SVM

May 8, 2020

[18]:
```
#Amul Neupane
#Machine Learning Fundamentals


import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import confusion_matrix
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
```

[19]:
```
# read the dataset
train_data = pd.read_csv("train 2.csv")
train_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 42000 entries, 0 to 41999
Columns: 785 entries, label to
pixel783
dtypes: int64(785)
memory usage: 251.5
MB
```

[20]:
```
# head
train_data.head()
```

[20]:

	label	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	…	pixel774	pixel775	pixel776	pixel777	pixel778	pixel779
0	1	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0
3	4	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0

```
4       0 … 0     0     0     0     0     0

   pixel780 pixel781 pixel782 pixel783
0         0  0     0     0
1         0  0     0     0
2         0  0     0     0
3         0  0     0     0
4         0  0     0     0

[5 rows x 785 columns]
```

[21]:
```
# read the dataset
test_data = pd.read_csv("test 2.csv")
test_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28000 entries, 0 to 27999
Columns: 784 entries, pixel0 to
pixel783
dtypes: int64(784)
memory usage: 167.5
MB
```

[22]:
```
# head
test_data.head()
```

[22]:
```
   pixel0 pixel1 pixel2 pixel3 pixel4 pixel5 pixel6 pixel7 pixel8 \
0       0    0     0     0     0     0     0     0     0
1       0    0     0     0     0     0     0     0     0
2       0    0     0     0     0     0     0     0     0
3       0    0     0     0     0     0     0     0     0
4       0    0     0     0     0     0     0     0     0

 pixel9 … pixel774 pixel775 pixel776 pixel777 pixel778 pixel779 \
0       0 … 0     0     0     0     0     0
1       0 … 0     0     0     0     0     0
2       0 … 0     0     0     0     0     0
3       0 … 0     0     0     0     0     0
4       0 … 0     0     0     0     0     0

   pixel780 pixel781 pixel782 pixel783
0         0  0     0     0
1         0  0     0     0
2         0  0     0     0
3         0  0     0     0
4         0  0     0     0
[5 rows x 784 columns]
```

[23]:
```
train_data.isnull().sum().head(10)
```

[23]:
```
label    0
pixel0   0
pixel1   0
pixel2   0
pixel3   0
pixel4   0
pixel5   0
pixel6   0
pixel7   0
pixel8   0
dtype: int64
```

[24]:
```
test_data.isnull().sum().head(10)
```

[24]:
```
pixel0   0
pixel1   0
pixel2   0
pixel3   0
pixel4   0
pixel5   0
pixel6   0
pixel7   0
pixel8   0
pixel9   0
dtype: int64
```

[25]:
```
test_data.describe()
```

[25]:

	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7
count	28000.0	28000.0	28000.0	28000.0	28000.0	28000.0	28000.0	28000.0
mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
std	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
max	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	pixel8	pixel9	…	pixel774	pixel775	pixel776
count	28000.0	28000.0	…	28000.000000	28000.000000	28000.000000
mean	0.0	0.0	…	0.164607	0.073214	0.028036
std	0.0	0.0	…	5.473293	3.616811	1.813602
min	0.0	0.0	…	0.000000	0.000000	0.000000
25%	0.0	0.0	…	0.000000	0.000000	0.000000
50%	0.0	0.0	…	0.000000	0.000000	0.000000
75%	0.0	0.0	…	0.000000	0.000000	0.000000

```
max       0.0     0.0 …   253.000000  254.000000  193.000000

          pixel777   pixel778 pixel779 pixel780 pixel781 pixel782 \
count 28000.000000             28000.0  28000.0  28000.0  28000.0
28000.000000
mean      0.011250     0.006536     0.0      0.0      0.0       0.0
std       1.205211     0.807475     0.0      0.0      0.0       0.0
min       0.000000     0.000000     0.0      0.0      0.0       0.0
25%       0.000000     0.000000     0.0      0.0      0.0       0.0
50%       0.000000     0.000000     0.0      0.0      0.0       0.0
75%       0.000000     0.000000     0.0      0.0      0.0       0.0
max     187.000000   119.000000     0.0      0.0      0.0       0.0
      pixel783

count   28000.0

mean        0.0

std         0.0

min         0.0

25%         0.0

50%         0.0

75%         0.0

max         0.0

[8 rows x 784 columns]
```

