```python
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten, Dropout, BatchNormalization
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical

(x_train, y_train), (x_test, y_test) = mnist.load_data()

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)

model = Sequential()

model.add(Flatten(input_shape=(28, 28)))

model.add(Dense(1024, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(512, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(256, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(128, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(64, activation='relu'))
```

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```python
model.add(Dropout(0.3))

model.add(Dense(128, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(64, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.3))

model.add(Dense(10, activation='softmax'))

optimizer = tf.keras.optimizers.Adam(learning_rate=0.0001)
model.compile(optimizer=optimizer,
              loss='categorical_crossentropy',
              metrics=['accuracy'])

model.fit(x_train, y_train, epochs=100, batch_size=64, validation_split=0.2)

test_loss, test_acc = model.evaluate(x_test, y_test)
print(f'Test accuracy: {test_acc}')
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
/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 a laye
  super().__init__(**kwargs)
Epoch 1/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 15s 6ms/step - accuracy: 0.4478 - loss: 1.7879 - val_accuracy: 0.9139 - val_loss: 0.3079
Epoch 2/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.8421 - loss: 0.5467 - val_accuracy: 0.9438 - val_loss: 0.1913
Epoch 3/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 5s 5ms/step - accuracy: 0.8970 - loss: 0.3715 - val_accuracy: 0.9575 - val_loss: 0.1459
Epoch 4/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 5s 5ms/step - accuracy: 0.9241 - loss: 0.2754 - val_accuracy: 0.9656 - val_loss: 0.1190
Epoch 5/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 4s 5ms/step - accuracy: 0.9372 - loss: 0.2260 - val_accuracy: 0.9685 - val_loss: 0.1082
Epoch 6/100
750/750 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.9495 - loss: 0.1801 - val_accuracy: 0.9709 - val_loss: 0.0957
Epoch 7/100
```

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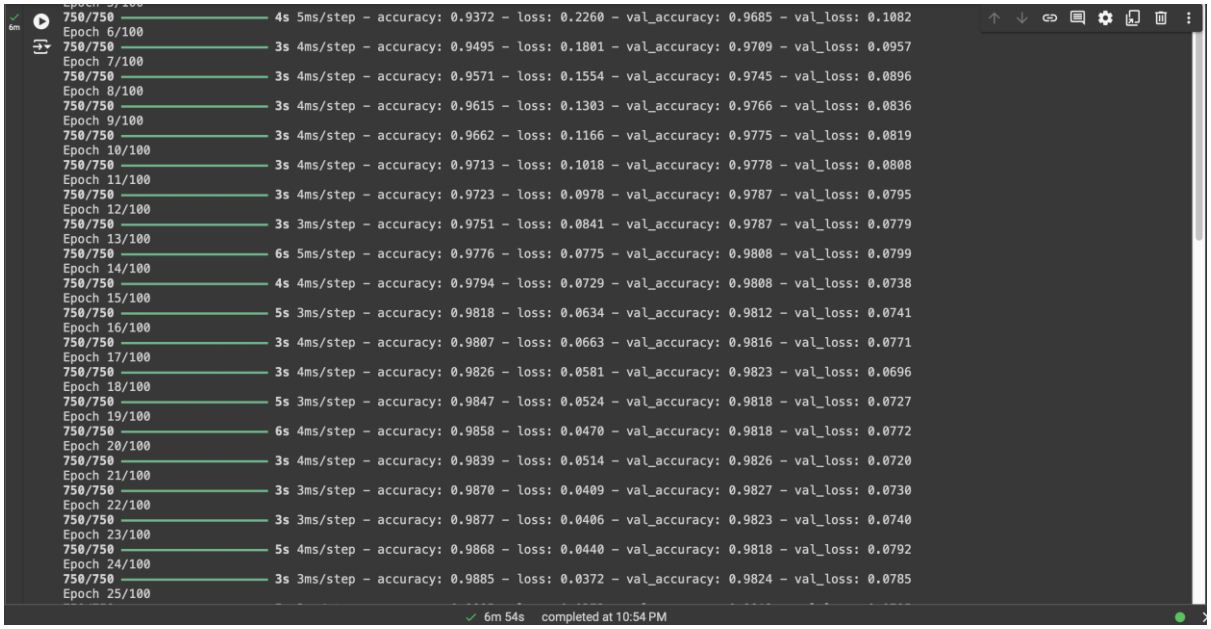
750/750 4s 5ms/step - accuracy: 0.9372 - loss: 0.2260 - val_accuracy: 0.9685 - val_loss: 0.1082
Epoch 6/100
750/750 3s 4ms/step - accuracy: 0.9495 - loss: 0.1801 - val_accuracy: 0.9709 - val_loss: 0.0957
Epoch 7/100
750/750 3s 4ms/step - accuracy: 0.9571 - loss: 0.1554 - val_accuracy: 0.9745 - val_loss: 0.0896
Epoch 8/100
750/750 3s 4ms/step - accuracy: 0.9615 - loss: 0.1303 - val_accuracy: 0.9766 - val_loss: 0.0836
Epoch 9/100
750/750 3s 4ms/step - accuracy: 0.9662 - loss: 0.1166 - val_accuracy: 0.9775 - val_loss: 0.0819
Epoch 10/100
750/750 3s 4ms/step - accuracy: 0.9713 - loss: 0.1018 - val_accuracy: 0.9778 - val_loss: 0.0808
Epoch 11/100
750/750 3s 4ms/step - accuracy: 0.9723 - loss: 0.0978 - val_accuracy: 0.9787 - val_loss: 0.0795
Epoch 12/100
750/750 3s 3ms/step - accuracy: 0.9751 - loss: 0.0841 - val_accuracy: 0.9787 - val_loss: 0.0779
Epoch 13/100
750/750 6s 5ms/step - accuracy: 0.9776 - loss: 0.0775 - val_accuracy: 0.9808 - val_loss: 0.0799
Epoch 14/100
