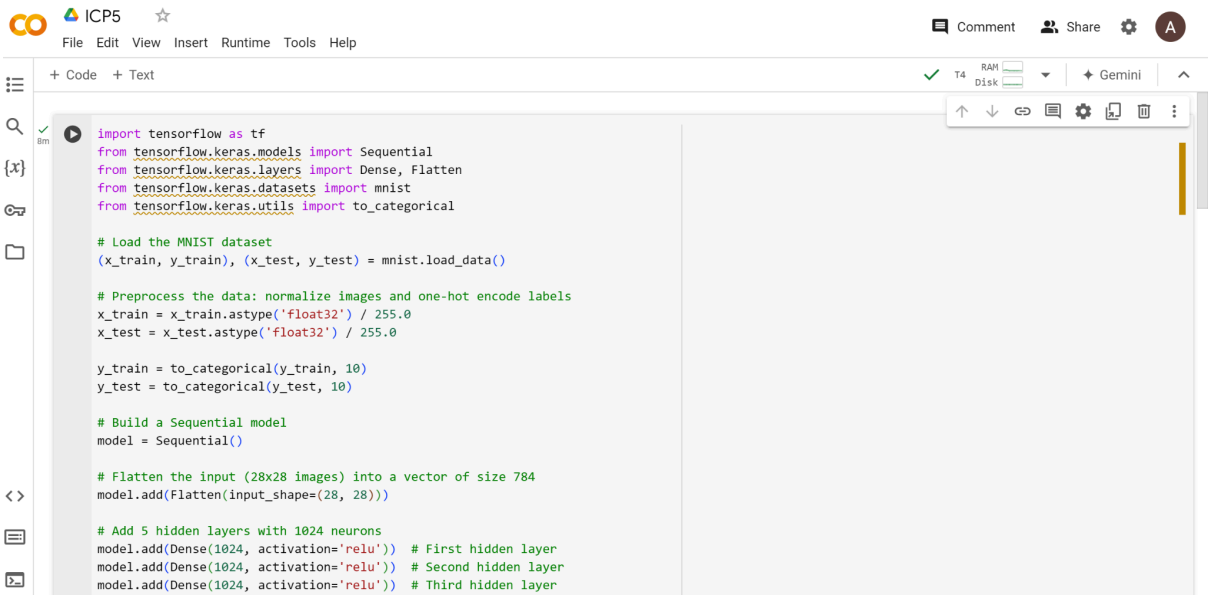
ICP5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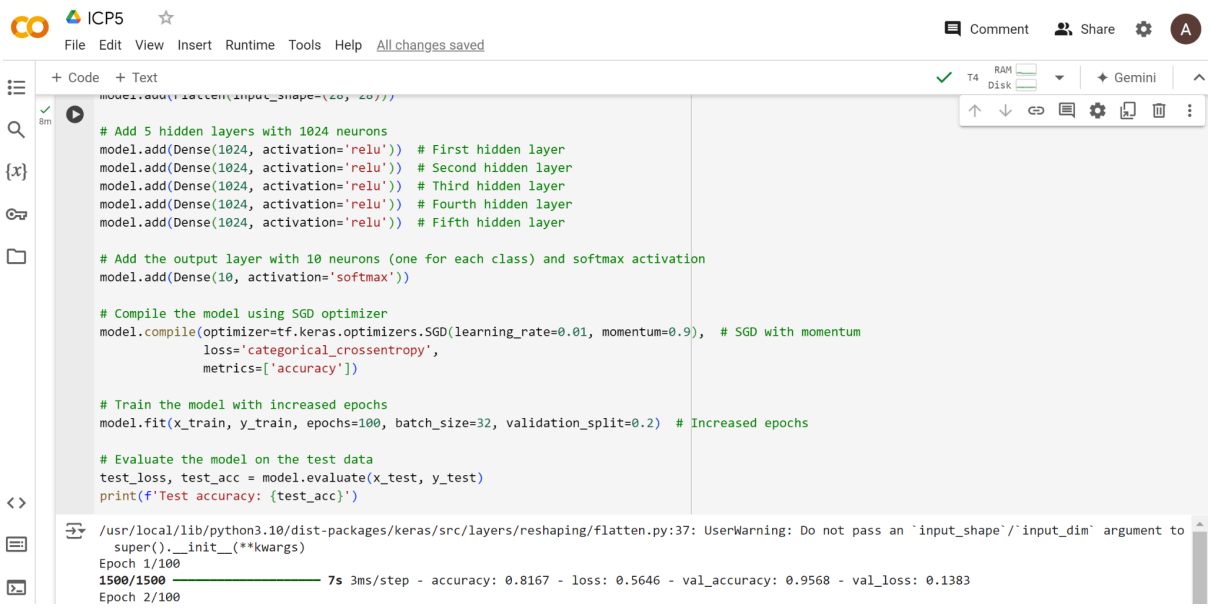
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
# Load the MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()
# Preprocess the data: normalize images and one-hot encode labels
x_train = x_train.astype('float32') / 255.0
x_test = x_test.astype('float32') / 255.0
y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)
# Build a Sequential model
model = Sequential()
# Flatten the input (28x28 images) into a vector of size 784
model.add(Flatten(input_shape=(28, 28)))
# Add 5 hidden layers with 1024 neurons
model.add(Dense(1024, activation='relu')) # First hidden layer
model.add(Dense(1024, activation='relu')) # Second hidden layer
model.add(Dense(1024, activation='relu')) # Third hidden layer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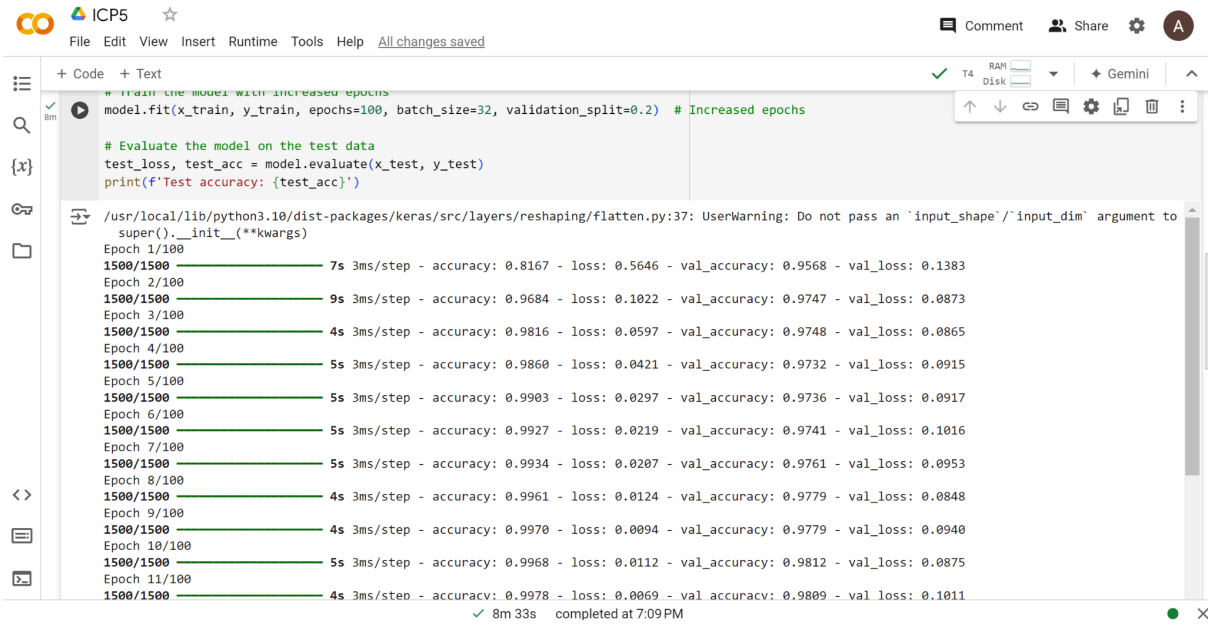
Add 5 hidden layers with 1024 neurons
model.add(Dense(1024, activation='relu')) # First hidden layer
model.add(Dense(1024, activation='relu')) # Second hidden layer
model.add(Dense(1024, activation='relu')) # Third hidden layer
model.add(Dense(1024, activation='relu')) # Fourth hidden layer
model.add(Dense(1024, activation='relu')) # Fifth hidden layer
# Add the output layer with 10 neurons (one for each class) and softmax activation
model.add(Dense(10, activation='softmax'))
