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```
import tensorflow as tf
from tensorflow.keras import layers, models

# Define the CNN model using tf.keras.Sequential
model = models.Sequential()

# Add the first convolutional layer with input shape (28, 28, 1) for MNIST images
model.add(layers.Conv2D(8, (3, 3), input_shape=(28, 28, 1), activation='relu', padding='same'))
model.add(layers.MaxPooling2D((2, 2)))

# Add the second convolutional layer
model.add(layers.Conv2D(16, (3, 3), input_shape=(14, 14), padding='same', activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))

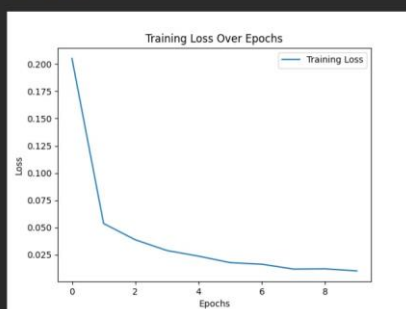
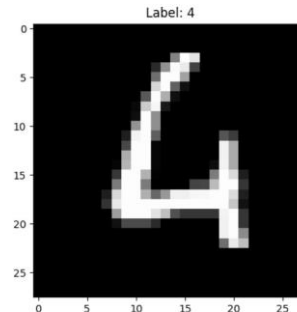
# Add the third convolutional layer
model.add(layers.Conv2D(32, (3, 3), input_shape=(7, 7), padding='same', activation='relu'))

# Flatten the output for the fully connected layers
model.add(layers.Flatten())

# Add the first fully connected layer
model.add(layers.Dense(128, input_shape=(1, 1568), activation='relu'))
model.add(layers.Dropout(0.2))

# Add the output layer with 10 units for the 10 classes in MNIST
model.add(layers.Dense(10, input_shape=(1, 128), activation='softmax'))

# Display the model summary
model.summary()
```



```
750/750 [=====] - 8s 11ms/step - loss: 0.0119 - accuracy: 0.9961 - val_loss: 0.0398 - val_accuracy: 0.9894
Epoch 9/10
750/750 [=====] - 8s 11ms/step - loss: 0.0122 - accuracy: 0.9965 - val_loss: 0.0428 - val_accuracy: 0.9892
Epoch 10/10
750/750 [=====] - 8s 11ms/step - loss: 0.0102 - accuracy: 0.9966 - val_loss: 0.0480 - val_accuracy: 0.9884
313/313 [=====] - 1s 4ms/step - loss: 0.0354 - accuracy: 0.9900
Test Accuracy: 0.9900000095367432
Process finished with exit code 0
```

Task1: list the 5 activation function

1. Sign(signum)
- 2.sigmoid
3. ReLU
4. Piece-wise linear
5. Hyperbolic tangent

Task 3: a) what is adam?

Adam combines ideas from two other optimization methods, RMSprop and Momentum. It adapts the learning rates of each parameter individually, allowing for dynamic adjustments during training. This adaptability often helps converge faster and handle different types of data and model architectures effectively.

b) what does sparse categorical crossentropy mean ?

Sparse Categorical Crossentropy is a loss function used in classification tasks where the classes are mutually exclusive (each instance can belong to only one class). It is suitable when your labels are integers (e.g., 0 for class 0, 1 for class 1) rather than one-hot encoded vectors. The function calculates the cross entropy between the predicted probabilities and the true class labels.

c) what does "epoch" mean ?

An epoch is one complete pass through the entire training dataset during the training of a machine learning model. During each epoch, the model processes the entire dataset, computes the loss, and adjusts its parameters based on the optimization algorithm. Training for multiple epochs allows the model to learn patterns in the data, with each epoch refining the model's parameters to improve performance.

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