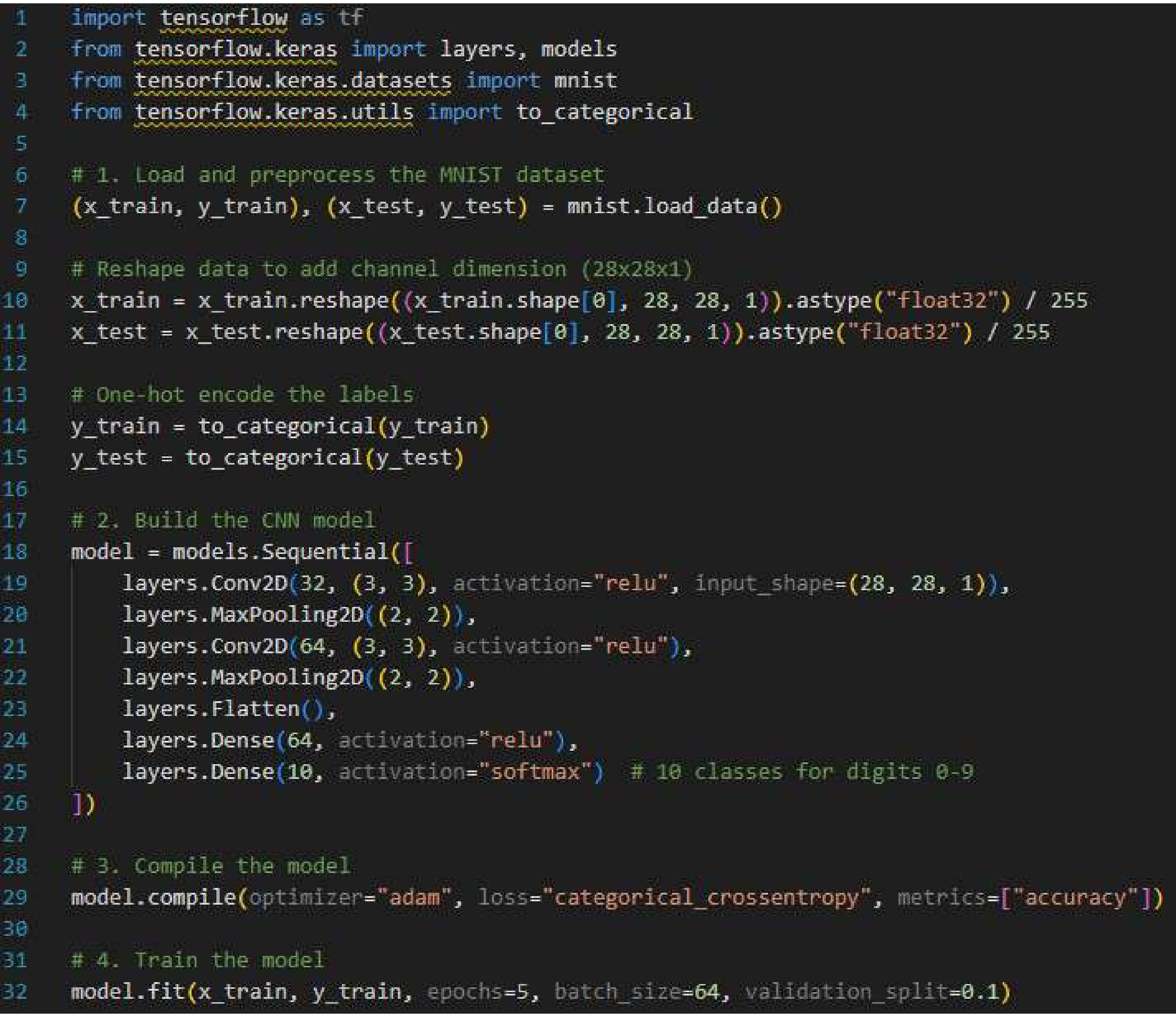
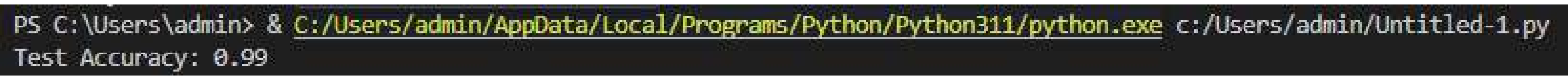
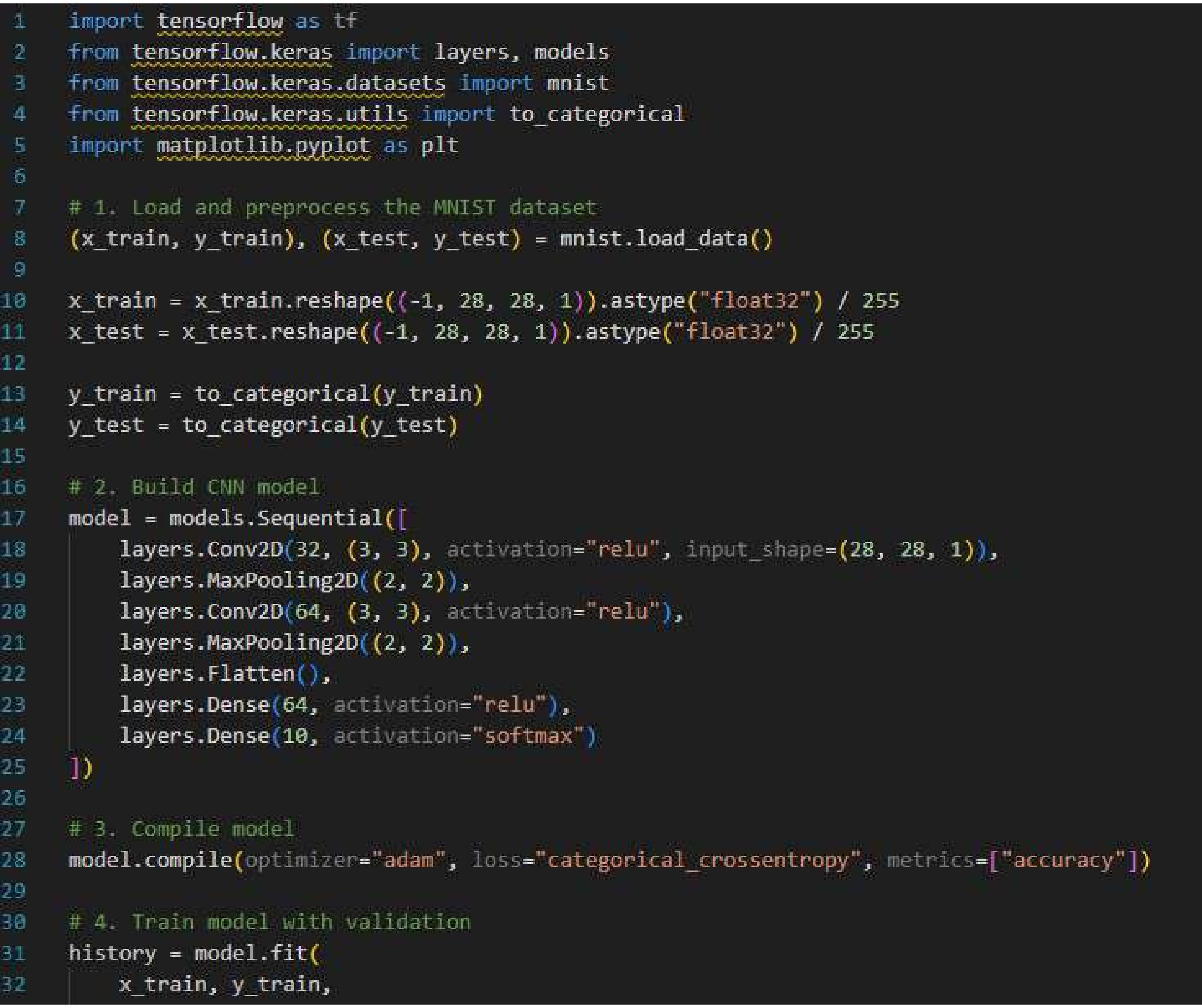


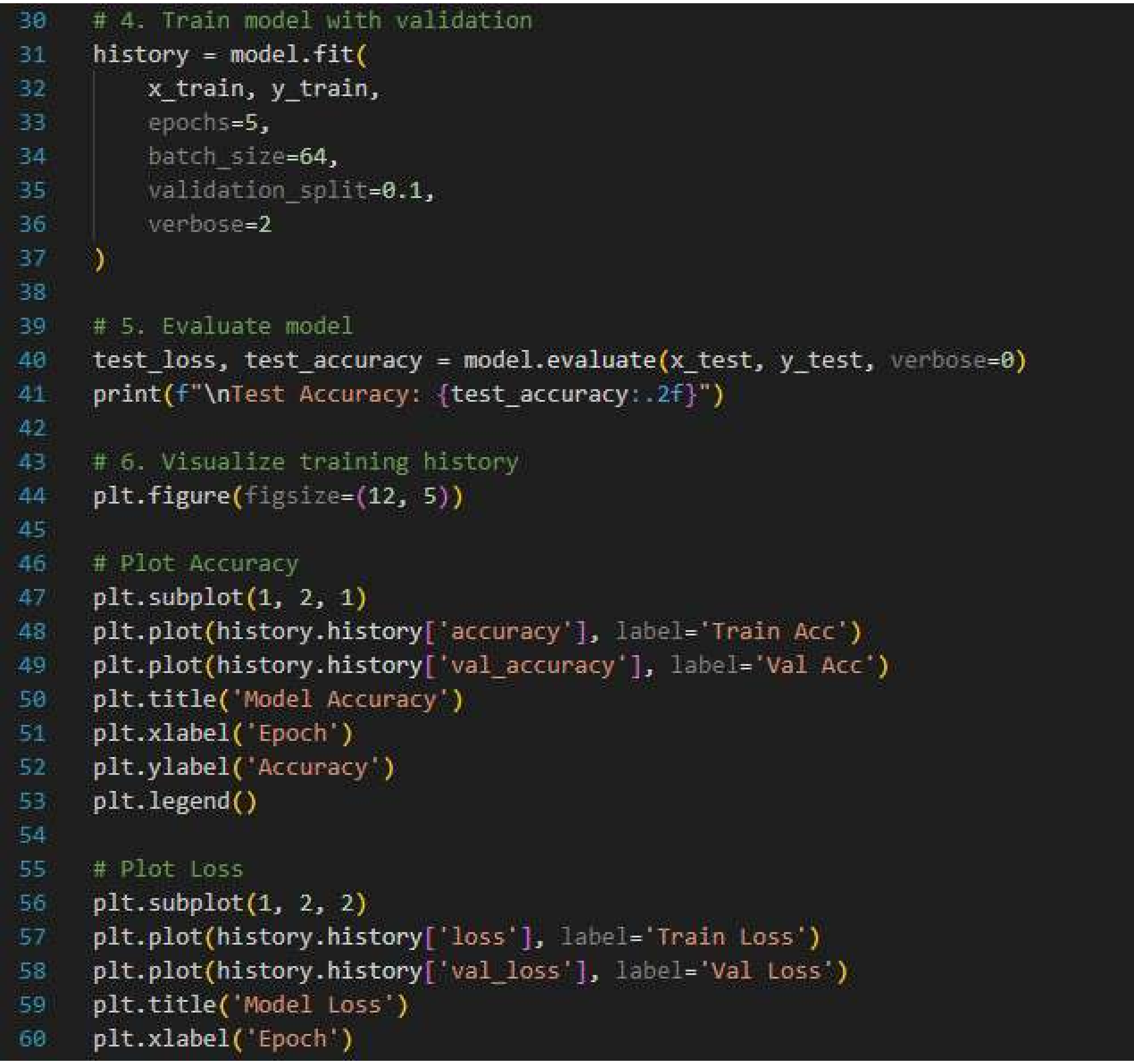
```python
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical

# 1. Load and preprocess the MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Reshape data to add channel dimension (28x28x1)
x_train = x_train.reshape((x_train.shape[0], 28, 28, 1)).astype("float32") / 255
x_test = x_test.reshape((x_test.shape[0], 28, 28, 1)).astype("float32") / 255

# One-hot encode the labels
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# 2. Build the CNN model
model = models.Sequential([
    layers.Conv2D(32, (3, 3), activation="relu", input_shape=(28, 28, 1)),
    layers.MaxPooling2D((2, 2)),
    layers.Conv2D(64, (3, 3), activation="relu"),
    layers.MaxPooling2D((2, 2)),
    layers.Flatten(),
    layers.Dense(64, activation="relu"),
    layers.Dense(10, activation="softmax")  # 10 classes for digits 0-9
])

# 3. Compile the model
model.compile(optimizer="adam", loss="categorical_crossentropy", metrics=["accuracy"])

# 4. Train the model
model.fit(x_train, y_train, epochs=5, batch_size=64, validation_split=0.1)
```



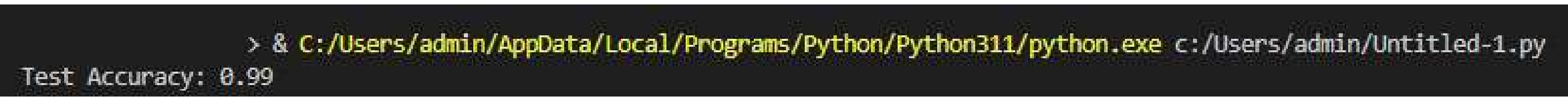
```
PS C:\Users\admin> & C:/Users/admin/AppData/Local/Programs/Python/Python311/python.exe c:/Users/admin/Untitled-1.py
Test Accuracy: 0.99
```



```python
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
import matplotlib.pyplot as plt

# 1. Load and preprocess the MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()

x_train = x_train.reshape((-1, 28, 28, 1)).astype("float32") / 255
x_test = x_test.reshape((-1, 28, 28, 1)).astype("float32") / 255

y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# 2. Build CNN model
model = models.Sequential([
    layers.Conv2D(32, (3, 3), activation="relu", input_shape=(28, 28, 1)),
    layers.MaxPooling2D((2, 2)),
    layers.Conv2D(64, (3, 3), activation="relu"),
    layers.MaxPooling2D((2, 2)),
    layers.Flatten(),
    layers.Dense(64, activation="relu"),
    layers.Dense(10, activation="softmax")
])

# 3. Compile model
model.compile(optimizer="adam", loss="categorical_crossentropy", metrics=["accuracy"])

# 4. Train model with validation
history = model.fit(
    x_train, y_train,
```



```python
# 4. Train model with validation
history = model.fit(
    x_train, y_train,
    epochs=5,
    batch_size=64,
    validation_split=0.1,
    verbose=2
)

# 5. Evaluate model
test_loss, test_accuracy = model.evaluate(x_test, y_test, verbose=0)
print(f"\nTest Accuracy: {test_accuracy:.2f}")

# 6. Visualize training history
plt.figure(figsize=(12, 5))

# Plot Accuracy
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Acc')
plt.plot(history.history['val_accuracy'], label='Val Acc')
plt.title('Model Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

# Plot Loss
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Val Loss')
plt.title('Model Loss')
plt.xlabel('Epoch')
```



```
                  > & C:/Users/admin/AppData/Local/Programs/Python/Python311/python.exe c:/Users/admin/Untitled-1.py
Test Accuracy: 0.99
```