# Compile the model using SGD optimizer
model.compile(optimizer=tf.keras.optimizers.SGD(learning_rate=0.01, momentum=0.9), # SGD with momentum
loss='categorical_crossentropy',
metrics=['accuracy'])
# Train the model with increased epochs
model.fit(x_train, y_train, epochs=100, batch_size=32, validation_split=0.2) # Increased epochs
Evaluate the model on the test data
test_loss, test_acc = model.evaluate(x_test, y_test)
print(f'Test accuracy: {test_acc}')
/usr/local/lib/python3.10/dist-packages/keras/src/layers/reshaping/flatten.py:37: UserWarning: Do not pass an `input_shape`/`input_dim` argument to
super().__init__(**kwargs)
Epoch 1/100
1500/1500 7s 3ms/step - accuracy: 0.8167 - loss: 0.5646 - val_accuracy: 0.9568 - val_loss: 0.1383
Epoch 2/100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Train the model with increased epochs
model.fit(x_train, y_train, epochs=100, batch_size=32, validation_split=0.2) # Increased epochs
Evaluate the model on the test data
test_loss, test_acc = model.evaluate(x_test, y_test)
print(f'Test accuracy: {test_acc}')
/usr/local/lib/python3.10/dist-packages/keras/src/layers/reshaping/flatten.py:37: UserWarning: Do not pass an `input_shape`/`input_dim` argument to
super().__init__(**kwargs)
Epoch 1/100
1500/1500 7s 3ms/step - accuracy: 0.8167 - loss: 0.5646 - val_accuracy: 0.9568 - val_loss: 0.1383
