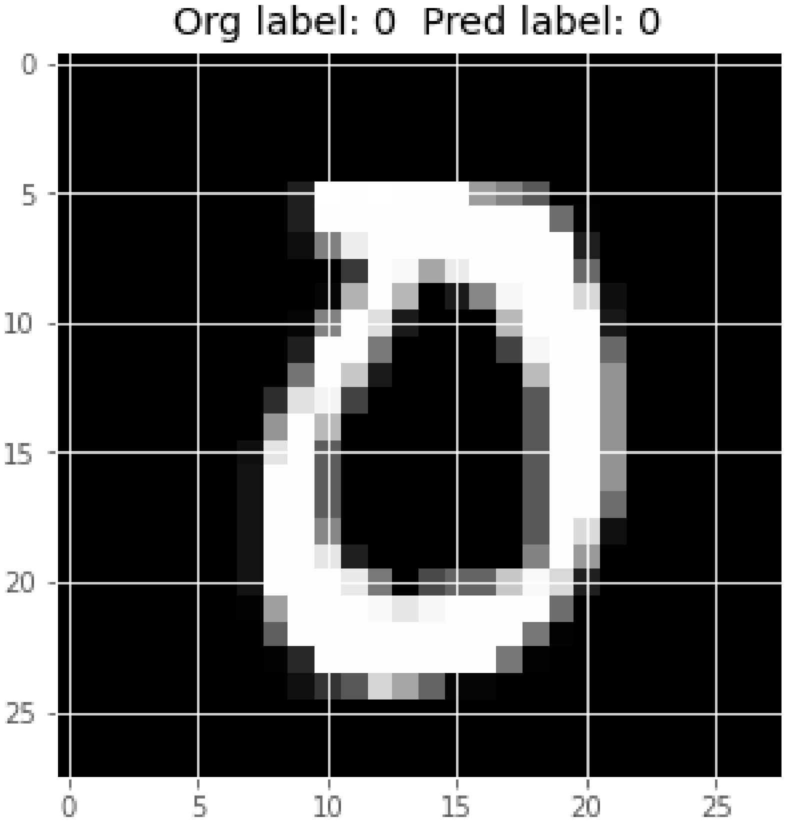
Show the test images with original and predected labels

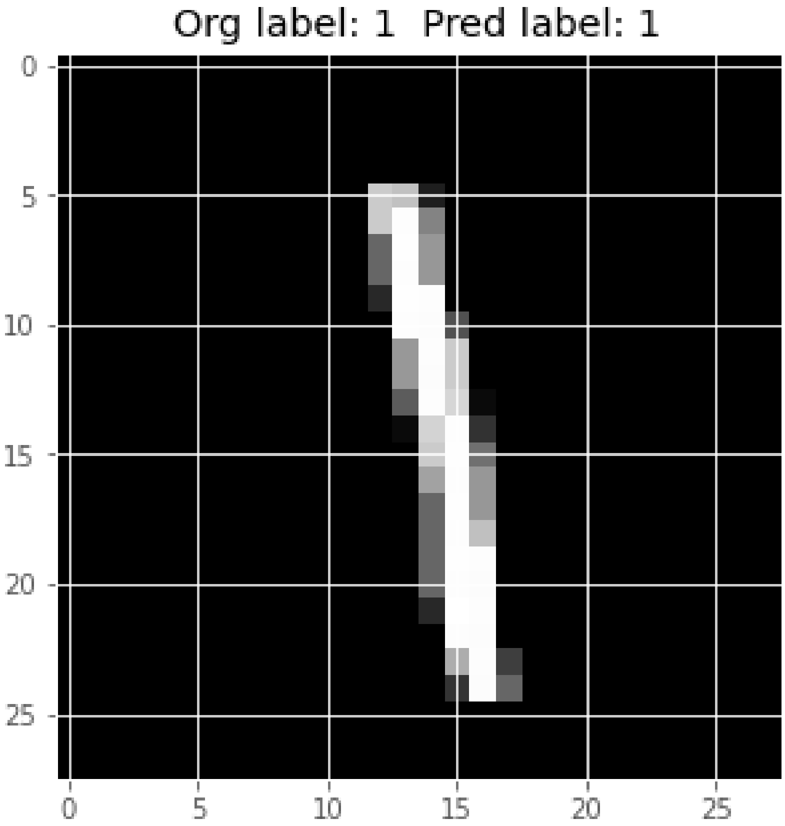
[21]:

