```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.datasets import fetch_openml
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.neural_network import MLPClassifier
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
```

Data Preperation

```
# Loading the MNIST dataset from OpenML
mnist= fetch_openml('mnist_784',version=1, as_frame=True)
X,y = mnist['data'],mnist['target']
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: FutureWarning: The default value of `parser` will change from `
  warn(
```

```
y.head()
```

```
0    5
1    0
2    4
3    1
4    9
Name: class, dtype: category
Categories (10, object): ['0', '1', '2', '3', ..., '6', '7', '8', '9']
```

```
X.head(10)
```

	pixel1	pixel2	pixel3	pixel4	pixel5	pixel6	pixel7	pixel8	pixel9	pixel10	...	pixel775	pixel776	pixel777	pixel778	pixel779
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0

10 rows × 784 columns

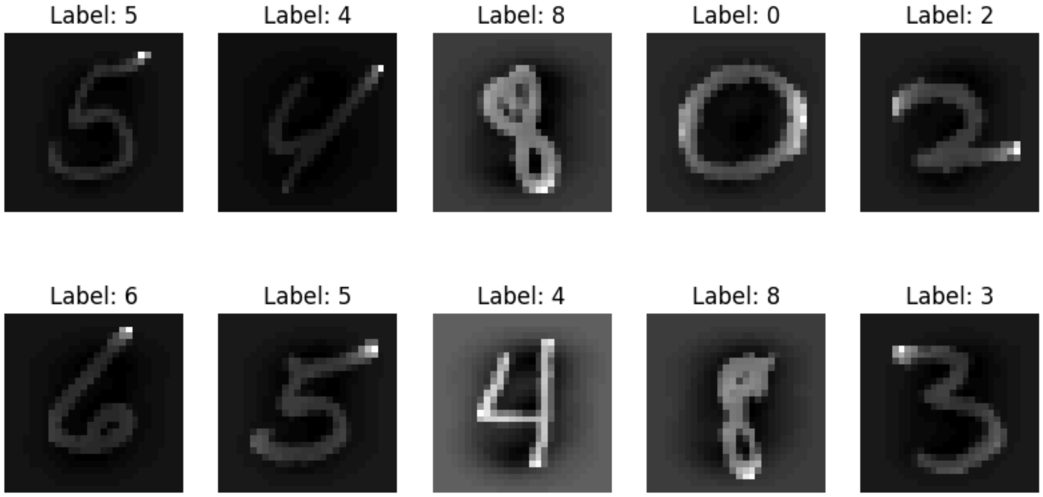
```
# Converting target labels as integers:-
y = y.astype(int)
```

```
# Splitting the data into train and test dataset:-
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2,random_state=42)
```

```
# Standarize the features (pixel value):-
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

Data Visualization

```
# visualizing a few sample images:-
fig, axes= plt.subplots(nrows=2,ncols=5,figsize=(10,5))
for i, ax in enumerate(axes.flat):
  ax.imshow(X_train[i].reshape(28,28), cmap='gray')
  ax.set_title(f"Label: {y_train.iloc[i]}")
  ax.axis('off')
plt.show()
```



Model Selection and Training

```
# Will be using Multi-Layer Perceptron(MLP) classifier as the model
model= MLPClassifier(hidden_layer_sizes=(128, 64), max_iter=1000, random_state=42)
```

```
# Train the model on the training data::-
model.fit(X_train,y_train)
```

```
▾                                   MLPClassifier
MLPClassifier(hidden_layer_sizes=(128, 64), max_iter=1000, random_state=42)
```

Model Evaluation

```
# Predict on the test set:-
y_pred= model.predict(X_test)
```

```
# Printing the classification report and confusion matrix:-
print("Classification Report:\n", classification_report(y_test, y_pred))
print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred))
```

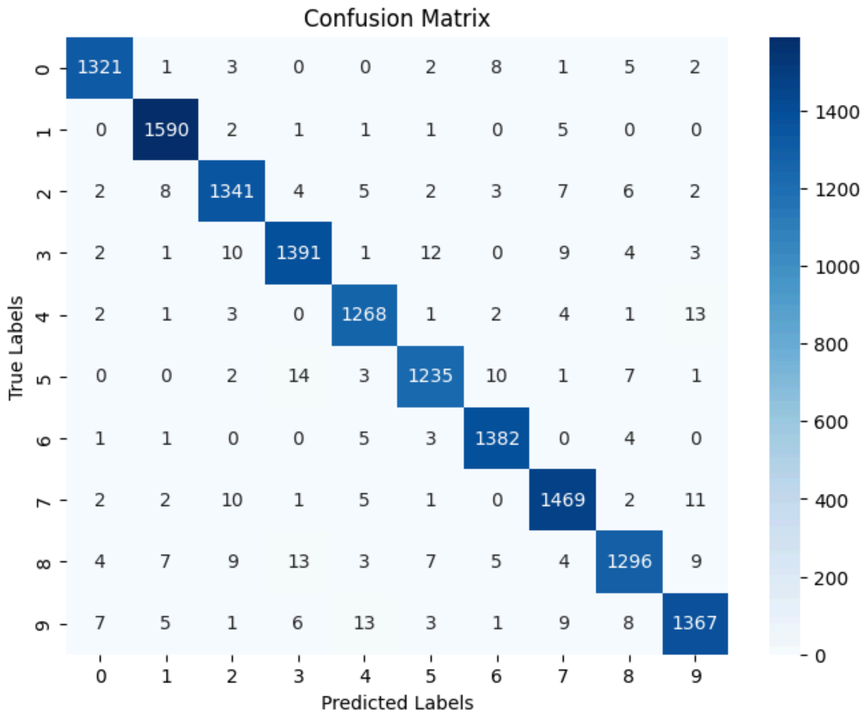
```
Classification Report:
               precision    recall  f1-score   support

           0       0.99      0.98      0.98      1343
           1       0.98      0.99      0.99      1600
           2       0.97      0.97      0.97      1380
           3       0.97      0.97      0.97      1433
           4       0.97      0.98      0.98      1295
           5       0.97      0.97      0.97      1273
           6       0.98      0.99      0.98      1396
           7       0.97      0.98      0.98      1503
           8       0.97      0.96      0.96      1357
           9       0.97      0.96      0.97      1420

    accuracy                           0.98     14000
   macro avg       0.98      0.98      0.98     14000
weighted avg       0.98      0.98      0.98     14000

Confusion Matrix:
 [[1321    1    3    0    0    2    8    1    5    2]
 [   0 1590    2    1    1    1    0    5    0    0]
 [   2    8 1341    4    5    2    3    7    6    2]
 [   2    1   10 1391    1   12    0    9    4    3]
 [   2    1    3    0 1268    1    2    4    1   13]
 [   0    0    2   14    3 1235   10    1    7    1]
 [   1    1    0    0    5    3 1382    0    4    0]
 [   2    2   10    1    5    1    0 1469    2   11]
 [   4    7    9   13    3    7    5    4 1296    9]
 [   7    5    1    6   13    3    1    9    8 1367]]
```

```
# Visualizing the confusion matrix using a heatmap:
plt.figure(figsize=(8,6))
sns.heatmap(confusion_matrix(y_test, y_pred), annot=True,fmt='d', cmap='Blues')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix')
plt.show()
```



Sample Test

```
# Getting a sample set from the test data:-
sample_index = np.random.randint(0, len(X_test))
sample_image = X_test[sample_index]
sample_label = y_test.iloc[sample_index]


# Predict the label for the sample image:
predicted_label = model.predict([sample_image])[0]


# Displaing the sample image and the predicted label:
plt.imshow(sample_image.reshape(28, 28), cmap='gray')
plt.title(f"Predicted Label: {predicted_label}, True Label:{sample_label}")
plt.axis('off')
plt.show()
```

Predicted Label: 8, True Label:8

Start coding or generate with AI.