Tanawin-st123975-CNN

October 8, 2023

[ ]:
```
!nvidia-smi
```

```
Sun Oct  8 13:05:19 2023
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 525.105.17   Driver Version: 525.105.17   CUDA Version: 12.0     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla T4            Off  | 00000000:00:04.0 Off |                    0 |
| N/A   50C    P8    10W /  70W |      0MiB / 15360MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

[ ]:
```
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras import layers, models
import numpy as np
import matplotlib.pyplot as plt
```

[ ]:
```
print(tf.config.list_physical_devices('GPU'))
```

```
[PhysicalDevice(name='/physical_device:GPU:0', device_type='GPU')]
```

[ ]:
```
# Load and preprocess the MNIST dataset
(train_images, train_labels), (test_images, test_labels) = mnist.load_data()

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

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz
11490434/11490434 [==============================] - 1s 0us/step
```

[ ]:
```
# Define the CNN model with more layers
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(128, activation='relu'),
    layers.Dropout(0.5),
    layers.Dense(64, activation='relu'),
    layers.Dropout(0.5),
    layers.Dense(10)
])



# Compile the model with SGD optimizer
optimizer = tf.keras.optimizers.SGD(learning_rate=0.01, momentum=0.9)
model.compile(optimizer=optimizer,
              loss=tf.keras.losses.
 ↪SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])

model.summary()
```

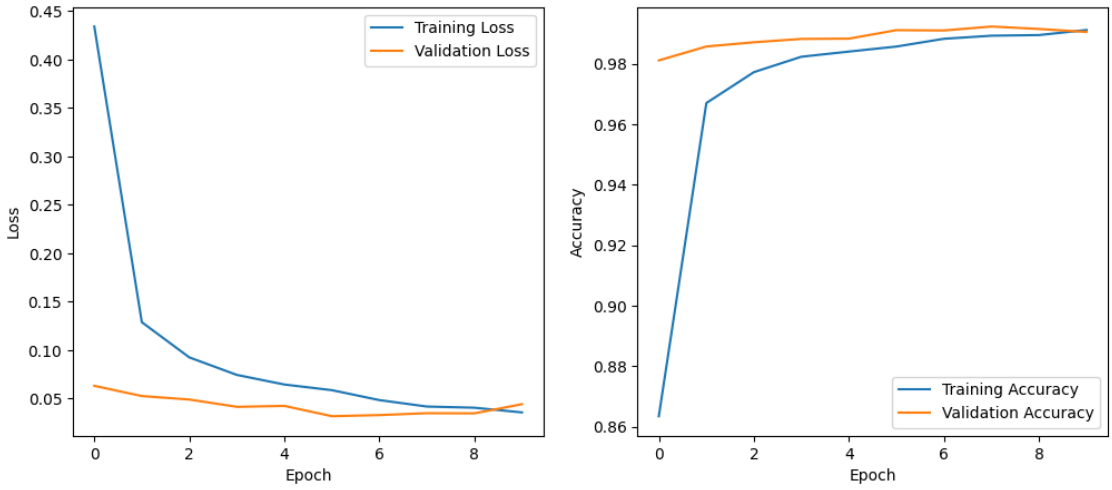
```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 32)        320

 max_pooling2d (MaxPooling2  (None, 13, 13, 32)        0
 D)

 conv2d_1 (Conv2D)           (None, 11, 11, 64)        18496

 max_pooling2d_1 (MaxPoolin  (None, 5, 5, 64)          0
 g2D)

 conv2d_2 (Conv2D)           (None, 3, 3, 64)          36928

 flatten (Flatten)           (None, 576)               0
```

```
 dense (Dense)               (None, 128)               73856

 dropout (Dropout)           (None, 128)               0

 dense_1 (Dense)             (None, 64)                8256

 dropout_1 (Dropout)         (None, 64)                0

 dense_2 (Dense)             (None, 10)                650

=================================================================
Total params: 138506 (541.04 KB)
Trainable params: 138506 (541.04 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

[ ]:
```
# Train the model and collect the training history
history = model.fit(train_images.reshape(-1, 28, 28, 1), train_labels,␣
 ↪epochs=10, validation_data=(test_images.reshape(-1, 28, 28, 1), test_labels))

model.save("my_cnn_model.h5")

# Plot the training loss and validation loss
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

# Plot the training accuracy and validation accuracy
plt.subplot(1, 2, 2)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.show()
```