750/750 4s 4ms/step - accuracy: 0.9794 - loss: 0.0729 - val_accuracy: 0.9808 - val_loss: 0.0738
Epoch 15/100
750/750 5s 3ms/step - accuracy: 0.9818 - loss: 0.0634 - val_accuracy: 0.9812 - val_loss: 0.0741
Epoch 16/100
750/750 3s 4ms/step - accuracy: 0.9807 - loss: 0.0663 - val_accuracy: 0.9816 - val_loss: 0.0771
Epoch 17/100
750/750 3s 4ms/step - accuracy: 0.9826 - loss: 0.0581 - val_accuracy: 0.9823 - val_loss: 0.0696
Epoch 18/100
750/750 5s 3ms/step - accuracy: 0.9847 - loss: 0.0524 - val_accuracy: 0.9818 - val_loss: 0.0727
Epoch 19/100
750/750 6s 4ms/step - accuracy: 0.9858 - loss: 0.0470 - val_accuracy: 0.9818 - val_loss: 0.0772
Epoch 20/100
750/750 3s 4ms/step - accuracy: 0.9839 - loss: 0.0514 - val_accuracy: 0.9826 - val_loss: 0.0720
Epoch 21/100
750/750 3s 3ms/step - accuracy: 0.9870 - loss: 0.0409 - val_accuracy: 0.9827 - val_loss: 0.0730
Epoch 22/100
750/750 3s 3ms/step - accuracy: 0.9877 - loss: 0.0406 - val_accuracy: 0.9823 - val_loss: 0.0740
Epoch 23/100
750/750 5s 4ms/step - accuracy: 0.9868 - loss: 0.0440 - val_accuracy: 0.9818 - val_loss: 0.0792
Epoch 24/100
750/750 3s 3ms/step - accuracy: 0.9885 - loss: 0.0372 - val_accuracy: 0.9824 - val_loss: 0.0785
Epoch 25/100
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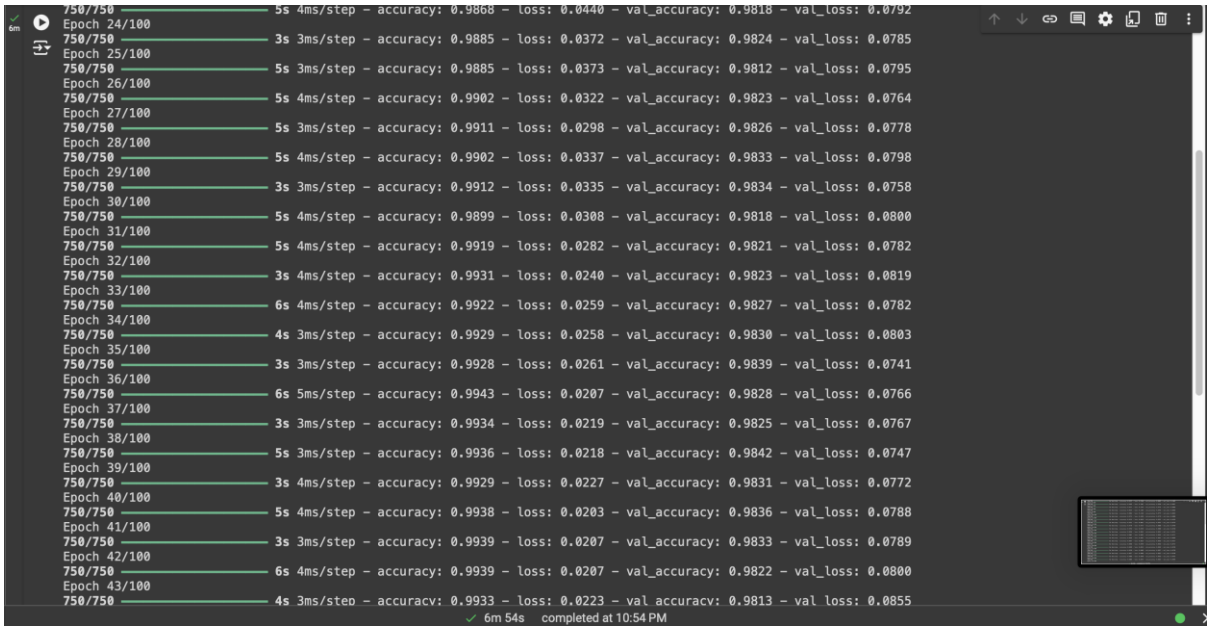
750/750 5s 4ms/step - accuracy: 0.9868 - loss: 0.0440 - val_accuracy: 0.9818 - val_loss: 0.0792
Epoch 24/100
750/750 3s 3ms/step - accuracy: 0.9885 - loss: 0.0372 - val_accuracy: 0.9824 - val_loss: 0.0785
Epoch 25/100
750/750 5s 3ms/step - accuracy: 0.9885 - loss: 0.0373 - val_accuracy: 0.9812 - val_loss: 0.0795
Epoch 26/100
750/750 5s 4ms/step - accuracy: 0.9902 - loss: 0.0322 - val_accuracy: 0.9823 - val_loss: 0.0764
