

# ICP4-REPORT

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+ Code + Text T4 RAM Disk Gemini
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```
5m ▶ #importing
import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten, Dropout
from tensorflow.keras.optimizers import SGD, RMSprop, Adam
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical

#Load the MINST 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 Model
model = Sequential()

#Flatten the input (28x28 images) into a vector of size 784
model.add(Flatten(input_shape=(28, 28)))

#Add a Five hidden layers with neurons and ReLU activation
act='relu'
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3m ▶ act='relu'
model.add(Dense(1024, activation=act))
model.add(Dense(1024, activation=act))
model.add(Dense(1024, activation=act))
model.add(Dense(1024, activation=act))
model.add(Dense(1024, activation=act))

#Add the output layer with 10 neurons (for 10 classes) and softmax activation
model.add(Dense(10, activation='softmax'))

#Compile the model
model.compile(optimizer='rmsprop',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

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

# Evaluate the model on the test data
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  
super().\_\_init\_\_(\*\*kwargs)  
Epoch 1/100  
750/750 — 8s 5ms/step - accuracy: 0.8024 - loss: 0.6197 - val\_accuracy: 0.9603 - val\_loss: 0.1422  
Epoch 2/100  
750/750 — 8s 4ms/step - accuracy: 0.9654 - loss: 0.1297 - val\_accuracy: 0.9732 - val\_loss: 0.1005

+ Code + Text		✓ T4 RAM Disk			
✓ 5m	▶	Epoch 3/100			
		750/750	2s 3ms/step	accuracy: 0.9795 - loss: 0.0763 - val_accuracy: 0.9772 - val_loss: 0.0879	↑ ↓ ↺ 🗨
	↺	Epoch 4/100			
		750/750	2s 3ms/step	accuracy: 0.9842 - loss: 0.0578 - val_accuracy: 0.9752 - val_loss: 0.1017	
		Epoch 5/100			
		750/750	3s 3ms/step	accuracy: 0.9881 - loss: 0.0449 - val_accuracy: 0.9742 - val_loss: 0.1383	
		Epoch 6/100			
		750/750	3s 4ms/step	accuracy: 0.9896 - loss: 0.0382 - val_accuracy: 0.9779 - val_loss: 0.1412	
		Epoch 7/100			
		750/750	4s 5ms/step	accuracy: 0.9921 - loss: 0.0305 - val_accuracy: 0.9762 - val_loss: 0.1371	
		Epoch 8/100			
		750/750	5s 5ms/step	accuracy: 0.9923 - loss: 0.0273 - val_accuracy: 0.9795 - val_loss: 0.1198	
		Epoch 9/100			
		750/750	3s 5ms/step	accuracy: 0.9948 - loss: 0.0215 - val_accuracy: 0.9744 - val_loss: 0.1558	
		Epoch 10/100			
		750/750	6s 6ms/step	accuracy: 0.9953 - loss: 0.0176 - val_accuracy: 0.9793 - val_loss: 0.1517	
		Epoch 11/100			
		750/750	3s 4ms/step	accuracy: 0.9956 - loss: 0.0173 - val_accuracy: 0.9772 - val_loss: 0.1967	
		Epoch 12/100			
		750/750	3s 4ms/step	accuracy: 0.9955 - loss: 0.0171 - val_accuracy: 0.9803 - val_loss: 0.1710	
		Epoch 13/100			
		750/750	3s 3ms/step	accuracy: 0.9963 - loss: 0.0158 - val_accuracy: 0.9817 - val_loss: 0.1527	
		Epoch 14/100			
		750/750	3s 4ms/step	accuracy: 0.9977 - loss: 0.0095 - val_accuracy: 0.9773 - val_loss: 0.1730	
		Epoch 15/100			
		750/750	5s 3ms/step	accuracy: 0.9975 - loss: 0.0096 - val_accuracy: 0.9771 - val_loss: 0.1860	
		Epoch 16/100			
		750/750	2s 3ms/step	accuracy: 0.9976 - loss: 0.0111 - val_accuracy: 0.9808 - val_loss: 0.1806	
		Epoch 17/100			
		750/750	2s 3ms/step	accuracy: 0.9978 - loss: 0.0102 - val_accuracy: 0.9820 - val_loss: 0.1701	

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Epoch 18/100  
750/750 3s 4ms/step - accuracy: 0.9988 - loss: 0.0059 - val\_accuracy: 0.9803 - val\_loss: 0.1741  
Epoch 19/100  
750/750 4s 3ms/step - accuracy: 0.9991 - loss: 0.0052 - val\_accuracy: 0.9819 - val\_loss: 0.1950  
Epoch 20/100  
750/750 2s 3ms/step - accuracy: 0.9993 - loss: 0.0023 - val\_accuracy: 0.9763 - val\_loss: 0.2829  
Epoch 21/100  
750/750 3s 3ms/step - accuracy: 0.9988 - loss: 0.0056 - val\_accuracy: 0.9808 - val\_loss: 0.2553  
Epoch 22/100  
750/750 3s 4ms/step - accuracy: 0.9986 - loss: 0.0049 - val\_accuracy: 0.9792 - val\_loss: 0.1953  
Epoch 23/100  
750/750 2s 3ms/step - accuracy: 0.9991 - loss: 0.0037 - val\_accuracy: 0.9807 - val\_loss: 0.2405  
Epoch 24/100  
750/750 2s 3ms/step - accuracy: 0.9989 - loss: 0.0076 - val\_accuracy: 0.9822 - val\_loss: 0.2097  
Epoch 25/100  
750/750 2s 3ms/step - accuracy: 0.9991 - loss: 0.0049 - val\_accuracy: 0.9793 - val\_loss: 0.2431  
Epoch 26/100  
750/750 3s 3ms/step - accuracy: 0.9992 - loss: 0.0045 - val\_accuracy: 0.9826 - val\_loss: 0.2388  
Epoch 27/100  
750/750 3s 4ms/step - accuracy: 0.9986 - loss: 0.0074 - val\_accuracy: 0.9805 - val\_loss: 0.2352  
Epoch 28/100  
750/750 4s 3ms/step - accuracy: 0.9989 - loss: 0.0054 - val\_accuracy: 0.9793 - val\_loss: 0.2172  
Epoch 29/100  
750/750 2s 3ms/step - accuracy: 0.9992 - loss: 0.0038 - val\_accuracy: 0.9826 - val\_loss: 0.2355  
Epoch 30/100  
750/750 2s 3ms/step - accuracy: 0.9993 - loss: 0.0031 - val\_accuracy: 0.9786 - val\_loss: 0.2881  
Epoch 31/100  
750/750 3s 4ms/step - accuracy: 0.9987 - loss: 0.0062 - val\_accuracy: 0.9806 - val\_loss: 0.2260  
Epoch 32/100  
750/750 2s 3ms/step - accuracy: 0.9992 - loss: 0.0034 - val\_accuracy: 0.9783 - val\_loss: 0.2195

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Epoch 33/100  
750/750 2s 3ms/step - accuracy: 0.9993 - loss: 0.0027 - val\_accuracy: 0.9812 - val\_loss: 0.2342  
Epoch 34/100  
750/750 2s 3ms/step - accuracy: 0.9997 - loss: 0.0013 - val\_accuracy: 0.9822 - val\_loss: 0.2229  
Epoch 35/100  
750/750 3s 3ms/step - accuracy: 0.9996 - loss: 0.0020 - val\_accuracy: 0.9806 - val\_loss: 0.2516  
Epoch 36/100  
750/750 3s 4ms/step - accuracy: 0.9998 - loss: 0.0010 - val\_accuracy: 0.9808 - val\_loss: 0.2569  
Epoch 37/100  
750/750 2s 3ms/step - accuracy: 0.9997 - loss: 0.0017 - val\_accuracy: 0.9827 - val\_loss: 0.2292  
Epoch 38/100  
750/750 2s 3ms/step - accuracy: 0.9998 - loss: 8.4062e-04 - val\_accuracy: 0.9809 - val\_loss: 0.2457  
Epoch 39/100  
750/750 2s 3ms/step - accuracy: 0.9999 - loss: 9.3428e-04 - val\_accuracy: 0.9827 - val\_loss: 0.2143  
Epoch 40/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.2082e-04 - val\_accuracy: 0.9827 - val\_loss: 0.2427  
Epoch 41/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 5.4331e-06 - val\_accuracy: 0.9818 - val\_loss: 0.2672  
Epoch 42/100  
750/750 2s 3ms/step - accuracy: 0.9999 - loss: 3.1426e-04 - val\_accuracy: 0.9827 - val\_loss: 0.2533  
Epoch 43/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.1711e-04 - val\_accuracy: 0.9826 - val\_loss: 0.2784  
Epoch 44/100  
750/750 2s 3ms/step - accuracy: 0.9997 - loss: 0.0024 - val\_accuracy: 0.9797 - val\_loss: 0.2352  
Epoch 45/100  
750/750 2s 3ms/step - accuracy: 0.9995 - loss: 0.0026 - val\_accuracy: 0.9801 - val\_loss: 0.2861  
Epoch 46/100  
750/750 3s 4ms/step - accuracy: 0.9998 - loss: 7.1075e-04 - val\_accuracy: 0.9825 - val\_loss: 0.2588  
Epoch 47/100  
750/750 2s 3ms/step - accuracy: 0.9999 - loss: 5.0752e-04 - val\_accuracy: 0.9829 - val\_loss: 0.2679

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Epoch 48/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 2.0492e-06 - val\_accuracy: 0.9826 - val\_loss: 0.2666

Epoch 49/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.3626e-07 - val\_accuracy: 0.9824 - val\_loss: 0.2676

Epoch 50/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 2.7453e-07 - val\_accuracy: 0.9823 - val\_loss: 0.2686

Epoch 51/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 2.6576e-07 - val\_accuracy: 0.9824 - val\_loss: 0.2694

Epoch 52/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 1.9875e-07 - val\_accuracy: 0.9825 - val\_loss: 0.2701

Epoch 53/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.6135e-07 - val\_accuracy: 0.9825 - val\_loss: 0.2707

Epoch 54/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 1.5996e-07 - val\_accuracy: 0.9825 - val\_loss: 0.2713

Epoch 55/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.3402e-07 - val\_accuracy: 0.9825 - val\_loss: 0.2718

Epoch 56/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 1.4189e-07 - val\_accuracy: 0.9826 - val\_loss: 0.2723

Epoch 57/100  
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 1.4033e-07 - val\_accuracy: 0.9826 - val\_loss: 0.2728

Epoch 58/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.0565e-07 - val\_accuracy: 0.9826 - val\_loss: 0.2733

Epoch 59/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.0412e-07 - val\_accuracy: 0.9826 - val\_loss: 0.2737

Epoch 60/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 9.9981e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2741

Epoch 61/100  
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 6.9875e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2745

Epoch 62/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 1.0095e-07 - val\_accuracy: 0.9826 - val\_loss: 0.2749

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Epoch 63/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 8.0505e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2750

Epoch 64/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 6.4617e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2756

Epoch 65/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 8.5184e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2759

Epoch 66/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 8.2565e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2762

Epoch 67/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 7.3205e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2766

Epoch 68/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 6.1118e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2768

Epoch 69/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 5.1547e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2771

Epoch 70/100  
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 5.7586e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2774

Epoch 71/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 6.8109e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2777

Epoch 72/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 4.7924e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2779

Epoch 73/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 5.6404e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2782

Epoch 74/100  
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 5.9614e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2784

Epoch 75/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 6.6516e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2787

Epoch 76/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.7111e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2789

Epoch 77/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 6.0107e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2792

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Epoch 78/100  
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 5.1739e-08 - val\_accuracy: 0.9827 - val\_loss: 0.2796

Epoch 79/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 6.4196e-08 - val\_accuracy: 0.9827 - val\_loss: 0.2796

Epoch 80/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.8560e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2798

Epoch 81/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 4.5726e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2800

Epoch 82/100  
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 4.1586e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2802

Epoch 83/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 5.9109e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2804

Epoch 84/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.8359e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2806

Epoch 85/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 3.7439e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2808

Epoch 86/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 3.7392e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2810

Epoch 87/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.1770e-08 - val\_accuracy: 0.9826 - val\_loss: 0.2812

Epoch 88/100  
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 4.3376e-08 - val\_accuracy: 0.9825 - val\_loss: 0.2814

Epoch 89/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.5045e-08 - val\_accuracy: 0.9825 - val\_loss: 0.2816

Epoch 90/100  
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 3.5923e-08 - val\_accuracy: 0.9825 - val\_loss: 0.2817

Epoch 91/100  
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 2.3566e-08 - val\_accuracy: 0.9825 - val\_loss: 0.2819

Epoch 92/100  
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.7250e-08 - val\_accuracy: 0.9825 - val\_loss: 0.2821

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Epoch 78/100
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 5.1739e-08 - val_accuracy: 0.9827 - val_loss: 0.2822
Epoch 79/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 6.4196e-08 - val_accuracy: 0.9827 - val_loss: 0.2796
Epoch 80/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.8560e-08 - val_accuracy: 0.9826 - val_loss: 0.2798
Epoch 81/100
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 4.5726e-08 - val_accuracy: 0.9826 - val_loss: 0.2800
Epoch 82/100
750/750 4s 3ms/step - accuracy: 1.0000 - loss: 4.1586e-08 - val_accuracy: 0.9826 - val_loss: 0.2802
Epoch 83/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 5.9109e-08 - val_accuracy: 0.9826 - val_loss: 0.2804
Epoch 84/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.8359e-08 - val_accuracy: 0.9826 - val_loss: 0.2806
Epoch 85/100
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 3.7439e-08 - val_accuracy: 0.9826 - val_loss: 0.2808
Epoch 86/100
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 3.7392e-08 - val_accuracy: 0.9826 - val_loss: 0.2810
Epoch 87/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.1770e-08 - val_accuracy: 0.9826 - val_loss: 0.2812
Epoch 88/100
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 4.3376e-08 - val_accuracy: 0.9825 - val_loss: 0.2814
Epoch 89/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.5045e-08 - val_accuracy: 0.9825 - val_loss: 0.2816
Epoch 90/100
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 3.5923e-08 - val_accuracy: 0.9825 - val_loss: 0.2817
Epoch 91/100
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 2.3566e-08 - val_accuracy: 0.9825 - val_loss: 0.2819
Epoch 92/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 3.7250e-08 - val_accuracy: 0.9825 - val_loss: 0.2821
Epoch 93/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.2544e-08 - val_accuracy: 0.9825 - val_loss: 0.2822
Epoch 94/100
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 3.8276e-08 - val_accuracy: 0.9825 - val_loss: 0.2824
Epoch 95/100
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 4.0666e-08 - val_accuracy: 0.9825 - val_loss: 0.2826
Epoch 96/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 4.2794e-08 - val_accuracy: 0.9825 - val_loss: 0.2827
Epoch 97/100
750/750 3s 3ms/step - accuracy: 1.0000 - loss: 3.9812e-08 - val_accuracy: 0.9825 - val_loss: 0.2829
Epoch 98/100
750/750 3s 4ms/step - accuracy: 1.0000 - loss: 2.7806e-08 - val_accuracy: 0.9825 - val_loss: 0.2830
Epoch 99/100
750/750 5s 3ms/step - accuracy: 1.0000 - loss: 3.4375e-08 - val_accuracy: 0.9825 - val_loss: 0.2832
Epoch 100/100
750/750 2s 3ms/step - accuracy: 1.0000 - loss: 2.9671e-08 - val_accuracy: 0.9825 - val_loss: 0.2833
313/313 1s 3ms/step - accuracy: 0.9819 - loss: 0.2460
Test accuracy: 0.9850999712944031
```

GITHUB REPO:- <https://github.com/PraveenDondapati/bda.git>

YOUTUBE LINK:- <https://youtu.be/TR9ZNSfv1cl>