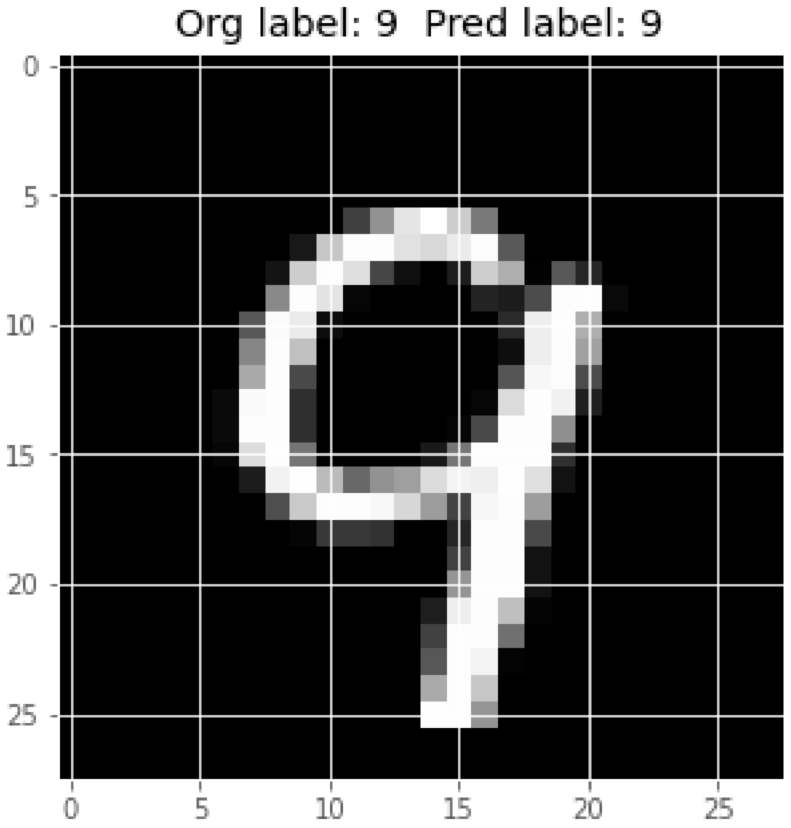
```
# Show the test images with original and predected labels

#pick the random values
nr = np.random.randint(1,40,15)

for i in nr:
    twod = (np.reshape(test_imgs[i], (28, 28))*255).astype(np.uint8)
    plt.title('Org label: {0}  Pred label: {1}'.
 ↪format(test_lbls[i],test_labels_pred[i]))
    plt.imshow(twod, interpolation ='nearest', cmap='gray')
    plt.show()
```