Epoch 27/100
750/750 5s 3ms/step - accuracy: 0.9911 - loss: 0.0298 - val_accuracy: 0.9826 - val_loss: 0.0778
Epoch 28/100
750/750 5s 4ms/step - accuracy: 0.9902 - loss: 0.0337 - val_accuracy: 0.9833 - val_loss: 0.0798
Epoch 29/100
750/750 3s 3ms/step - accuracy: 0.9912 - loss: 0.0335 - val_accuracy: 0.9834 - val_loss: 0.0758
Epoch 30/100
750/750 5s 4ms/step - accuracy: 0.9899 - loss: 0.0308 - val_accuracy: 0.9818 - val_loss: 0.0800
Epoch 31/100
750/750 5s 4ms/step - accuracy: 0.9919 - loss: 0.0282 - val_accuracy: 0.9821 - val_loss: 0.0782
Epoch 32/100
750/750 3s 4ms/step - accuracy: 0.9931 - loss: 0.0240 - val_accuracy: 0.9823 - val_loss: 0.0819
Epoch 33/100
750/750 6s 4ms/step - accuracy: 0.9922 - loss: 0.0259 - val_accuracy: 0.9827 - val_loss: 0.0782
Epoch 34/100
750/750 4s 3ms/step - accuracy: 0.9929 - loss: 0.0258 - val_accuracy: 0.9830 - val_loss: 0.0803
Epoch 35/100
750/750 3s 3ms/step - accuracy: 0.9928 - loss: 0.0261 - val_accuracy: 0.9839 - val_loss: 0.0741
Epoch 36/100
750/750 6s 5ms/step - accuracy: 0.9943 - loss: 0.0207 - val_accuracy: 0.9828 - val_loss: 0.0766
Epoch 37/100
750/750 3s 3ms/step - accuracy: 0.9934 - loss: 0.0219 - val_accuracy: 0.9825 - val_loss: 0.0767
Epoch 38/100
750/750 5s 3ms/step - accuracy: 0.9936 - loss: 0.0218 - val_accuracy: 0.9842 - val_loss: 0.0747
Epoch 39/100
750/750 3s 4ms/step - accuracy: 0.9929 - loss: 0.0227 - val_accuracy: 0.9831 - val_loss: 0.0772
Epoch 40/100
750/750 5s 4ms/step - accuracy: 0.9938 - loss: 0.0203 - val_accuracy: 0.9836 - val_loss: 0.0788
Epoch 41/100
750/750 3s 3ms/step - accuracy: 0.9939 - loss: 0.0207 - val_accuracy: 0.9833 - val_loss: 0.0789