Epoch 2/100
1500/1500 9s 3ms/step - accuracy: 0.9684 - loss: 0.1022 - val_accuracy: 0.9747 - val_loss: 0.0873
Epoch 3/100
1500/1500 4s 3ms/step - accuracy: 0.9816 - loss: 0.0597 - val_accuracy: 0.9748 - val_loss: 0.0865
Epoch 4/100
1500/1500 5s 3ms/step - accuracy: 0.9860 - loss: 0.0421 - val_accuracy: 0.9732 - val_loss: 0.0915
Epoch 5/100
1500/1500 5s 3ms/step - accuracy: 0.9903 - loss: 0.0297 - val_accuracy: 0.9736 - val_loss: 0.0917
Epoch 6/100
1500/1500 5s 3ms/step - accuracy: 0.9927 - loss: 0.0219 - val_accuracy: 0.9741 - val_loss: 0.1016
Epoch 7/100
1500/1500 5s 3ms/step - accuracy: 0.9934 - loss: 0.0207 - val_accuracy: 0.9761 - val_loss: 0.0953
Epoch 8/100
1500/1500 4s 3ms/step - accuracy: 0.9961 - loss: 0.0124 - val_accuracy: 0.9779 - val_loss: 0.0848
Epoch 9/100
1500/1500 4s 3ms/step - accuracy: 0.9970 - loss: 0.0094 - val_accuracy: 0.9779 - val_loss: 0.0940
Epoch 10/100
1500/1500 5s 3ms/step - accuracy: 0.9968 - loss: 0.0112 - val_accuracy: 0.9812 - val_loss: 0.0875
Epoch 11/100
1500/1500 4s 3ms/step - accuracy: 0.9978 - loss: 0.0069 - val_accuracy: 0.9809 - val_loss: 0.1011
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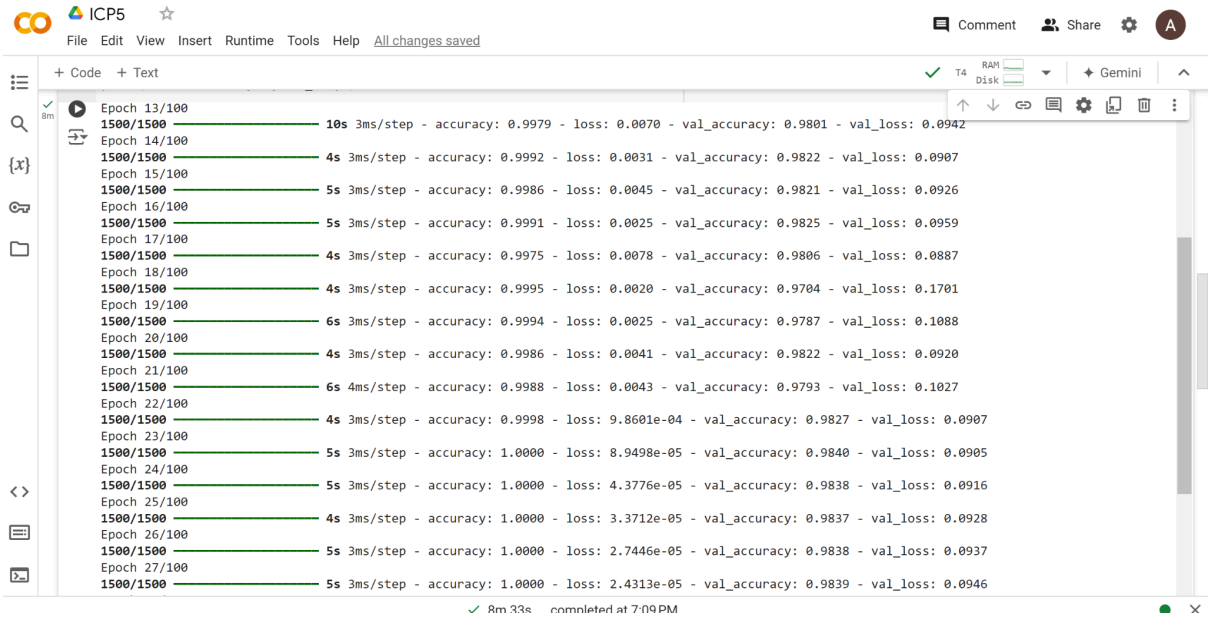
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Epoch 13/100
1500/1500 10s 3ms/step - accuracy: 0.9979 - loss: 0.0070 - val_accuracy: 0.9801 - val_loss: 0.0942