Org label: 6  Pred label: 6
0
5
10
15
20
25
0
5
10
15
20
25

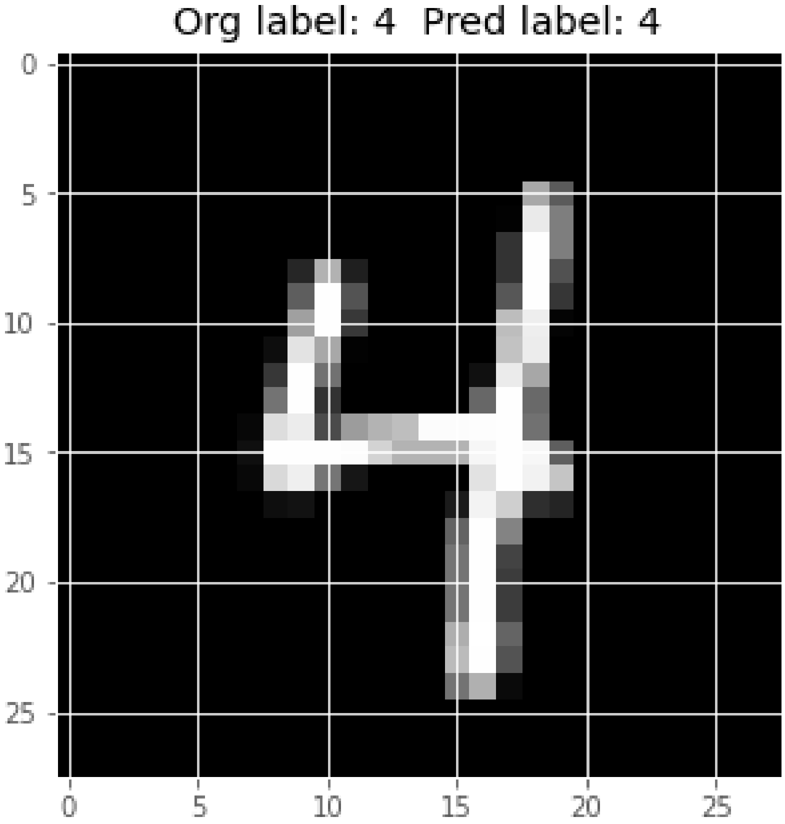

Org label: 5  Pred label: 5
0
5
10
15
20
25
0
5
10
15
20
25

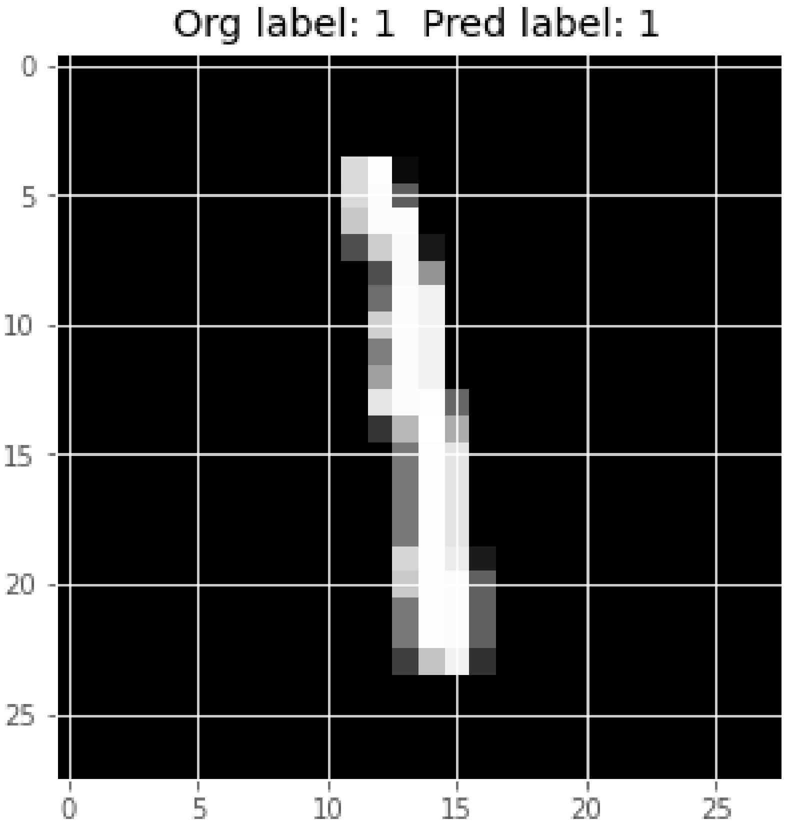

Org label: 0  Pred label: 0
0
5
10
15
20
25
0
5
10
15
20