Epoch 42/100
750/750 6s 4ms/step - accuracy: 0.9939 - loss: 0.0207 - val_accuracy: 0.9822 - val_loss: 0.0800
Epoch 43/100
750/750 4s 3ms/step - accuracy: 0.9933 - loss: 0.0223 - val_accuracy: 0.9813 - val_loss: 0.0855
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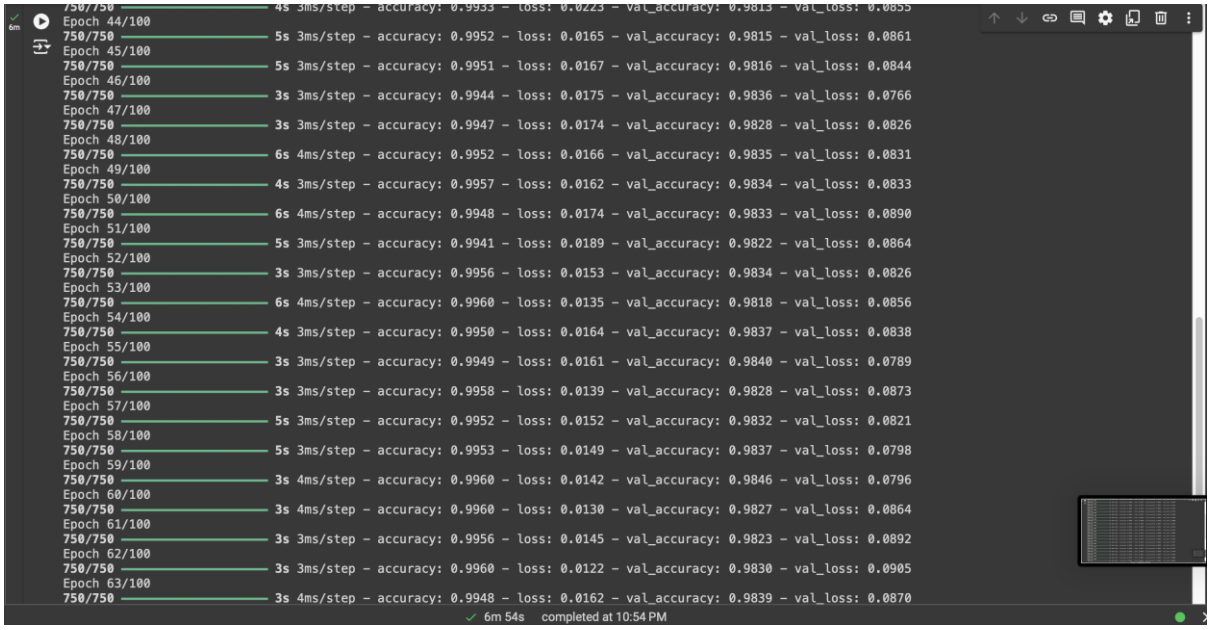
750/750 4s 3ms/step - accuracy: 0.9933 - loss: 0.0223 - val_accuracy: 0.9813 - val_loss: 0.0855
Epoch 44/100
750/750 5s 3ms/step - accuracy: 0.9952 - loss: 0.0165 - val_accuracy: 0.9815 - val_loss: 0.0861
Epoch 45/100
750/750 5s 3ms/step - accuracy: 0.9951 - loss: 0.0167 - val_accuracy: 0.9816 - val_loss: 0.0844
Epoch 46/100
750/750 3s 3ms/step - accuracy: 0.9944 - loss: 0.0175 - val_accuracy: 0.9836 - val_loss: 0.0766
Epoch 47/100
750/750 3s 3ms/step - accuracy: 0.9947 - loss: 0.0174 - val_accuracy: 0.9828 - val_loss: 0.0826
Epoch 48/100
750/750 6s 4ms/step - accuracy: 0.9952 - loss: 0.0166 - val_accuracy: 0.9835 - val_loss: 0.0831
Epoch 49/100
750/750 4s 3ms/step - accuracy: 0.9957 - loss: 0.0162 - val_accuracy: 0.9834 - val_loss: 0.0833
Epoch 50/100
750/750 6s 4ms/step - accuracy: 0.9948 - loss: 0.0174 - val_accuracy: 0.9833 - val_loss: 0.0890
Epoch 51/100
750/750 5s 3ms/step - accuracy: 0.9941 - loss: 0.0189 - val_accuracy: 0.9822 - val_loss: 0.0864
Epoch 52/100
750/750 3s 3ms/step - accuracy: 0.9956 - loss: 0.0153 - val_accuracy: 0.9834 - val_loss: 0.0826
Epoch 53/100
750/750 6s 4ms/step - accuracy: 0.9960 - loss: 0.0135 - val_accuracy: 0.9818 - val_loss: 0.0856
Epoch 54/100
750/750 4s 3ms/step - accuracy: 0.9950 - loss: 0.0164 - val_accuracy: 0.9837 - val_loss: 0.0838
Epoch 55/100