Epoch 14/100
1500/1500 4s 3ms/step - accuracy: 0.9992 - loss: 0.0031 - val_accuracy: 0.9822 - val_loss: 0.0907
Epoch 15/100
1500/1500 5s 3ms/step - accuracy: 0.9986 - loss: 0.0045 - val_accuracy: 0.9821 - val_loss: 0.0926
Epoch 16/100
1500/1500 5s 3ms/step - accuracy: 0.9991 - loss: 0.0025 - val_accuracy: 0.9825 - val_loss: 0.0959
Epoch 17/100
1500/1500 4s 3ms/step - accuracy: 0.9975 - loss: 0.0078 - val_accuracy: 0.9806 - val_loss: 0.0887
Epoch 18/100
1500/1500 4s 3ms/step - accuracy: 0.9995 - loss: 0.0020 - val_accuracy: 0.9704 - val_loss: 0.1701
Epoch 19/100
1500/1500 6s 3ms/step - accuracy: 0.9994 - loss: 0.0025 - val_accuracy: 0.9787 - val_loss: 0.1088
Epoch 20/100
1500/1500 4s 3ms/step - accuracy: 0.9986 - loss: 0.0041 - val_accuracy: 0.9822 - val_loss: 0.0920
Epoch 21/100
1500/1500 6s 4ms/step - accuracy: 0.9988 - loss: 0.0043 - val_accuracy: 0.9793 - val_loss: 0.1027
Epoch 22/100
1500/1500 4s 3ms/step - accuracy: 0.9998 - loss: 9.8601e-04 - val_accuracy: 0.9827 - val_loss: 0.0907
Epoch 23/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 8.9498e-05 - val_accuracy: 0.9840 - val_loss: 0.0905
Epoch 24/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 4.3776e-05 - val_accuracy: 0.9838 - val_loss: 0.0916
Epoch 25/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 3.3712e-05 - val_accuracy: 0.9837 - val_loss: 0.0928