25

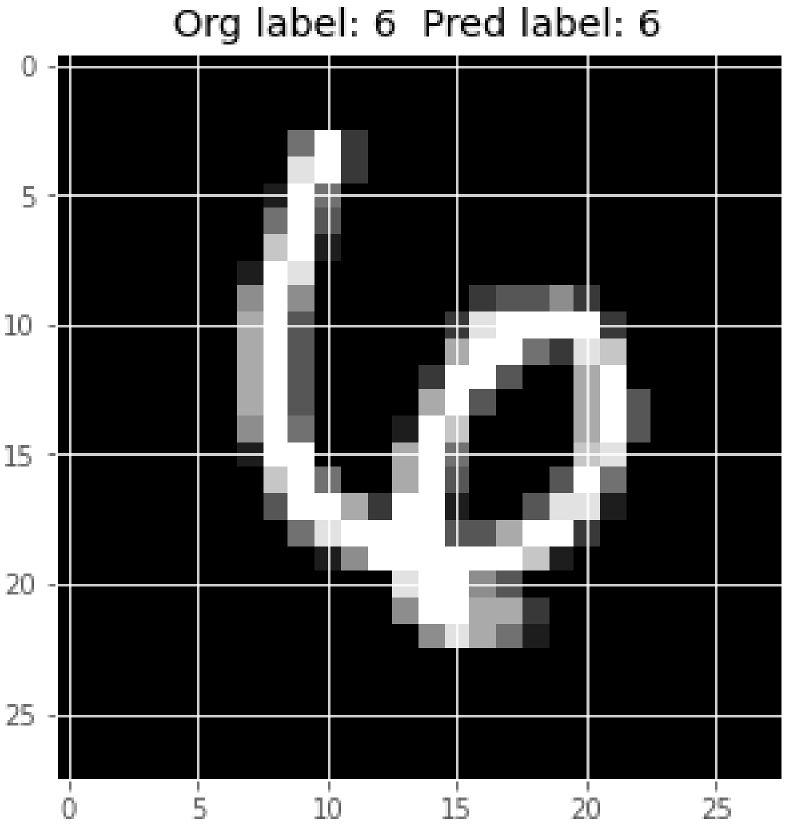

Org label: 1  Pred label: 1
0
5
10
15
20
25
0
5
10
15
20
25

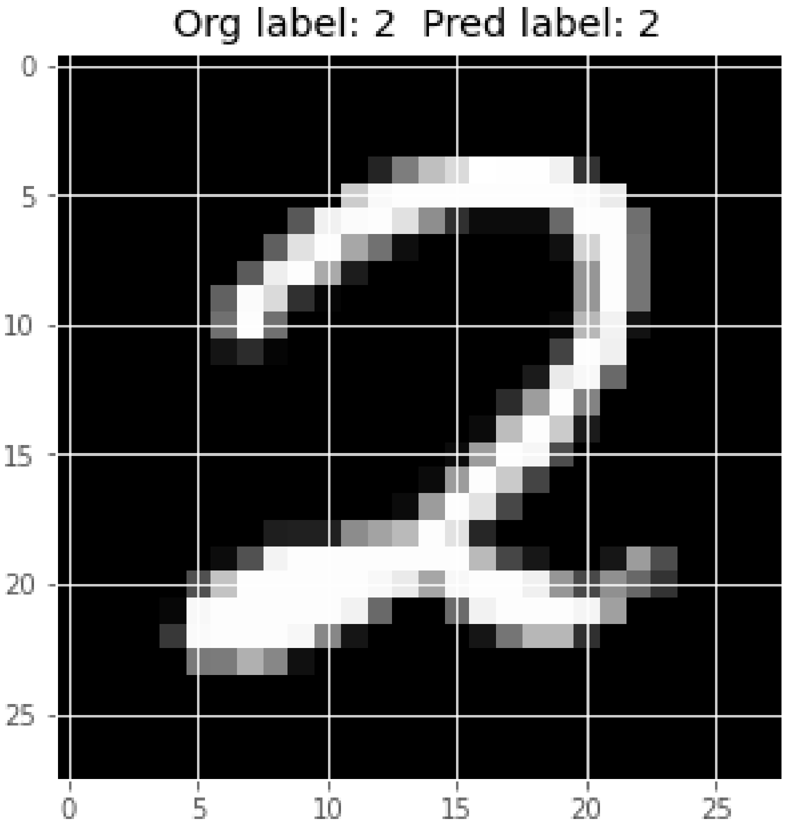


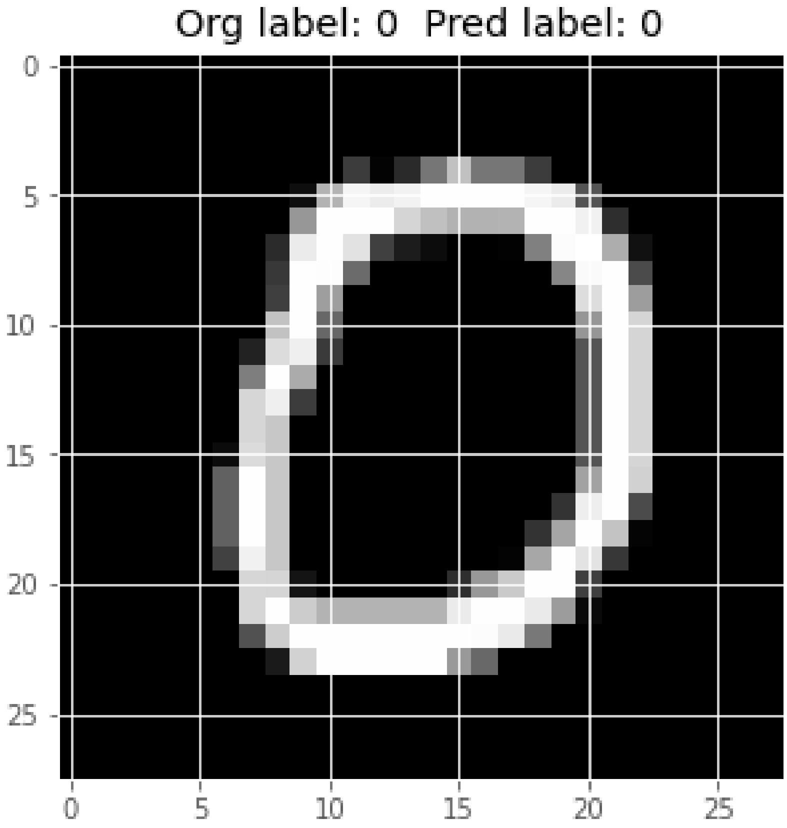
Org label: 9  Pred label: 9

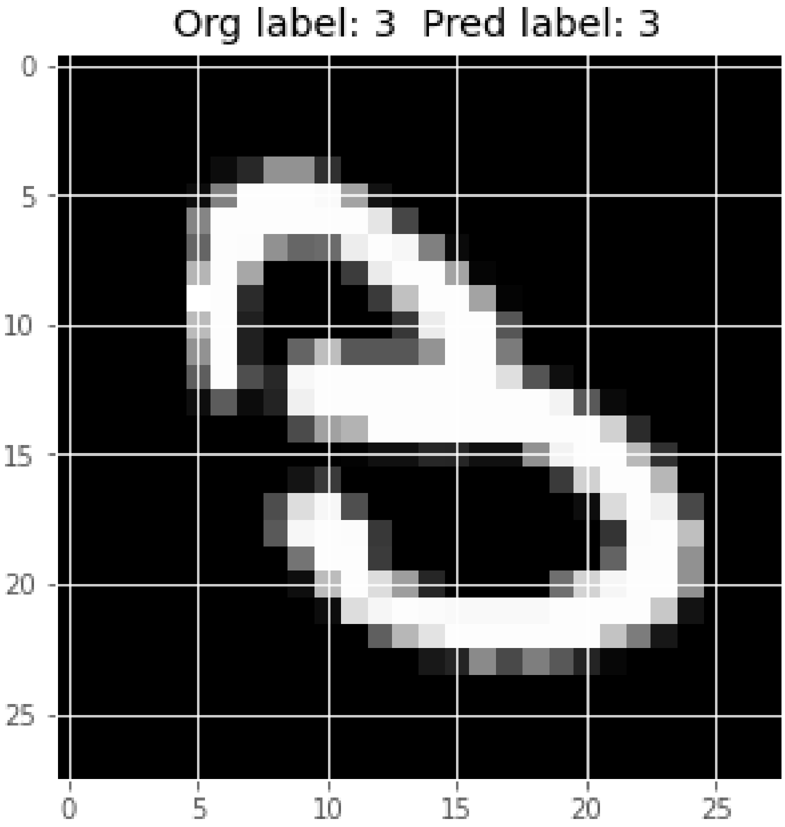