750/750 3s 3ms/step - accuracy: 0.9949 - loss: 0.0161 - val_accuracy: 0.9840 - val_loss: 0.0789
Epoch 56/100
750/750 3s 3ms/step - accuracy: 0.9958 - loss: 0.0139 - val_accuracy: 0.9828 - val_loss: 0.0873
Epoch 57/100
750/750 5s 3ms/step - accuracy: 0.9952 - loss: 0.0152 - val_accuracy: 0.9832 - val_loss: 0.0821
Epoch 58/100
750/750 5s 3ms/step - accuracy: 0.9953 - loss: 0.0149 - val_accuracy: 0.9837 - val_loss: 0.0798
Epoch 59/100
750/750 3s 4ms/step - accuracy: 0.9960 - loss: 0.0142 - val_accuracy: 0.9846 - val_loss: 0.0796
Epoch 60/100
750/750 3s 4ms/step - accuracy: 0.9960 - loss: 0.0130 - val_accuracy: 0.9827 - val_loss: 0.0864
Epoch 61/100
750/750 3s 3ms/step - accuracy: 0.9956 - loss: 0.0145 - val_accuracy: 0.9823 - val_loss: 0.0892
Epoch 62/100
750/750 3s 3ms/step - accuracy: 0.9960 - loss: 0.0122 - val_accuracy: 0.9830 - val_loss: 0.0905
Epoch 63/100
750/750 3s 4ms/step - accuracy: 0.9948 - loss: 0.0162 - val_accuracy: 0.9839 - val_loss: 0.0870
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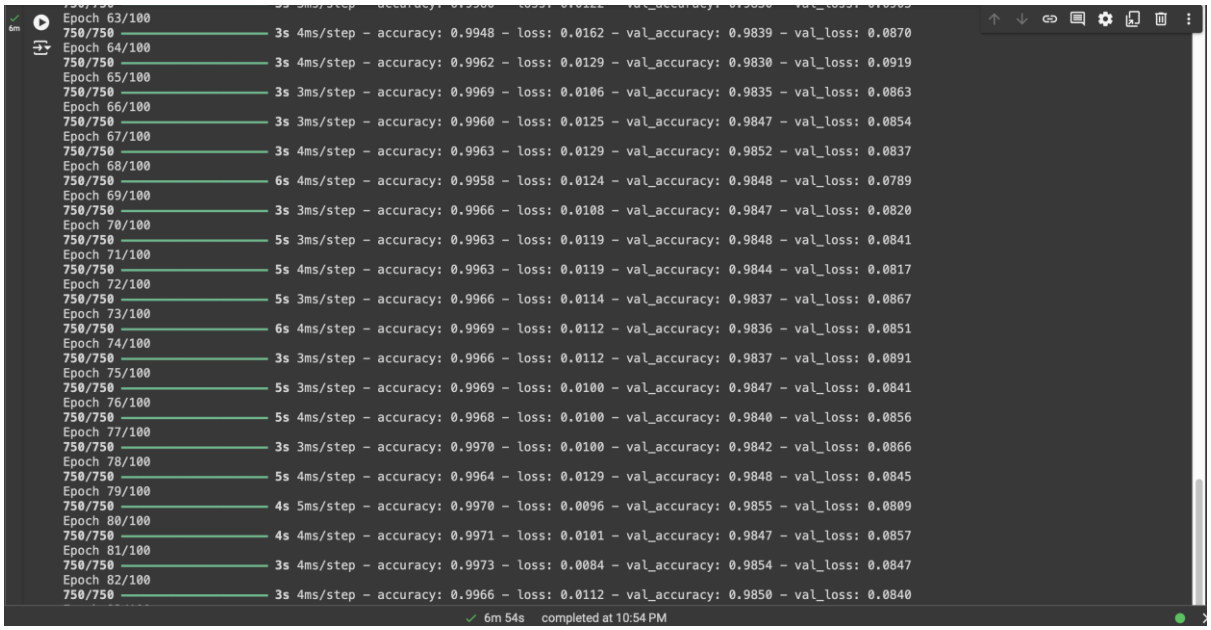
Epoch 63/100
750/750 3s 4ms/step - accuracy: 0.9948 - loss: 0.0162 - val_accuracy: 0.9839 - val_loss: 0.0870
Epoch 64/100
750/750 3s 4ms/step - accuracy: 0.9962 - loss: 0.0129 - val_accuracy: 0.9830 - val_loss: 0.0919
Epoch 65/100
750/750 3s 3ms/step - accuracy: 0.9969 - loss: 0.0106 - val_accuracy: 0.9835 - val_loss: 0.0863
Epoch 66/100
750/750 3s 3ms/step - accuracy: 0.9960 - loss: 0.0125 - val_accuracy: 0.9847 - val_loss: 0.0854
Epoch 67/100
750/750 3s 4ms/step - accuracy: 0.9963 - loss: 0.0129 - val_accuracy: 0.9852 - val_loss: 0.0837
Epoch 68/100
750/750 6s 4ms/step - accuracy: 0.9958 - loss: 0.0124 - val_accuracy: 0.9848 - val_loss: 0.0789
Epoch 69/100
750/750 3s 3ms/step - accuracy: 0.9966 - loss: 0.0108 - val_accuracy: 0.9847 - val_loss: 0.0820
Epoch 70/100
750/750 5s 3ms/step - accuracy: 0.9963 - loss: 0.0119 - val_accuracy: 0.9848 - val_loss: 0.0841
Epoch 71/100
750/750 5s 4ms/step - accuracy: 0.9963 - loss: 0.0119 - val_accuracy: 0.9844 - val_loss: 0.0817
Epoch 72/100
750/750 5s 3ms/step - accuracy: 0.9966 - loss: 0.0114 - val_accuracy: 0.9837 - val_loss: 0.0867
Epoch 73/100
750/750 6s 4ms/step - accuracy: 0.9969 - loss: 0.0112 - val_accuracy: 0.9836 - val_loss: 0.0851
Epoch 74/100
750/750 3s 3ms/step - accuracy: 0.9966 - loss: 0.0112 - val_accuracy: 0.9837 - val_loss: 0.0891
Epoch 75/100
750/750 5s 3ms/step - accuracy: 0.9969 - loss: 0.0100 - val_accuracy: 0.9847 - val_loss: 0.0841
Epoch 76/100
750/750 5s 4ms/step - accuracy: 0.9968 - loss: 0.0100 - val_accuracy: 0.9840 - val_loss: 0.0856
Epoch 77/100
750/750 3s 3ms/step - accuracy: 0.9970 - loss: 0.0100 - val_accuracy: 0.9842 - val_loss: 0.0866
Epoch 78/100
750/750 5s 4ms/step - accuracy: 0.9964 - loss: 0.0129 - val_accuracy: 0.9848 - val_loss: 0.0845
Epoch 79/100
750/750 4s 5ms/step - accuracy: 0.9970 - loss: 0.0096 - val_accuracy: 0.9855 - val_loss: 0.0809
Epoch 80/100
750/750 4s 4ms/step - accuracy: 0.9971 - loss: 0.0101 - val_accuracy: 0.9847 - val_loss: 0.0857
Epoch 81/100
750/750 3s 4ms/step - accuracy: 0.9973 - loss: 0.0084 - val_accuracy: 0.9854 - val_loss: 0.0847
Epoch 82/100
750/750 3s 4ms/step - accuracy: 0.9966 - loss: 0.0112 - val_accuracy: 0.9850 - val_loss: 0.0840
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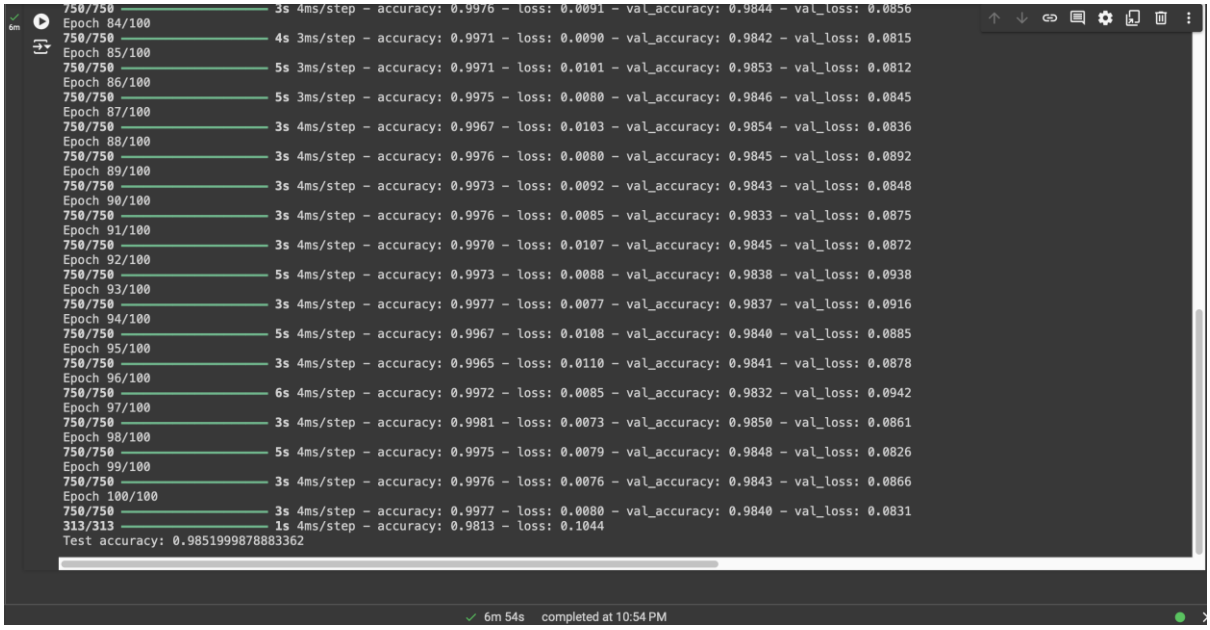

https://github.com/nithin1086/BDA