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# Step 1: Import Libraries
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten
from tensorflow.keras.utils import to_categorical

# Step 2: Load and Preprocess the Data
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Normalize pixel values to [0, 1]
x_train = x_train / 255.0
x_test = x_test / 255.0

# One-hot encode the labels
y_train_cat = to_categorical(y_train, 10)
y_test_cat = to_categorical(y_test, 10)

# Step 3: Visualize Some Digits
plt.figure(figsize=(10,4))
for i in range(10):
    plt.subplot(2, 5, i+1)
    plt.imshow(x_train[i], cmap='gray')
    plt.title(f"Label: {y_train[i]}")
    plt.axis('off')
plt.tight_layout()
plt.show()

# Step 4: Build the Neural Network Model
model = Sequential([
    Flatten(input_shape=(28, 28)),
    Dense(128, activation='relu'),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Step 5: Compile the Model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

# Step 6: Train the Model
history = model.fit(x_train, y_train_cat, epochs=5, validation_split=0.1)

# Step 7: Evaluate the Model
test_loss, test_acc = model.evaluate(x_test, y_test_cat)
print(f"\nTest Accuracy: {test_acc:.4f}")

# Step 8: Predict and Visualize
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predictions = model.predict(x_test)

# Show sample prediction
plt.figure(figsize=(10,4))
for i in range(10):
    plt.subplot(2, 5, i+1)
    plt.imshow(x_test[i], cmap='gray')
    plt.title(f"Predicted: {np.argmax(predictions[i])}")
    plt.axis('off')
plt.tight_layout()
plt.show()
```

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Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mni
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
```
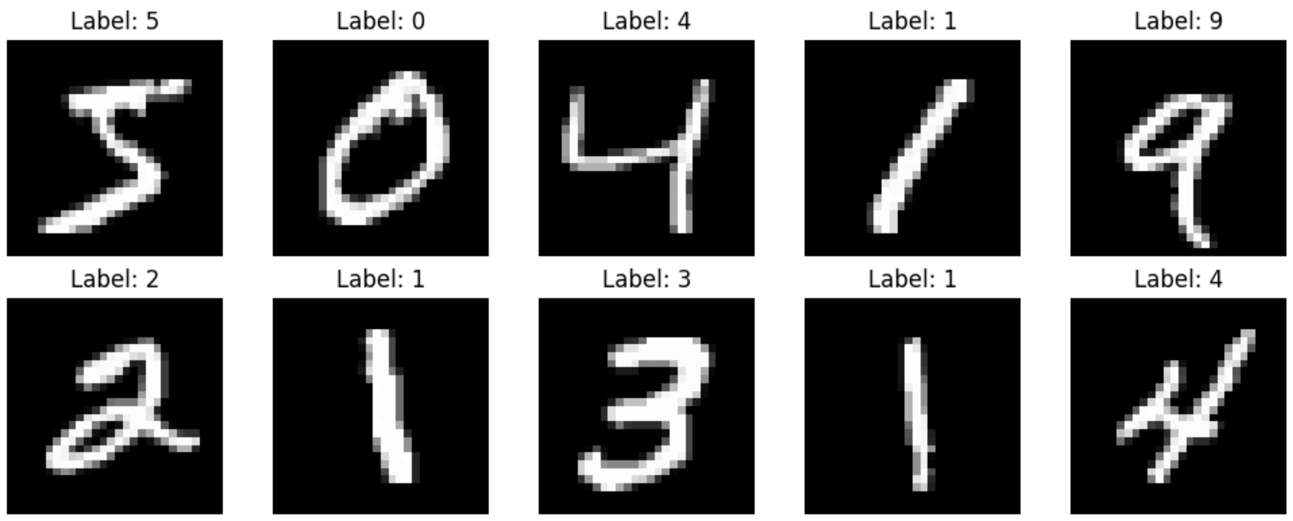
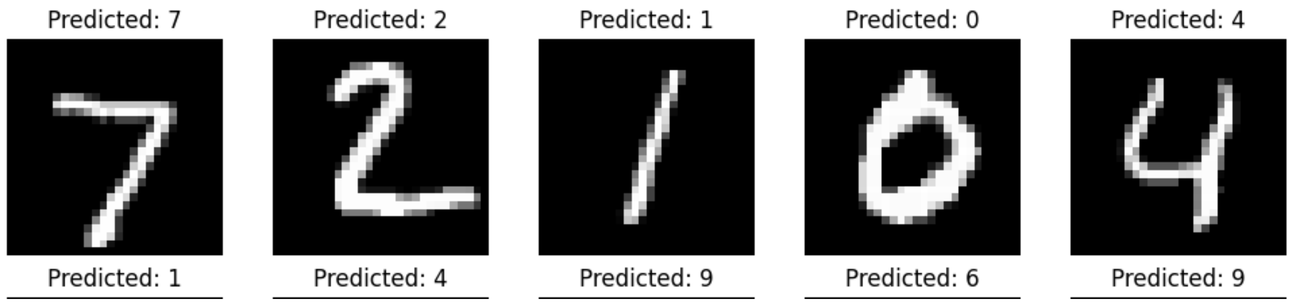



```
/usr/local/lib/python3.11/dist-packages/keras/src/layers/reshaping/flatten.py:37: Use
  super().__init__(**kwargs)
Epoch 1/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 9s 4ms/step - accuracy: 0.8655 - loss: 0.4589 - val_ac
Epoch 2/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 10s 4ms/step - accuracy: 0.9640 - loss: 0.1181 - val_a
Epoch 3/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 11s 5ms/step - accuracy: 0.9762 - loss: 0.0757 - val_a
Epoch 4/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 7s 4ms/step - accuracy: 0.9834 - loss: 0.0531 - val_ac
Epoch 5/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 10s 4ms/step - accuracy: 0.9861 - loss: 0.0418 - val_a
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step - accuracy: 0.9764 - loss: 0.0826

Test Accuracy: 0.9790
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 2ms/step
```


Predicted: 7
Predicted: 2
Predicted: 1
Predicted: 0
Predicted: 4
Predicted: 1
Predicted: 4
Predicted: 9
Predicted: 6
Predicted: 9