Org label: 4  Pred label: 4
0
5
10
15
20
25
0
5
10
15
20
25

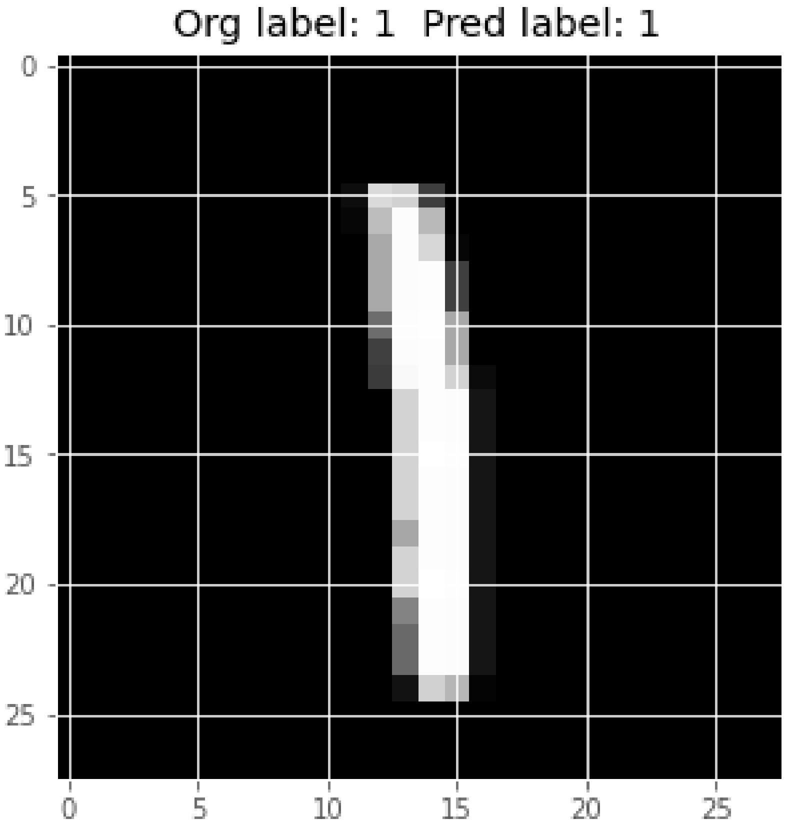

Org label: 1  Pred label: 1
0
5
10
15
20
25
0
5
10
15
20
25

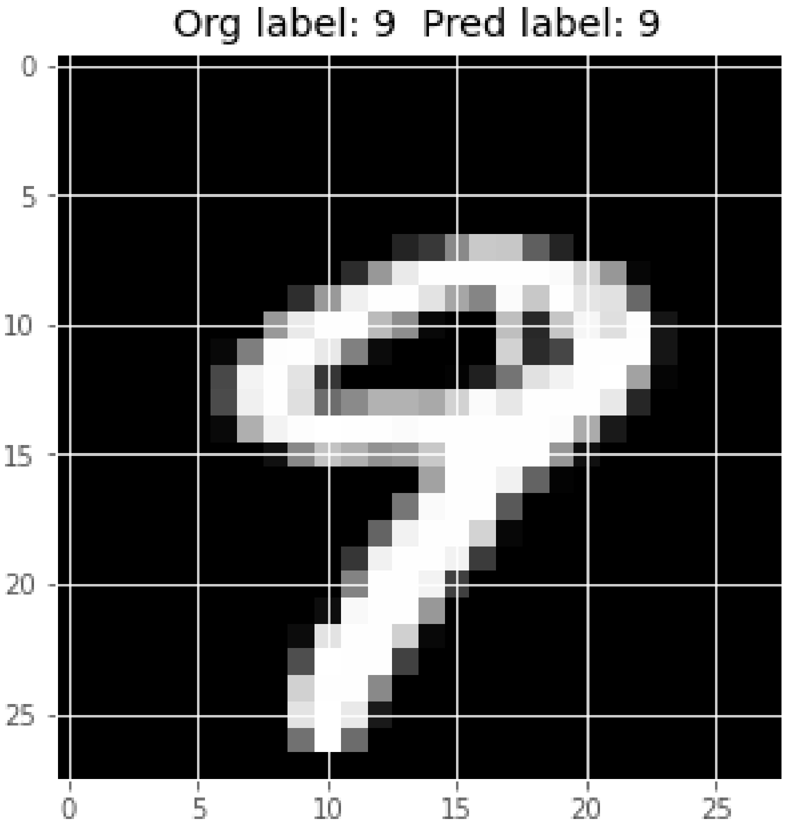

Org label: 6  Pred label: 6
0
5
10
15
20
25
0
5
10
15
20
25

