

In [1]:

```
import pandas as pd
```

In [2]:

```
df = pd.read_csv('digit_data.csv')
```

In [3]:

```
df.head()
```

Out[3]:

	label	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	...	pixel774	pix
0	1	0	0	0	0	0	0	0	0	0	...	0	
1	0	0	0	0	0	0	0	0	0	0	...	0	
2	1	0	0	0	0	0	0	0	0	0	...	0	
3	4	0	0	0	0	0	0	0	0	0	...	0	
4	0	0	0	0	0	0	0	0	0	0	...	0	

5 rows × 785 columns



In [4]:

```
df.tail()
```

Out[4]:

	label	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	...	pixel774	
41995	0	0	0	0	0	0	0	0	0	0	...	0	
41996	1	0	0	0	0	0	0	0	0	0	...	0	
41997	7	0	0	0	0	0	0	0	0	0	...	0	
41998	6	0	0	0	0	0	0	0	0	0	...	0	
41999	9	0	0	0	0	0	0	0	0	0	...	0	

5 rows × 785 columns



In [5]:

```
df.shape
```

Out[5]:

```
(42000, 785)
```

In [6]:

```
df.columns
```

Out[6]:

```
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)
```

In [7]:

```
df.duplicated().sum()
```

Out[7]:

```
0
```

In [8]:

```
df.isnull().sum()
```

Out[8]:

```
label      0  
pixel0     0  
pixel1     0  
pixel2     0  
pixel3     0  
..  
pixel779   0  
pixel780   0  
pixel781   0  
pixel782   0  
pixel783   0  
Length: 785, dtype: int64
```

In [9]:

```
df.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
```

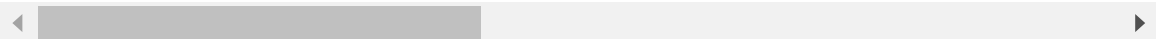
In [10]:

```
df.describe()
```

Out[10]:

	label	pixel0	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7
count	42000.000000	42000.0	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	0.0	0.0
std	2.887730	0.0	0.0	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	0.0	0.0
25%	2.000000	0.0	0.0	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	0.0	0.0
75%	7.000000	0.0	0.0	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	0.0	0.0

8 rows × 785 columns



In [11]:

```
df.nunique()
```

Out[11]:

```
label      10
pixel0      1
pixel1      1
pixel2      1
pixel3      1
..
pixel779    3
pixel780    1
pixel781    1
pixel782    1
pixel783    1
Length: 785, dtype: int64
```

In [12]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [13]:

```
import numpy as np
```

In [14]:

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

In [15]:

```
df['label'].unique()
```

Out[15]:

```
array([1, 0, 4, 7, 3, 5, 8, 9, 2, 6], dtype=int64)
```

In [16]:

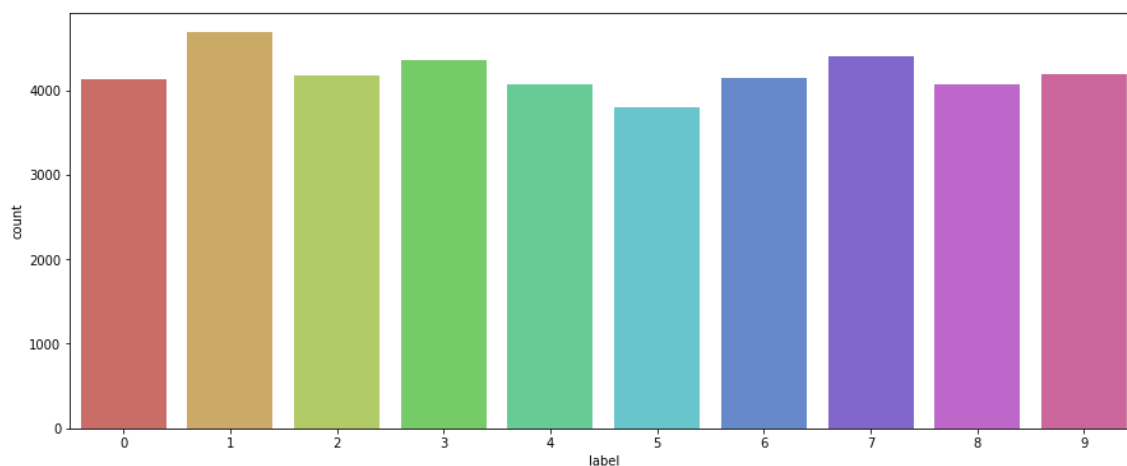
```
df['label'].value_counts()
```

Out[16]:

```
1    4684
7    4401
3    4351
9    4188
2    4177
6    4137
0    4132
4    4072
8    4063
5    3795
Name: label, dtype: int64
```

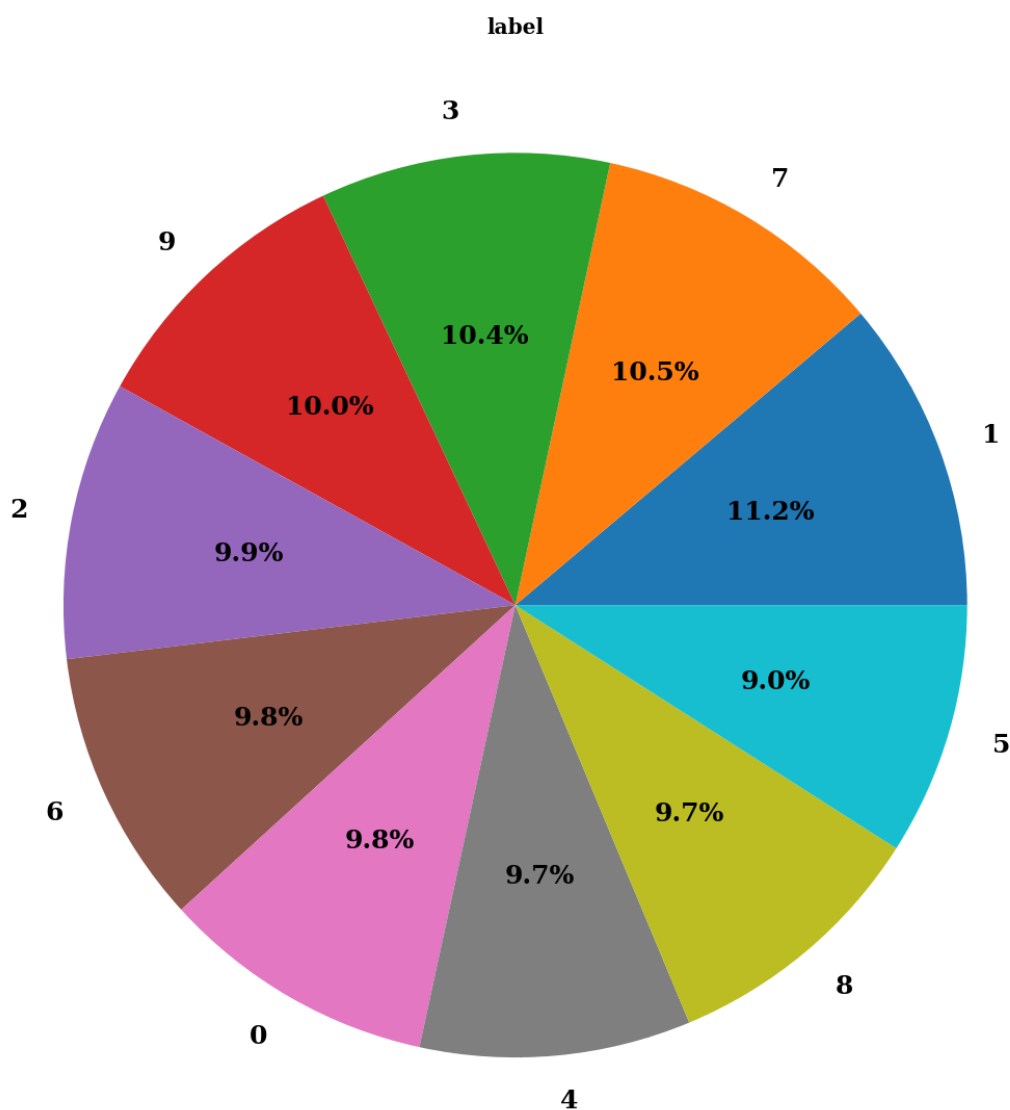
In [17]:

```
plt.figure(figsize=(15,6))
sns.countplot(df['label'], data = df, palette = 'hls')
plt.show()
```