Epoch 26/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 2.7446e-05 - val_accuracy: 0.9838 - val_loss: 0.0937
Epoch 27/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 2.4313e-05 - val_accuracy: 0.9839 - val_loss: 0.0946
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1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 2.4313e-05 - val_accuracy: 0.9839 - val_loss:
Epoch 28/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 2.1828e-05 - val_accuracy: 0.9841 - val_loss: 0.0953
Epoch 29/100
1500/1500 5s 4ms/step - accuracy: 1.0000 - loss: 1.8395e-05 - val_accuracy: 0.9841 - val_loss: 0.0960
Epoch 30/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 1.7977e-05 - val_accuracy: 0.9841 - val_loss: 0.0967
Epoch 31/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 1.6102e-05 - val_accuracy: 0.9842 - val_loss: 0.0972
Epoch 32/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 1.3985e-05 - val_accuracy: 0.9841 - val_loss: 0.0978
Epoch 33/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 1.2513e-05 - val_accuracy: 0.9842 - val_loss: 0.0983
Epoch 34/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 1.1675e-05 - val_accuracy: 0.9842 - val_loss: 0.0988
Epoch 35/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 1.1012e-05 - val_accuracy: 0.9843 - val_loss: 0.0992
Epoch 36/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 9.8778e-06 - val_accuracy: 0.9843 - val_loss: 0.0996
Epoch 37/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 9.6201e-06 - val_accuracy: 0.9843 - val_loss: 0.1001
Epoch 38/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 9.2972e-06 - val_accuracy: 0.9843 - val_loss: 0.1005
Epoch 39/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 7.3724e-06 - val_accuracy: 0.9843 - val_loss: 0.1008
Epoch 40/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 8.1735e-06 - val_accuracy: 0.9843 - val_loss: 0.1012
Epoch 41/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 7.9859e-06 - val_accuracy: 0.9843 - val_loss: 0.1015
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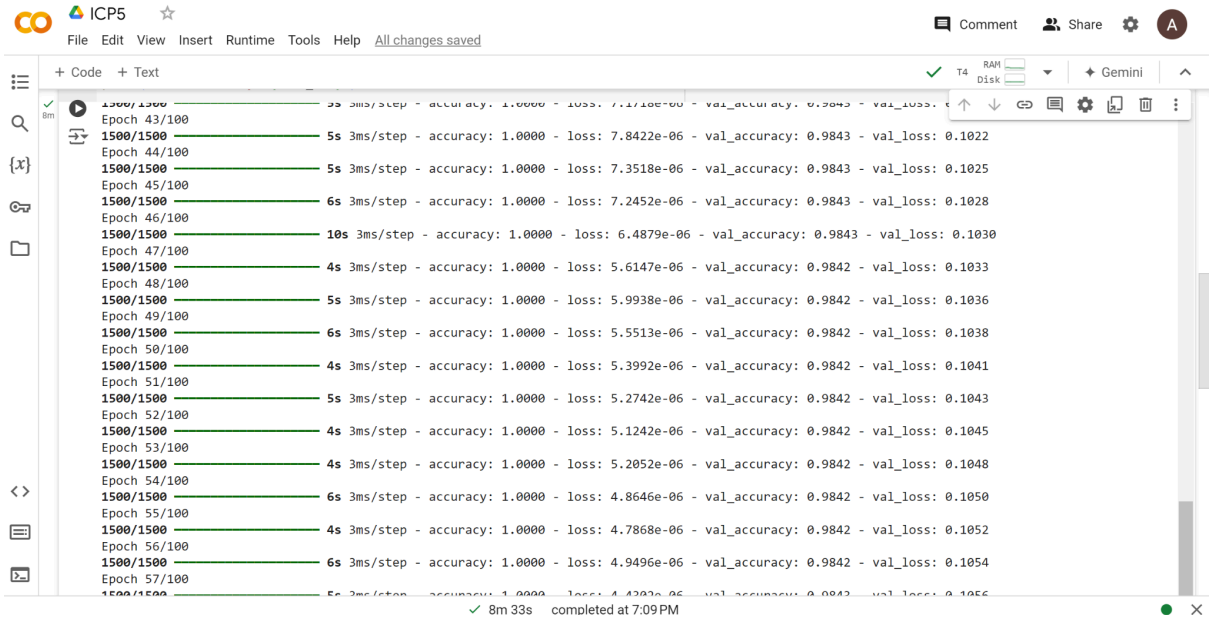
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Epoch 43/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 7.8422e-06 - val_accuracy: 0.9843 - val_loss: 0.1022
Epoch 44/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 7.3518e-06 - val_accuracy: 0.9843 - val_loss: 0.1025
Epoch 45/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 7.2452e-06 - val_accuracy: 0.9843 - val_loss: 0.1028
Epoch 46/100
1500/1500 10s 3ms/step - accuracy: 1.0000 - loss: 6.4879e-06 - val_accuracy: 0.9843 - val_loss: 0.1030
Epoch 47/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 5.6147e-06 - val_accuracy: 0.9842 - val_loss: 0.1033
