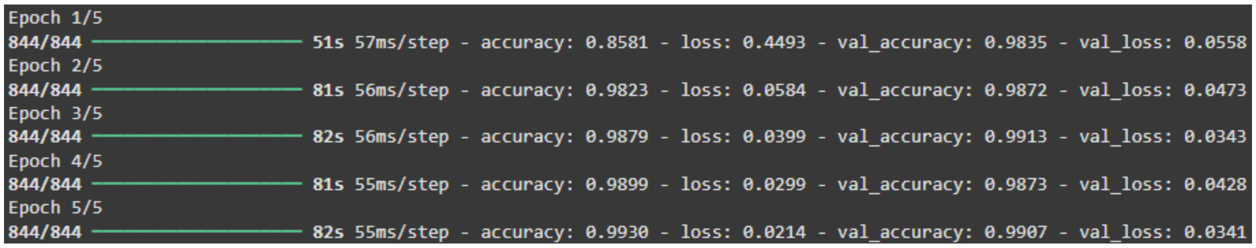
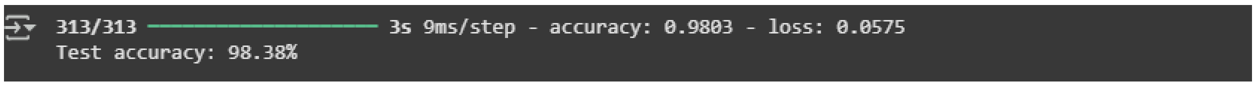
RECOGNIZING HANDWRITTEN DIGITS WITH DEEP LEARNING FOR SMARTER AI APPLICATIONS

```
# Import necessary libraries
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras import datasets, layers, models
from tensorflow.keras.utils import to_categorical
from sklearn.model_selection import train_test_split

# Load the MNIST dataset
(train_images, train_labels), (test_images, test_labels) = datasets.mnist.load_data()

# Preprocess the data
# Reshape images to 28x28x1 (grayscale)
train_images = train_images.reshape((train_images.shape[0], 28, 28, 1))
test_images = test_images.reshape((test_images.shape[0], 28, 28, 1))

# Normalize the pixel values to be between 0 and 1
train_images, test_images = train_images / 255.0, test_images / 255.0

# Convert labels to one-hot encoding
train_labels = to_categorical(train_labels, 10)
test_labels = to_categorical(test_labels, 10)

# Define 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.Conv2D(64, (3, 3), activation='relu'),
    layers.Flatten(),

    layers.Dense(64, activation='relu'),

    layers.Dense(10, activation='softmax')  # 10 classes for 0-9 digits

])


# Compile the model

model.compile(optimizer='adam',

              loss='categorical_crossentropy',

              metrics=['accuracy'])


# Train the model

history = model.fit(train_images, train_labels, epochs=5, batch_size=64, validation_split=0.1)
```



```
Epoch 1/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 51s 57ms/step - accuracy: 0.8581 - loss: 0.4493 - val_accuracy: 0.9835 - val_loss: 0.0558
Epoch 2/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 81s 56ms/step - accuracy: 0.9823 - loss: 0.0584 - val_accuracy: 0.9872 - val_loss: 0.0473
Epoch 3/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 82s 56ms/step - accuracy: 0.9879 - loss: 0.0399 - val_accuracy: 0.9913 - val_loss: 0.0343
Epoch 4/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 81s 55ms/step - accuracy: 0.9899 - loss: 0.0299 - val_accuracy: 0.9873 - val_loss: 0.0428
Epoch 5/5
844/844 ━━━━━━━━━━━━━━━━━━━━ 82s 55ms/step - accuracy: 0.9930 - loss: 0.0214 - val_accuracy: 0.9907 - val_loss: 0.0341
```

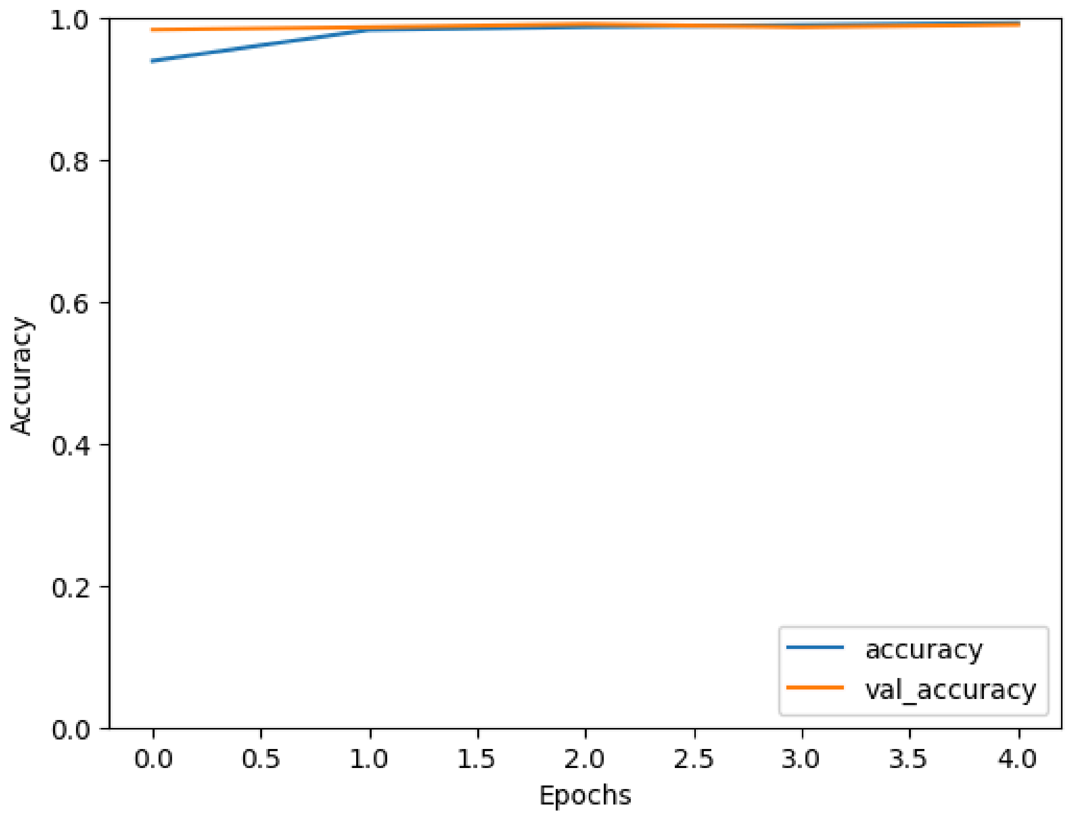
```
# Evaluate the model on the test set

test_loss, test_acc = model.evaluate(test_images, test_labels)

print(f"Test accuracy: {test_acc * 100:.2f}%")
```



```
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.9803 - loss: 0.0575
Test accuracy: 98.38%
```

```
# Save the model (optional)

model.save('mnist_cnn_model.h5')
```

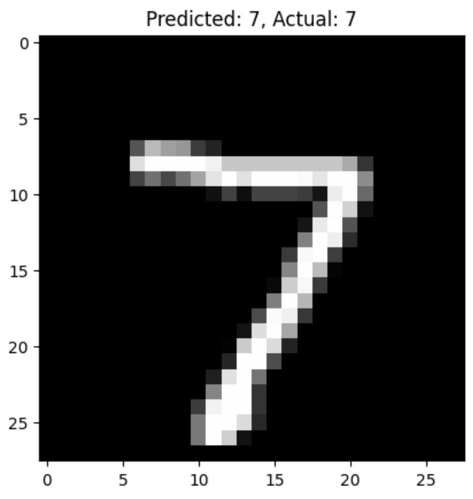
```
# Plot the training history (optional)

plt.plot(history.history['accuracy'], label='accuracy')

plt.plot(history.history['val_accuracy'], label = 'val_accuracy')

plt.xlabel('Epochs')

plt.ylabel('Accuracy')

plt.ylim([0, 1])

plt.legend(loc='lower right')

plt.show()
```

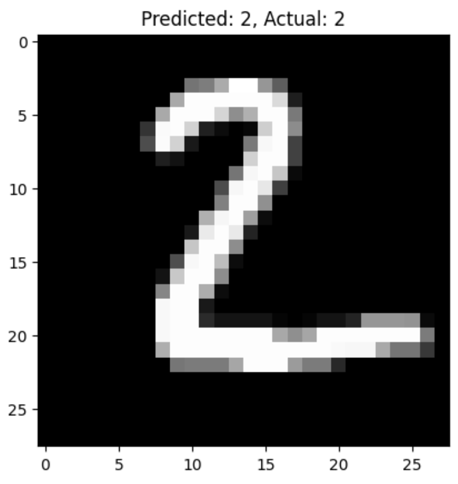


```
# Predictions (optional)

predictions = model.predict(test_images[:5])
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 97ms/step
```

```
# Show the predicted digits and the actual digits
for i in range(5):
    plt.imshow(test_images[i].reshape(28, 28), cmap='gray')
    plt.title(f"Predicted: {np.argmax(predictions[i])}, Actual: {np.argmax(test_labels[i])}")
    plt.show()
```





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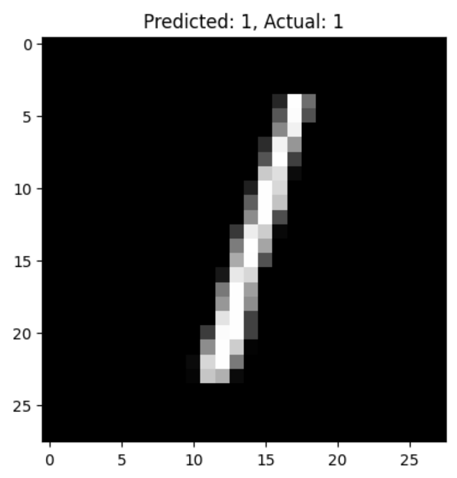

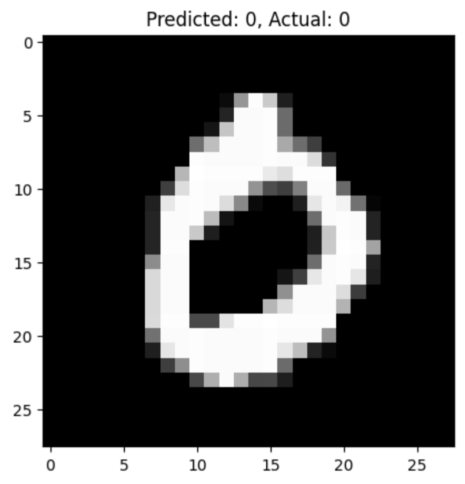

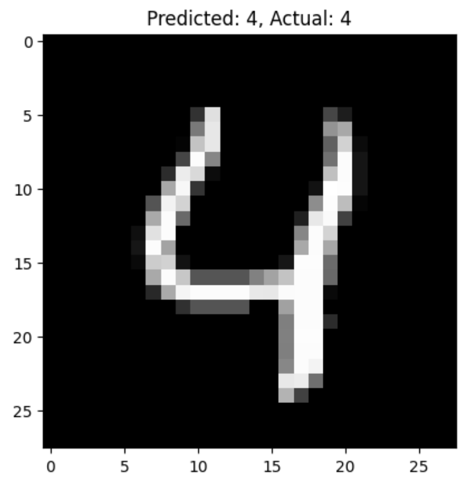

GOOGLE COLAB PROJECT LINK:https://colab.research.google.com/drive/1ERZQhstVOajZmELZwjWf1vAK0K6p5X6g#scrollTo=cnK3cPwUew03