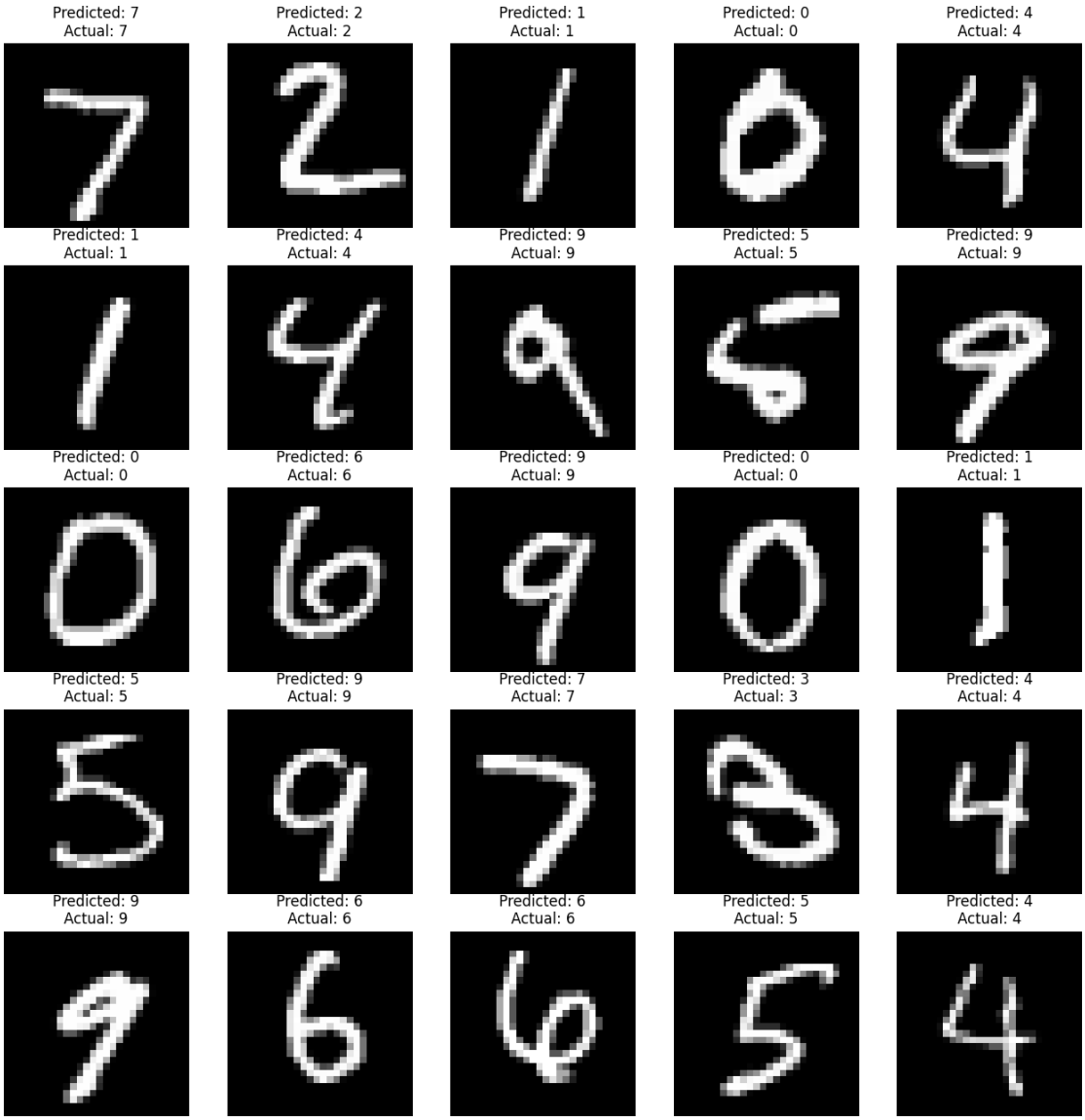
```
Epoch 1/10
1875/1875 [==============================] - 18s 4ms/step - loss: 0.4341 -
accuracy: 0.8634 - val_loss: 0.0633 - val_accuracy: 0.9811
Epoch 2/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.1289 -
accuracy: 0.9670 - val_loss: 0.0527 - val_accuracy: 0.9857
Epoch 3/10
```

```
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0926 -
accuracy: 0.9772 - val_loss: 0.0491 - val_accuracy: 0.9871
Epoch 4/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0745 -
accuracy: 0.9823 - val_loss: 0.0416 - val_accuracy: 0.9882
Epoch 5/10
1875/1875 [==============================] - 7s 3ms/step - loss: 0.0646 -
accuracy: 0.9840 - val_loss: 0.0425 - val_accuracy: 0.9883
Epoch 6/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0588 -
accuracy: 0.9857 - val_loss: 0.0319 - val_accuracy: 0.9911
Epoch 7/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0485 -
accuracy: 0.9883 - val_loss: 0.0331 - val_accuracy: 0.9910
Epoch 8/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0419 -
accuracy: 0.9893 - val_loss: 0.0350 - val_accuracy: 0.9923
Epoch 9/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0407 -
accuracy: 0.9895 - val_loss: 0.0348 - val_accuracy: 0.9915
Epoch 10/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0358 -
accuracy: 0.9912 - val_loss: 0.0443 - val_accuracy: 0.9905

/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3000:
UserWarning: You are saving your model as an HDF5 file via `model.save()`. This
file format is considered legacy. We recommend using instead the native Keras
format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(
```



[ ]:
```
# Make predictions on the test data
predictions = model.predict(test_images.reshape(-1, 28, 28, 1))

# Convert the raw predictions to class labels (0 to 9)
predicted_labels = np.argmax(predictions, axis=1)

# Display some sample predictions along with the actual labels
plt.figure(figsize=(16, 16))
for i in range(25):
    plt.subplot(5, 5, i + 1)
    plt.imshow(test_images[i], cmap='gray')
    plt.title(f"Predicted: {predicted_labels[i]}\nActual: {test_labels[i]}")
    plt.axis('off')

plt.show()
```

```
313/313 [==============================] - 1s 2ms/step
```


Predicted: 7
Actual: 7
Predicted: 2
Actual: 2
Predicted: 1
Actual: 1
Predicted: 0
Actual: 0
Predicted: 4
Actual: 4
Predicted: 1
Actual: 1
Predicted: 4
Actual: 4
Predicted: 9
Actual: 9
Predicted: 5
Actual: 5
Predicted: 9
Actual: 9
Predicted: 0
Actual: 0
Predicted: 6
Actual: 6
Predicted: 9
Actual: 9
Predicted: 0
Actual: 0
Predicted: 1
Actual: 1
Predicted: 5
Actual: 5
Predicted: 9
Actual: 9
Predicted: 7
Actual: 7
Predicted: 3
Actual: 3
Predicted: 4
Actual: 4
Predicted: 9
Actual: 9
Predicted: 6
Actual: 6
Predicted: 6
Actual: 6
Predicted: 5
Actual: 5
Predicted: 4
Actual: 4