Epoch 48/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 5.9938e-06 - val_accuracy: 0.9842 - val_loss: 0.1036
Epoch 49/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 5.5513e-06 - val_accuracy: 0.9842 - val_loss: 0.1038
Epoch 50/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 5.3992e-06 - val_accuracy: 0.9842 - val_loss: 0.1041
Epoch 51/100
1500/1500 5s 3ms/step - accuracy: 1.0000 - loss: 5.2742e-06 - val_accuracy: 0.9842 - val_loss: 0.1043
Epoch 52/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 5.1242e-06 - val_accuracy: 0.9842 - val_loss: 0.1045
Epoch 53/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 5.2052e-06 - val_accuracy: 0.9842 - val_loss: 0.1048
Epoch 54/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 4.8646e-06 - val_accuracy: 0.9842 - val_loss: 0.1050
Epoch 55/100
1500/1500 4s 3ms/step - accuracy: 1.0000 - loss: 4.7868e-06 - val_accuracy: 0.9842 - val_loss: 0.1052
Epoch 56/100
1500/1500 6s 3ms/step - accuracy: 1.0000 - loss: 4.9496e-06 - val_accuracy: 0.9842 - val_loss: 0.1054
Epoch 57/100
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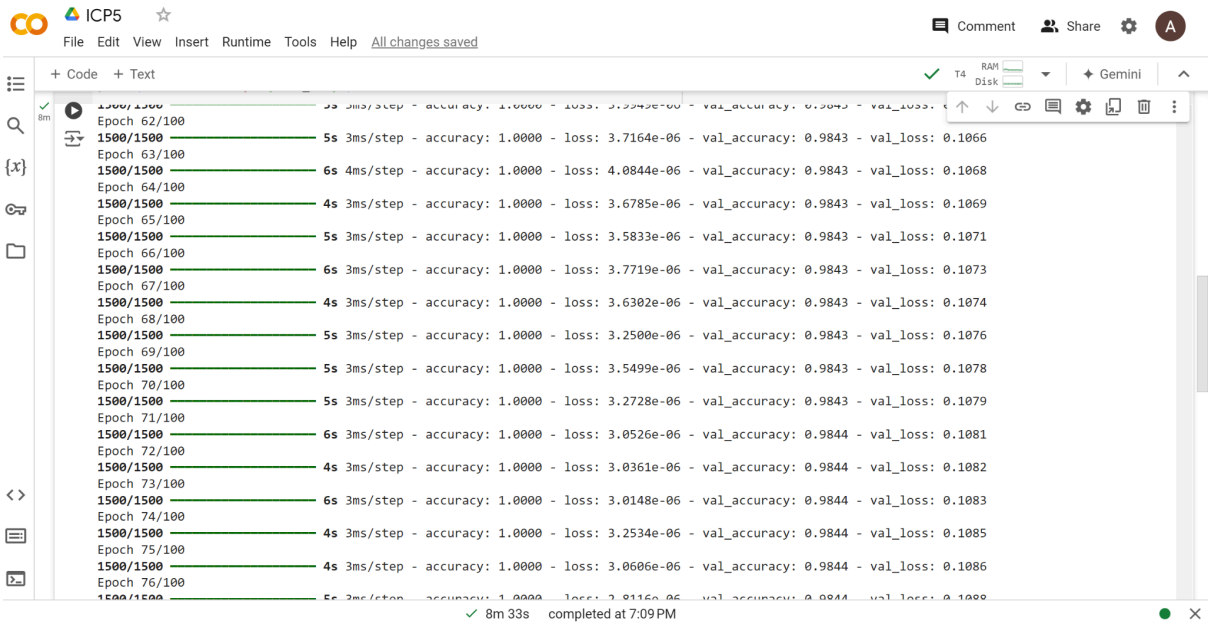

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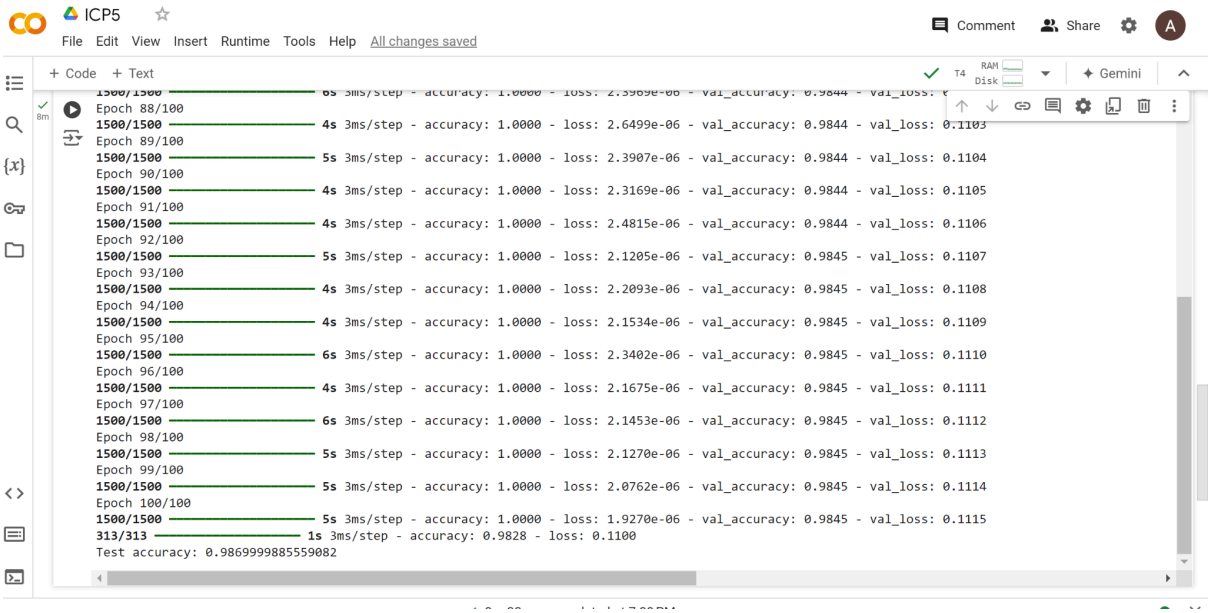

My GitHub link:https://github.com/w8162583/bda.git

My Youtube link:https://youtu.be/vhllebxLZ-0