[26]:
```
train_data.describe()
```

[26]:
```
 label pixel0 pixel1 pixel2 pixel3 pixel4 pixel5 \ count 42000.000000
42000.0 42000.0 42000.0 42000.0 42000.0 42000.0 42000.0
mean      4.456643     0.0      0.0      0.0      0.0      0.0      0.0
std       2.887730     0.0      0.0      0.0      0.0      0.0      0.0
min       0.000000     0.0      0.0      0.0      0.0      0.0      0.0
25%       2.000000     0.0      0.0      0.0      0.0      0.0      0.0
50%       4.000000     0.0      0.0      0.0      0.0      0.0      0.0
75%       7.000000     0.0      0.0      0.0      0.0      0.0      0.0
max       9.000000     0.0      0.0      0.0      0.0      0.0      0.0

       pixel6  pixel7  pixel8 …     pixel774     pixel775 \
count   42000.0   42000.0   42000.0   …   42000.000000
42000.000000 mean 0.0 0.0 0.0 … 0.219286 0.117095 std
0.0  0.0  0.0  …  6.312890  4.633819  min  0.0  0.0  0.0  …
0.000000 0.000000 25% 0.0 0.0 0.0 … 0.000000 0.000000
50%       0.0     0.0      0.0 …     0.000000     0.000000
```

```
75%       0.0     0.0     0.0 …     0.000000     0.000000
max       0.0     0.0     0.0 …   254.000000   254.000000
          pixel776    pixel777    pixel778    pixel779 pixel780 \
count 42000.000000 42000.00000 42000.000000           42000.0
42000.000000
mean      0.059024    0.02019    0.017238    0.002857      0.0
std       3.274488    1.75987    1.894498    0.414264      0.0
min       0.000000    0.00000    0.000000    0.000000      0.0
25%       0.000000    0.00000    0.000000    0.000000      0.0
50%       0.000000    0.00000    0.000000    0.000000      0.0
75%       0.000000    0.00000    0.000000    0.000000      0.0
max     253.000000   253.00000   254.00000062.000000      0.0
       pixel781 pixel782 pixel783

count 42000.0  42000.0  42000.0

mean       0.0      0.0      0.0

std        0.0      0.0      0.0

min        0.0      0.0      0.0

25%        0.0      0.0      0.0

50%        0.0      0.0      0.0

75%        0.0      0.0      0.0

max        0.0      0.0      0.0

[8 rows x 785 columns]
```

[27]:
```
print(train_data.columns)
print(test_data.columns)
```

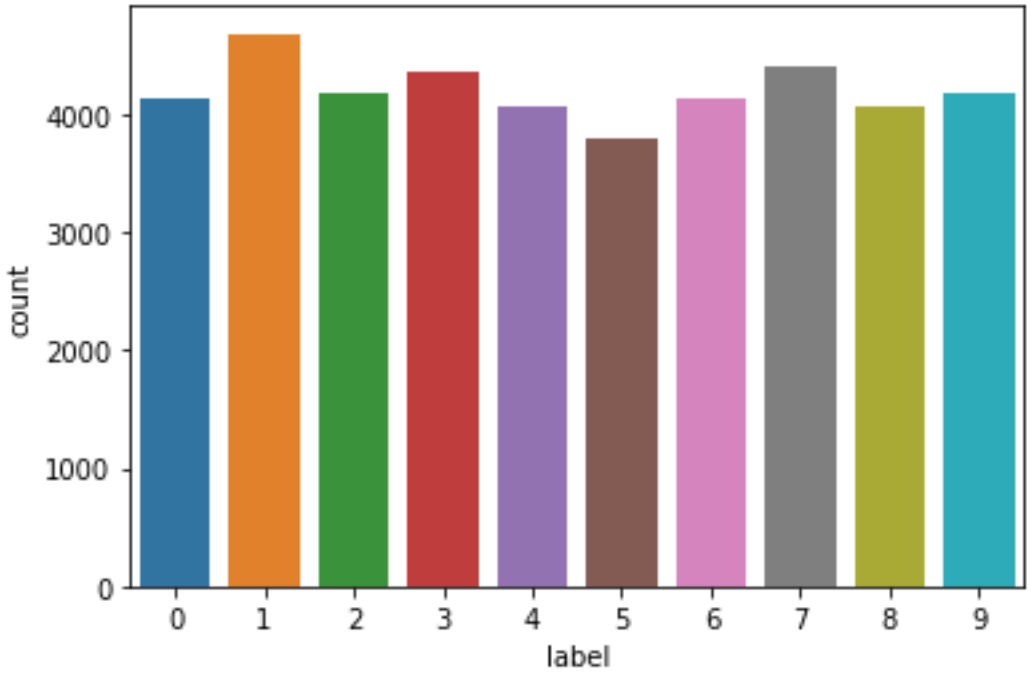
```
Index(['label', 'pixel0', 'pixel1', 'pixel2', 'pixel3', 'pixel4',
'pixel5',
       'pixel6', 'pixel7', 'pixel8',
       …
       'pixel774', 'pixel775', 'pixel776', 'pixel777', 'pixel778',
       'pixel779',
       'pixel780', 'pixel781', 'pixel782', 'pixel783'],
      dtype='object', length=785)
Index(['pixel0', 'pixel1', 'pixel2', 'pixel3', 'pixel4', 'pixel5',
'pixel6',
       'pixel7', 'pixel8', 'pixel9',
       …
       'pixel774', 'pixel775', 'pixel776', 'pixel777', 'pixel778',
       'pixel779',
       'pixel780', 'pixel781', 'pixel782', 'pixel783'],
      dtype='object', length=784)
```