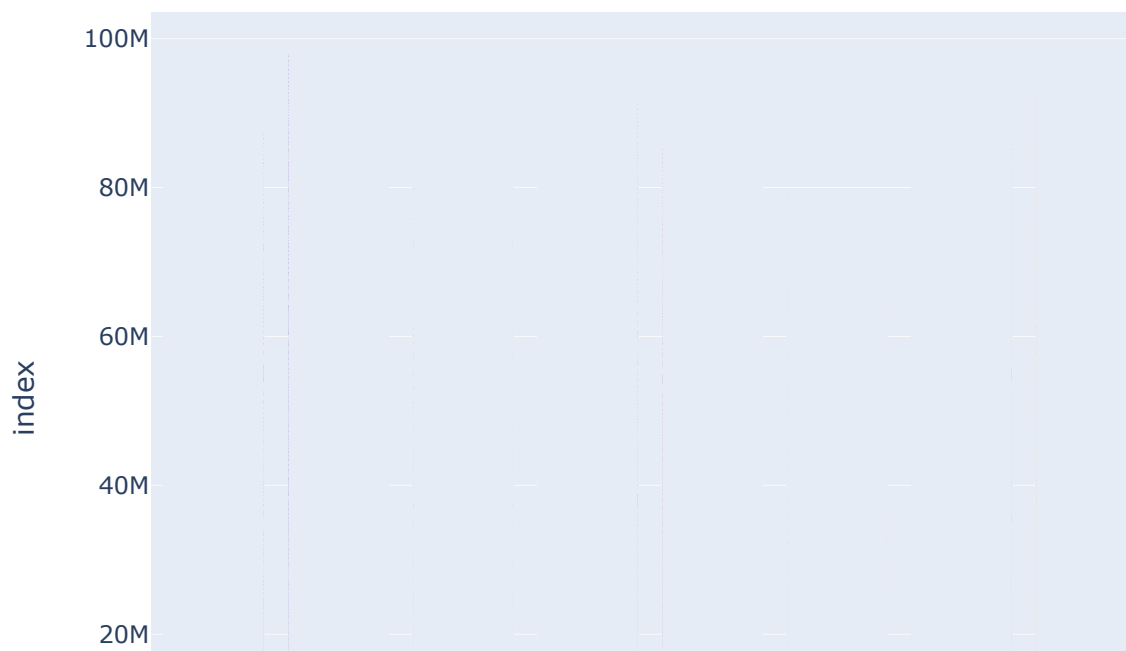
In [18]:

```
plt.figure(figsize=(30,20))
plt.pie(df['label'].value_counts(), labels=df['label'].value_counts().index, autopct='%1
        'color': 'black',
        'weight': 'bold',
        'family': 'serif' })
hfont = {'fontname':'serif', 'weight': 'bold'}
plt.title('label', size=20, **hfont)
plt.show()
```



In [20]:

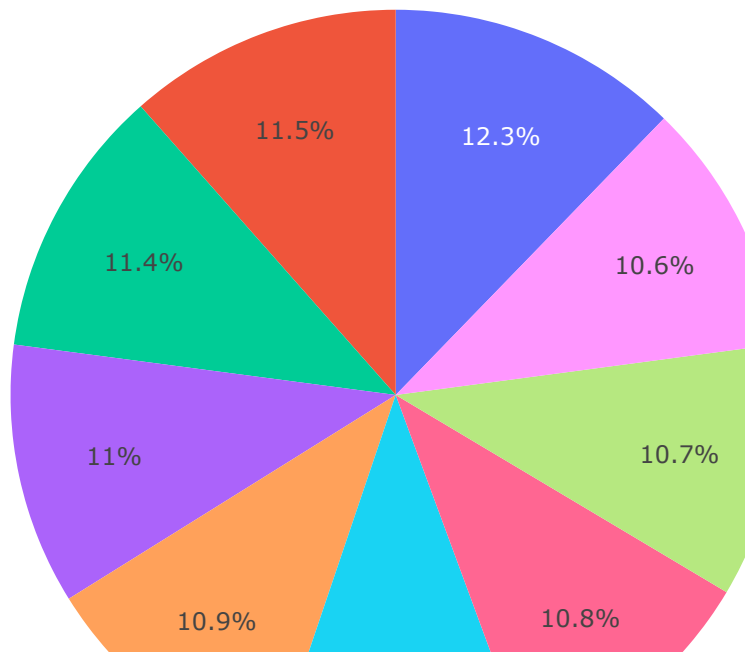
```
import plotly.express as px  
  
fig = px.bar(df, x="label", y= df.index, color = 'label')  
fig.show()
```



In [21]:

```
value_counts = df['label'].value_counts()
fig = px.pie(names=value_counts.index, values=value_counts.values)
fig.update_layout(
    title='Pie Chart of Label',
    title_x=0.5
)
fig.show()
```

Pie Chart of Label



In [22]:

```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
```

In [23]:

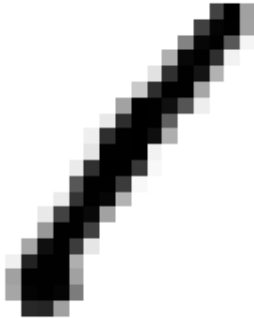
```
X = df.drop(["label"],axis=1)
y = df['label']
```

In [24]:

```
first_image = X.iloc[0]  
first_image = first_image.to_numpy().reshape(28,28)
```

In [26]:

```
plt.imshow(first_image, cmap='binary')  
plt.axis("off")  
plt.show()
```



In [27]:

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

In [28]:

```
lrc = LogisticRegression(multi_class = "multinomial")  
lrc.fit(X_train,y_train)
```

Out[28]:

```
▼          LogisticRegression  
LogisticRegression(multi_class='multinomial')
```

In [29]:

```
some_digit = X_test.iloc[[0]]  
some_digit_pred = lrc.predict(some_digit)  
some_digit_pred
```

Out[29]:

```
array([8], dtype=int64)
```


In [30]:

```
y_test.iloc[[0]]
```

Out[30]:

```
5457      8
Name: label, dtype: int64
```

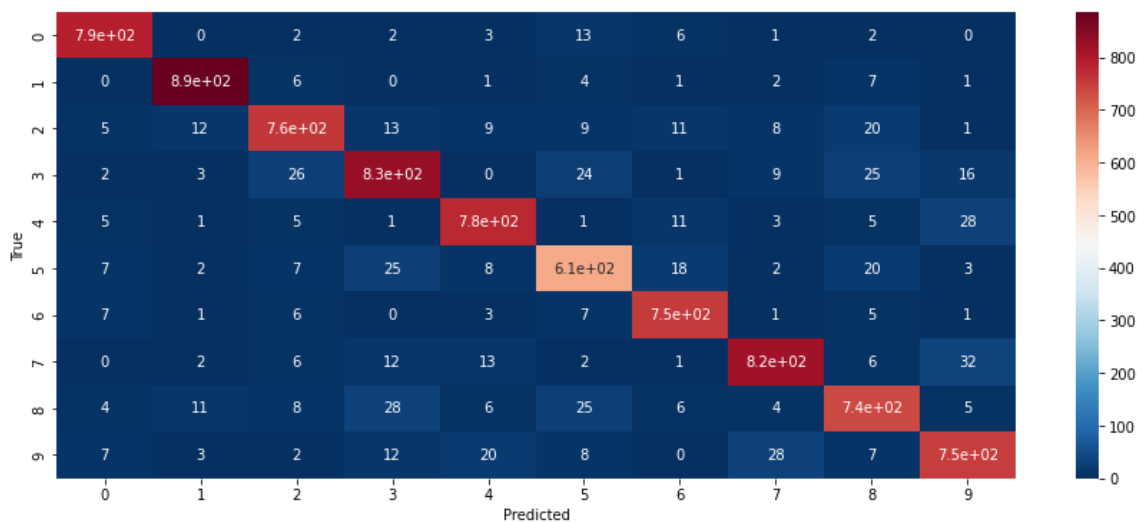
In [31]:

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

In [36]:

```
print(accuracy_score(y_test, y_pred))
confusion = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(15,6))
sns.heatmap(confusion, annot=True, cmap="RdBu_r")
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

0.9183333333333333



In [37]:

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

	precision	recall	f1-score	support
0	0.96	0.96	0.96	816
1	0.96	0.98	0.97	909
2	0.92	0.90	0.91	846
3	0.90	0.89	0.89	937
4	0.93	0.93	0.93	839
5	0.87	0.87	0.87	702
6	0.93	0.96	0.95	785
7	0.93	0.92	0.93	893
8	0.88	0.88	0.88	835
9	0.90	0.90	0.90	838
accuracy			0.92	8400
macro avg	0.92	0.92	0.92	8400
weighted avg	0.92	0.92	0.92	8400

In [38]:

```
dtc = DecisionTreeClassifier(random_state = 42)  
dtc.fit(X_train,y_train)
```

Out[38]:

▼ DecisionTreeClassifier

DecisionTreeClassifier(random_state=42)

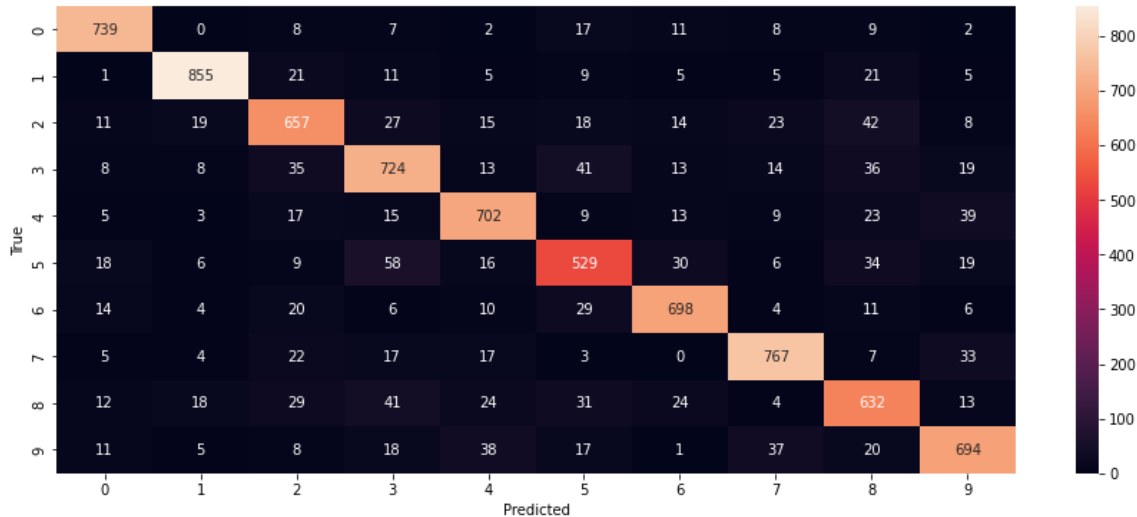
In [39]:

```
dtc_pred = dtc.predict(X_test)
```

In [40]:

```
print(accuracy_score(y_test,dtc_pred))
confusion = confusion_matrix(dtc_pred, y_pred)
plt.figure(figsize=(15,6))
sns.heatmap(confusion, annot=True, fmt='d')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

0.8525



In [41]:

```
from sklearn.metrics import classification_report
print(classification_report(y_test,dtc_pred))
```

	precision	recall	f1-score	support
0	0.93	0.91	0.92	816
1	0.91	0.94	0.93	909
2	0.82	0.81	0.81	846
3	0.83	0.81	0.82	937
4	0.85	0.85	0.85	839
5	0.77	0.79	0.78	702
6	0.87	0.89	0.88	785
7	0.90	0.88	0.89	893
8	0.79	0.78	0.78	835
9	0.84	0.85	0.84	838
accuracy			0.85	8400
macro avg	0.85	0.85	0.85	8400
weighted avg	0.85	0.85	0.85	8400

In [42]:

```
from sklearn.ensemble import RandomForestClassifier
rfc = RandomForestClassifier(random_state = 42)
rfc.fit(X_train,y_train)
```

Out[42]:

```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

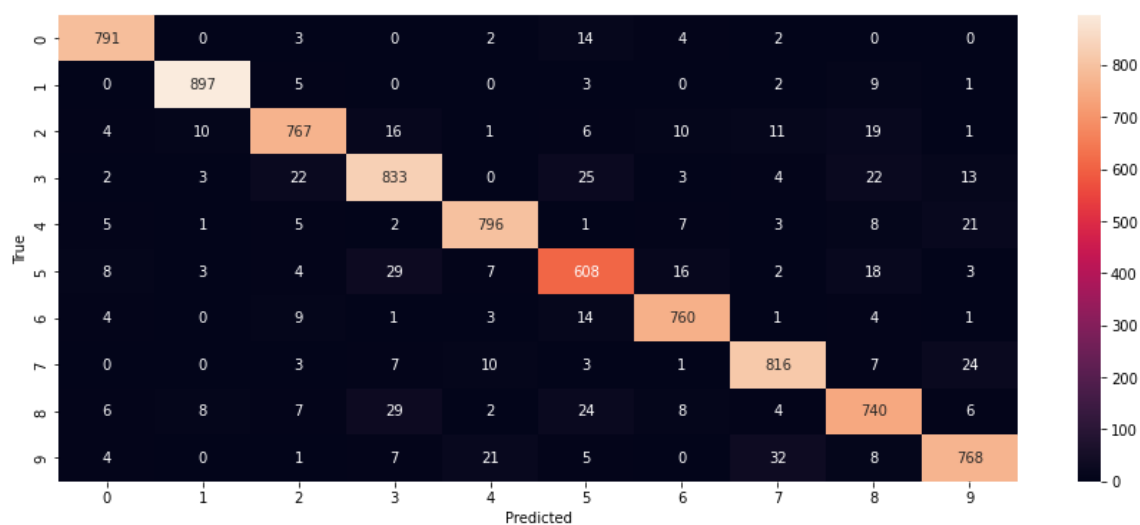
In [43]:

```
rfc_pred = rfc.predict(X_test)
```

In [44]:

```
print(accuracy_score(y_test,dtc_pred))
confusion = confusion_matrix(rfc_pred, y_test)
plt.figure(figsize=(15,6))
sns.heatmap(confusion, annot=True, fmt='d')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

0.8525



In [45]:

```
from sklearn.metrics import classification_report
print(classification_report(y_test,rfc_pred))
```

	precision	recall	f1-score	support
0	0.98	0.98	0.98	816
1	0.98	0.99	0.99	909
2	0.96	0.96	0.96	846
3	0.96	0.95	0.96	937
4	0.96	0.97	0.96	839
5	0.96	0.96	0.96	702
6	0.96	0.98	0.97	785
7	0.97	0.95	0.96	893
8	0.95	0.95	0.95	835
9	0.93	0.94	0.94	838
accuracy			0.96	8400
macro avg	0.96	0.96	0.96	8400
weighted avg	0.96	0.96	0.96	8400

In []: