

# MNIST Image Classification Exploration

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July 31, 2025

## 1 Introduction

This document presents an initial exploration of the MNIST dataset for image classification using Python and TensorFlow. The analysis includes loading the dataset, inspecting its structure, and visualizing sample images to understand the data's characteristics.

## 2 Libraries and Setup

The following Python libraries are imported to facilitate data loading, manipulation, and visualization:

```
1 import numpy as np
2 import pandas as pd
3 import matplotlib.pyplot as plt
4 import seaborn as sns
5 import cv2
6 from google.colab.patches import cv2_imshow
7 from PIL import Image
8 import tensorflow as tf
9 tf.random.set_seed(3)
10 from tensorflow import keras
11 from tensorflow.keras.datasets import mnist
12 from tensorflow.math import confusion_matrix
```

## 3 Data Loading

The MNIST dataset, consisting of handwritten digit images, is loaded using TensorFlow's Keras API:

```
1 (x_train, y_train), (x_test, y_test) = mnist.load_data()
```

The dataset is split into training and test sets. The training set contains 60,000 images, and the test set contains 10,000 images, each represented as a 28x28 pixel grayscale array.

## 4 Data Exploration

The shapes of the data arrays are inspected to confirm their dimensions:

```
1 print((x_train).shape) # Output: (60000, 28, 28)
2 print((y_train).shape) # Output: (60000,)
3 print((x_test).shape)  # Output: (10000, 28, 28)
4 print((y_test).shape)  # Output: (10000,)
```

The training data (`x_train`) consists of 60,000 images of size 28x28 pixels, with corresponding labels (`y_train`). The test data (`x_test`) contains 10,000 images with labels (`y_test`). Each image is a 2D NumPy array, and labels are single integers representing digits 0–9.

The type of `x_train` is confirmed as a NumPy array:

```
1 type(x_train) # Output: numpy.ndarray
```

## 5 Data Visualization

Sample images from the training and test sets are visualized to inspect the handwritten digits:

```
1 plt.imshow(x_train[4])
2 plt.show()
```

The fifth training image (index 4) is displayed, showing a handwritten digit. Similarly, the fifth test image is visualized along with its label:

```
1 plt.imshow(x_test[4])
2 plt.show()
3 print(y_test[4]) # Output: 9
```

The test image at index 4 is a handwritten digit '9', as confirmed by the corresponding label in `y_test`.

## 6 Analysis Summary

This exploration confirms the MNIST dataset is correctly loaded with 60,000 training and 10,000 test images, each 28x28 pixels. The data is stored as NumPy arrays, suitable for further preprocessing and model training. Visualizations verify that the images represent handwritten digits, with labels correctly associated (e.g., test image 4 is a '9'). Future steps could include normalizing pixel values, building a neural network model, and evaluating its performance using metrics like accuracy and a confusion matrix.