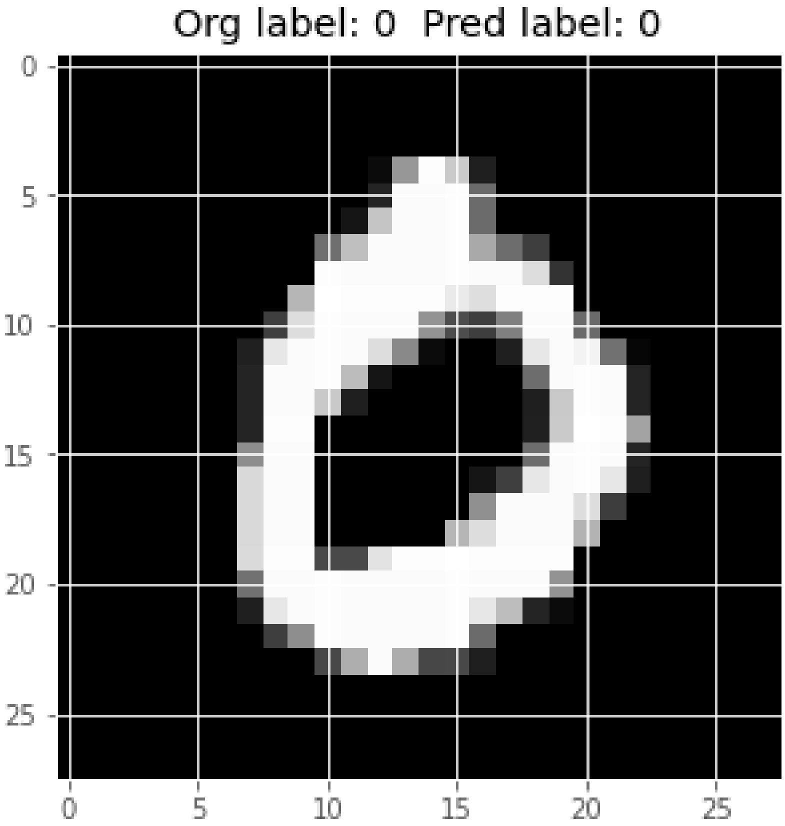

Org label: 2  Pred label: 2
0
5
10
15
20
25
0
5
10
15
20
25

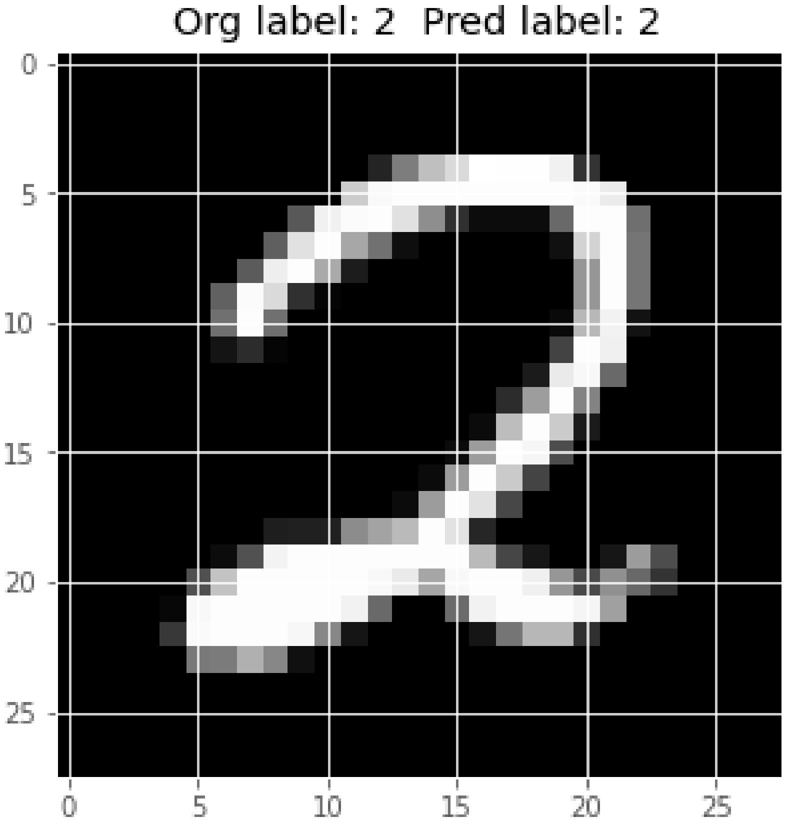

Org label: 0  Pred label: 0
0
5
10
15
20
25
0
5
10
15
20
25


Org label: 3  Pred label: 3
0
5
10
15
20
25
0
5
10
15
20
25


Org label: 1  Pred label: 1
0
5
10
15
20
25
0
5
10
15
20
25


Org label: 9  Pred label: 9
0
5
10
15
20
25
0
5
10
15
20
25


Org label: 0  Pred label: 0
0
5
10
15
20
25
0
5
10
15
20
25


Org label: 2  Pred label: 2
0
5
10
15
20
25
0
5
10
15
20
25

```
[ ]:
```