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# Step 1: Import Libraries
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.utils import to_categorical
import matplotlib.pyplot as plt

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

# Reshape for CNN: (samples, height, width, channels)
x_train = x_train.reshape(-1, 28, 28, 1).astype('float32') / 255
x_test = x_test.reshape(-1, 28, 28, 1).astype('float32') / 255

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

# Step 3: Build the CNN Model
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)),
    MaxPooling2D((2, 2)),

    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),

    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

# Step 4: Compile the Model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

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

# Step 6: Evaluate the Model
test_loss, test_acc = model.evaluate(x_test, y_test)
print(f"Test Accuracy: {test_acc * 100:.2f}%")

# Step 7: Plot Accuracy and Loss
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend()
plt.show()

# Step 8: Predict and Show Sample
import numpy as np

predictions = model.predict(x_test)
index = np.random.randint(0, len(x_test))
plt.imshow(x_test[index].reshape(28, 28), cmap='gray')
plt.title(f"Predicted: {np.argmax(predictions[index])}")
plt.axis('off')
plt.show()
```

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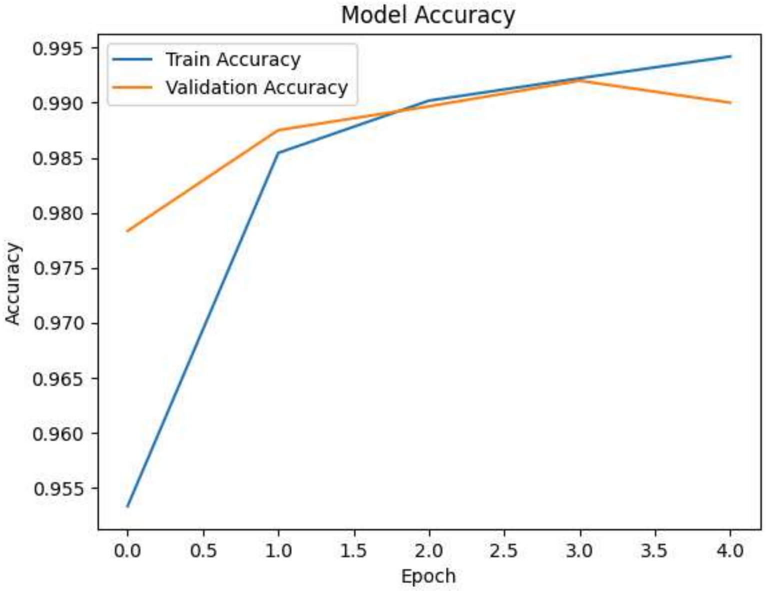
Epoch 1/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 55s 31ms/step - accuracy: 0.8882 - loss: 0.3526 - val_accuracy: 0.9783 - val_loss: 0.0675
Epoch 2/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 52s 31ms/step - accuracy: 0.9843 - loss: 0.0519 - val_accuracy: 0.9875 - val_loss: 0.0423
Epoch 3/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 81s 30ms/step - accuracy: 0.9893 - loss: 0.0340 - val_accuracy: 0.9897 - val_loss: 0.0414
Epoch 4/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 84s 32ms/step - accuracy: 0.9926 - loss: 0.0210 - val_accuracy: 0.9920 - val_loss: 0.0330
Epoch 5/5
1688/1688 ━━━━━━━━━━━━━━━━━━━━ 82s 32ms/step - accuracy: 0.9945 - loss: 0.0171 - val_accuracy: 0.9900 - val_loss: 0.0456
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.9892 - loss: 0.0348
Test Accuracy: 99.14%
```



Model Accuracy

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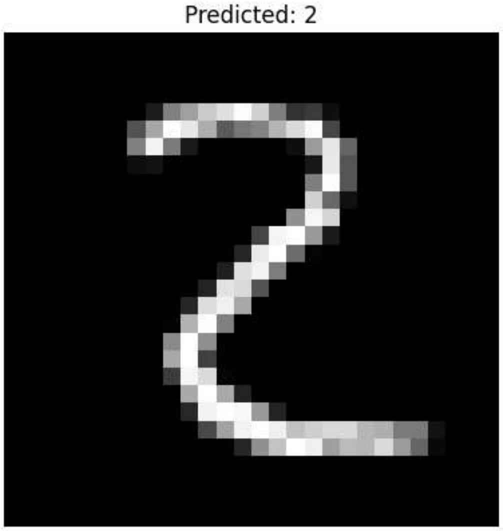
313/313 ━━━━━━━━━━━━━━━━━━━━ 4s 12ms/step
```



Predicted: 2