[28]:
```
order = list(np.sort(train_data['label'].unique()))
print(order)
```

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

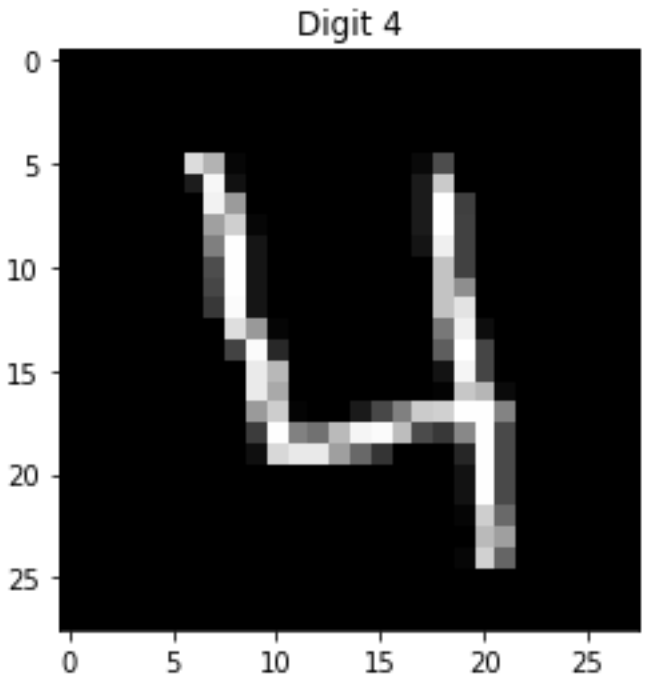
[29]:
```
sns.countplot(train_data["label"])
```

[29]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x121f35978>
```



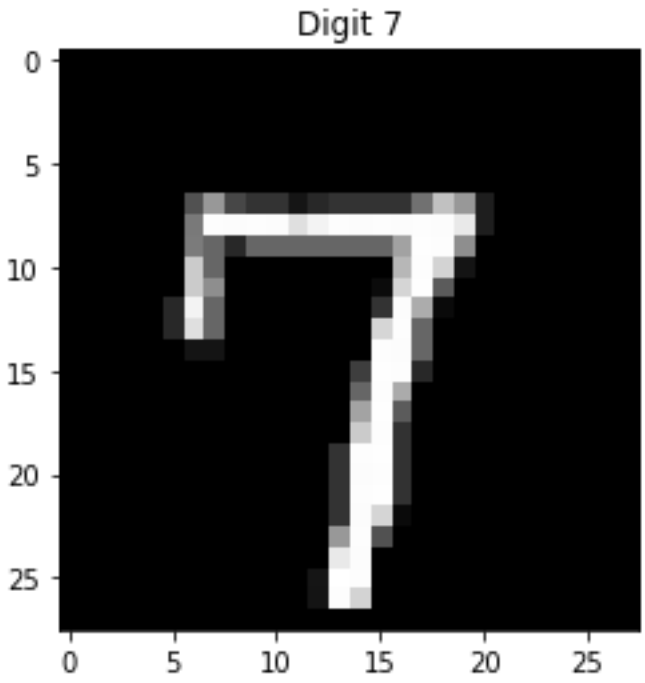
[30]:
```
# Plotting some samples as well as converting into matrix

four = train_data.iloc[3, 1:]
four.shape
four = four.values.reshape(28,28)
plt.imshow(four, cmap='gray')
plt.title("Digit 4")
```

[30]:
```
Text(0.5, 1.0, 'Digit 4')
```



[31]:
```
seven = train_data.iloc[6, 1:]
seven.shape
seven = seven.values.reshape(28, 28)
plt.imshow(seven, cmap='gray')
plt.title("Digit 7")
```

[31]: Text(0.5, 1.0, 'Digit 7')



[32]:
```
## Separating the X and Y variable

y = train_data['label']

## Dropping the variable 'label' from X variable
X = train_data.drop(columns = 'label')

## Printing the size of data
print(train_data.shape)
```

```
(42000, 785)
```

[33]:
```
# scaling the features
from sklearn.preprocessing import scale
X_scaled = scale(X)

# train test split
X_train, X_test, y_train, y_test  = train_test_split(X_scaled, y, test_size = 0.
 ↪3, train_size = 0.2 ,random_state = 10)
```

[34]:
```
# creating a KFold object with 5 splits
folds = KFold(n_splits = 5, shuffle = True, random_state = 10)

# specify range of hyperparameters
# Set the parameters by cross-validation
```

```
hyper_params = [  'gamma':  1e-2, 1e-3, 1e-4],
                     'C':  5,10]}]


# specify model
model = SVC(kernel="rbf")

# set up GridSearchCV()
model_cv = GridSearchCV(estimator = model,
                        param_grid = hyper_params,
                        scoring= 'accuracy',
                        cv = folds,
                        verbose = 1,
                        return_train_score=True)

# fit the model
model_cv.fit(X_train, y_train)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent
                                                                workers.
[Parallel(n_jobs=1)]: Done 30 out of 30 | elapsed: 44.4min finished
```

[34]:
```
GridSearchCV(cv=KFold(n_splits=5, random_state=10, shuffle=True),
             error_score=nan,
             estimator=SVC(C=1.0, break_ties=False, cache_size=200,
                           class_weight=None, coef0=0.0,
                           decision_function_shape='ovr', degree=3,
                           gamma='scale', kernel='rbf', max_iter=-1,
                           probability=False, random_state=None,
                           shrinking=True, tol=0.001, verbose=False),
             iid='deprecated', n_jobs=None, param_grid=[{'C': [5,
             10], 'gamma': [0.01, 0.001, 0.0001]}],
```

```
                pre_dispatch='2*n_jobs', refit=True,
                return_train_score=True, scoring='accuracy',
                verbose=1)
```

[36]:
```
#Accuracy and Confusion Matrix
from sklearn import metrics
from sklearn.metrics import confusion_matrix

# model
model = SVC(C=10, gamma=0.001, kernel="rbf")

model.fit(X_train, y_train)
y_pred = model.predict(X_test)

# metrics
print("accuracy", metrics.accuracy_score(y_test, y_pred), "\n")
print(metrics.confusion_matrix(y_test, y_pred),
```

```
"\n") accuracy 0.9438888888888889

[[1163    0    4    1    1    2    8    6    3    0]
 [   0 1389    4    2    4    0    1    9    4    0]
 [   1    4 1184   14    5    1    9   30    7    5]
 [   0    3   15 1263    0   14    2   23    8    3]
 [   1    2   20    3 1149    0   10   10    2   21]
 [   2    8    3   30    4 1064   15    9   11    3]
 [   8    1    3    0    3   13 1167   23    1    0]
 [   4    9   10    8   12    0    0 1255    2   30]
 [ 5 18 17 23 8 20 5 13 1098 10] [ 5 3 2 27 21
 1 1 51 3 1161]]
```

[ ]:

[ ]: