MNIST Dataset Introduction and Visualization

This notebook provides an introduction to the MNIST dataset and demonstrates various visualization techniques.

Dependencies

Import required libraries and modules

For testing purposes, see also test notebook in the same directory.

In [1]:
```
import sys
import os

# Add project root to Python path
current_dir = os.getcwd()
project_root = os.path.dirname(current_dir)
sys.path.append(project_root)

import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
from sklearn.decomposition import PCA
from src.utils.mnist_visualization import visualize_mnist_image
```

Loading MNIST Dataset

Let's load the MNIST dataset from local CSV files.

In [2]:
```
# Load training data
train_data = pd.read_csv(os.path.join(project_root, 'data', 'train.csv'))
X = train_data.iloc[:, 1:].values  # All columns except the first (labels)
y = train_data.iloc[:, 0].values   # First column (labels)

print(f"Dataset shape: {X.shape}")
print(f"Number of classes: {len(np.unique(y))}")
```

```
Dataset shape: (60000, 784)
Number of classes: 10
```

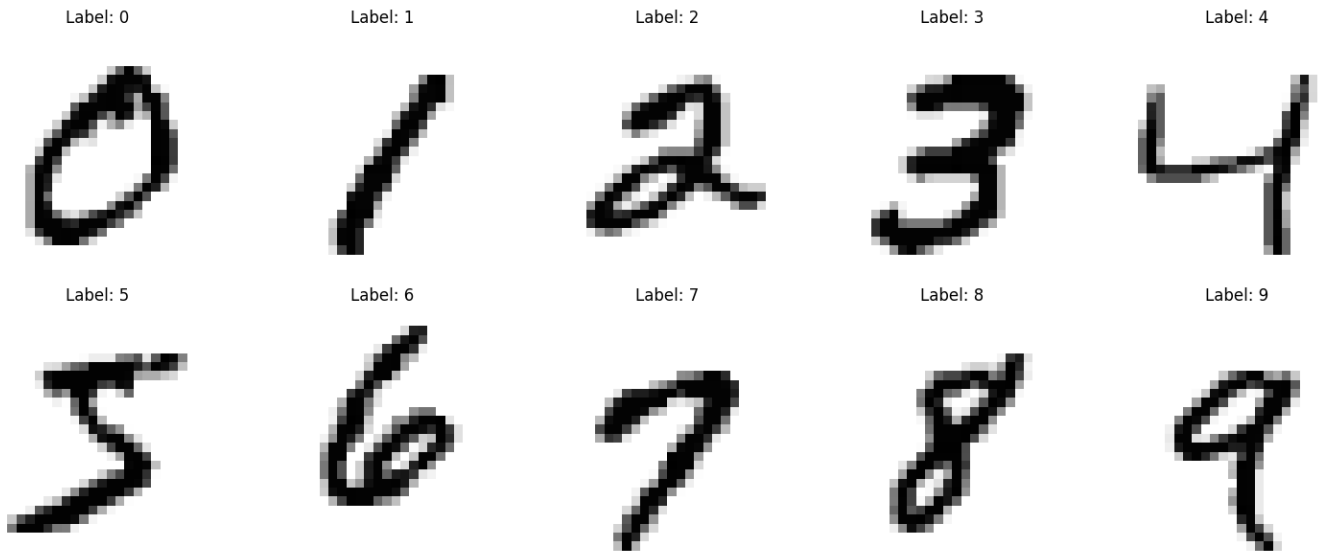
Visualizing Sample Images

Let's visualize one example for each digit class.

In [3]:
```
# Create a figure with subplots
fig, axes = plt.subplots(2, 5, figsize=(15, 6))
axes = axes.ravel()

# Get one example for each digit (0-9)
for digit in range(10):
    # Find the first occurrence of this digit
    idx = np.where(y == digit)[0][0]
    visualize_mnist_image(X[idx], digit, ax=axes[digit])

plt.tight_layout()
plt.show()
```

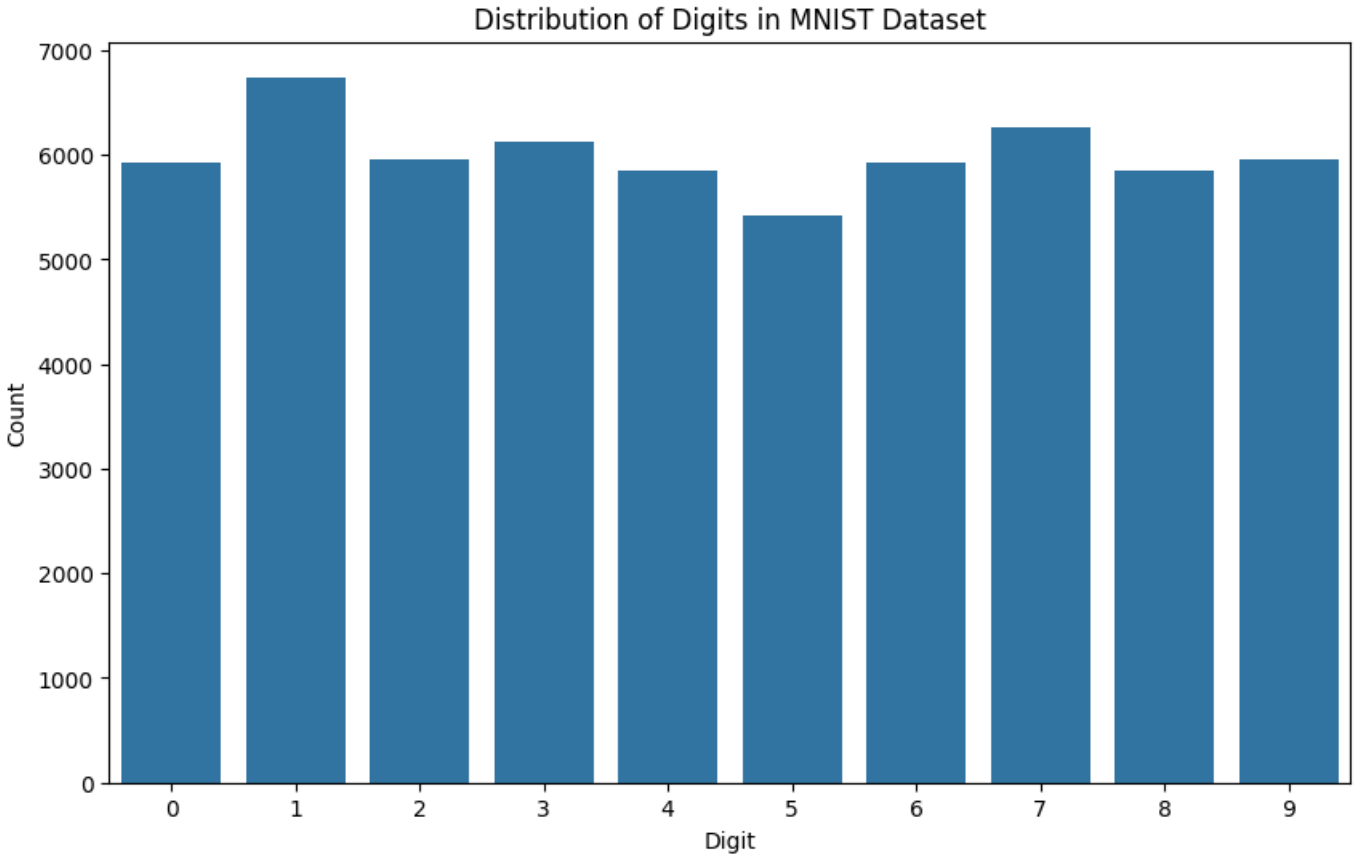


Class Distribution

Let's examine the distribution of classes in the dataset.

In [4]:
```
# Count occurrences of each digit
unique, counts = np.unique(y, return_counts=True)

# Create bar plot
plt.figure(figsize=(10, 6))
sns.barplot(x=unique, y=counts)
plt.title('Distribution of Digits in MNIST Dataset')
plt.xlabel('Digit')
plt.ylabel('Count')
plt.show()
```



Pixel Value Distribution with PCA

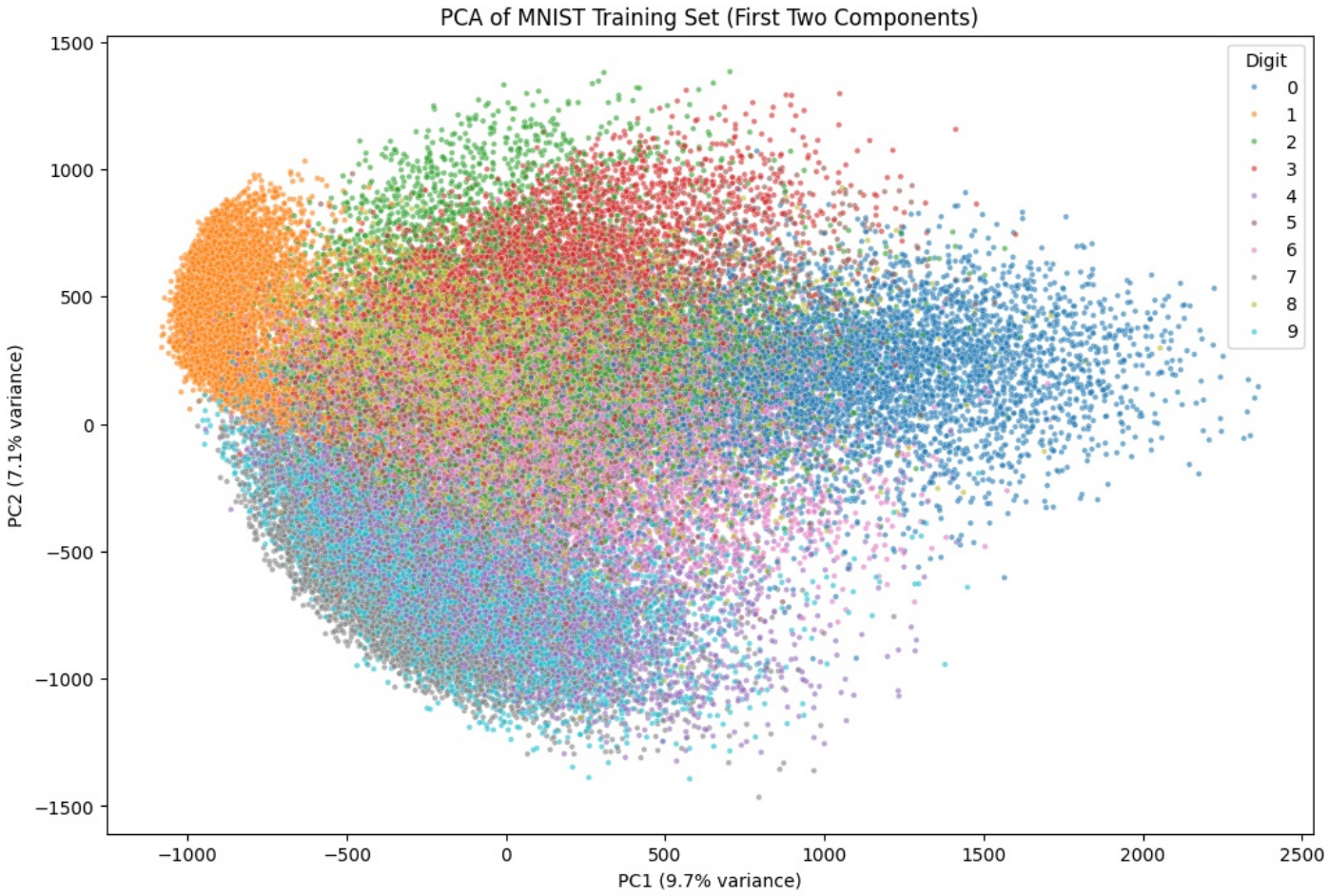
Let's analyze the distribution of pixel values in the dataset, using

In [5]:

```
# Perform PCA and plot
plt.figure(figsize=(12, 8))
pca = PCA(n_components=2)
X_pca = pca.fit_transform(train_data.drop('label', axis=1))
df_pca = pd.DataFrame(X_pca, columns=['PC1', 'PC2'])
df_pca['label'] = train_data['label']

# Plot PCA results with a categorical color palette
sns.scatterplot(
    data=df_pca,
    x='PC1',
    y='PC2',
    hue='label',
    palette='tab10',  # Palette with good contrast for categorical data
    alpha=0.6,
    s=10
)
plt.title("PCA of MNIST Training Set (First Two Components)")
plt.xlabel(f"PC1 ({pca.explained_variance_ratio_[0]:.1%} variance)")
plt.ylabel(f"PC2 ({pca.explained_variance_ratio_[1]:.1%} variance)")
plt.legend(title='Digit')

# Show all plots
plt.show()
```



In [ ]: