

```
# 20201CEI0003  
# 20201CEI00029  
# 20201CEI0095  
# 20201CEI0155
```

```
!pip install tensorflow
```

```
Requirement already satisfied: tensorflow in /usr/local/lib/python3.10/dist-packages (2.15.0)  
Requirement already satisfied: absl-py>=1.0.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: astunparse>=1.6.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: flatbuffers>=23.5.26 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: google-pasta>=0.1.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: h5py>=2.9.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: libclang>=13.0.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: ml-dtypes~0.2.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: numpy<2.0.0,>=1.23.5 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: opt-einsum>=2.3.2 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: six>=1.12.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: termcolor>=1.1.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: typing-extensions>=3.6.6 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: wrapt<1.15,>=1.11.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: grpcio<2.0,>=1.24.3 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: tensorboard<2.16,>=2.15 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: tensorflow-estimator<2.16,>=2.15.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: keras<2.16,>=2.15.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: wheel<1.0,>=0.23.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: google-auth-oauthlib<2,>=0.5 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: requests<3,>=2.21.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: cachetools<6.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: MarkupSafe>=2.1.1 in /usr/local/lib/python3.10/dist-packages (from werkzeug)  
Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in /usr/local/lib/python3.10/dist-packages (from tensorflow)  
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow)
```

```
from tensorflow import keras
from keras import layers

from matplotlib.pyplot import imshow
import numpy as np
import cv2
from keras.preprocessing.image import img_to_array
from tensorflow.keras.layers import Conv2D, MaxPooling2D, UpSampling2D
from tensorflow.keras.models import Sequential
np.random.seed(42)
SIZE=256
img_data=[]
img=cv2.imread('monalisa.png', 1) #Change 1 to 0 for grey images
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB) #Changing BGR to RGB to show images i
img=cv2.resize(img,(SIZE, SIZE))
img_data.append(img_to_array(img))
img_array = np.reshape(img_data, (len(img_data), SIZE, SIZE, 3))
img_array = img_array.astype('float32') / 255.
model = Sequential()
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', input_shape=(SIZ
model.add(MaxPooling2D((2, 2), padding='same'))
model.add(Conv2D(8, (3, 3), activation='relu', padding='same'))
model.add(MaxPooling2D((2, 2), padding='same'))
model.add(Conv2D(8, (3, 3), activation='relu', padding='same'))
model.add(MaxPooling2D((2, 2), padding='same'))
model.add(Conv2D(8, (3, 3), activation='relu', padding='same'))
model.add(UpSampling2D((2, 2)))
model.add(Conv2D(8, (3, 3), activation='relu', padding='same'))
model.add(UpSampling2D((2, 2)))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same'))
model.add(UpSampling2D((2, 2)))
model.add(Conv2D(3, (3, 3), activation='relu', padding='same'))
model.compile(optimizer='adam', loss='mean_squared_error', metrics=['accuracy'])
model.summary()
model.fit(img_array, img_array, epochs=500, shuffle=True)
print("Neural network output")
pred = model.predict(img_array)
imshow(pred[0].reshape(SIZE,SIZE,3), cmap="gray")
```

Model: "sequential\_3"

Layer (type)	Output Shape	Param #
<hr/>		
conv2d_21 (Conv2D)	(None, 256, 256, 32)	896
max_pooling2d_9 (MaxPooling2D)	(None, 128, 128, 32)	0
conv2d_22 (Conv2D)	(None, 128, 128, 8)	2312
max_pooling2d_10 (MaxPooling2D)	(None, 64, 64, 8)	0
conv2d_23 (Conv2D)	(None, 64, 64, 8)	584
max_pooling2d_11 (MaxPooling2D)	(None, 32, 32, 8)	0
conv2d_24 (Conv2D)	(None, 32, 32, 8)	584
up_sampling2d_9 (UpSampling2D)	(None, 64, 64, 8)	0
conv2d_25 (Conv2D)	(None, 64, 64, 8)	584
up_sampling2d_10 (UpSampling2D)	(None, 128, 128, 8)	0
conv2d_26 (Conv2D)	(None, 128, 128, 32)	2336
up_sampling2d_11 (UpSampling2D)	(None, 256, 256, 32)	0
conv2d_27 (Conv2D)	(None, 256, 256, 3)	867
<hr/>		
Total params: 8163 (31.89 KB)		
Trainable params: 8163 (31.89 KB)		
Non-trainable params: 0 (0.00 Byte)		

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Epoch 1/500

1/1 [=====] - 2s 2s/step - loss: 0.1119 - accuracy: 0.2481

Epoch 2/500

1/1 [=====] - 0s 198ms/step - loss: 0.1087 - accuracy: 0.2391

Epoch 3/500

1/1 [=====] - 0s 204ms/step - loss: 0.1045 - accuracy: 0.2269

Epoch 4/500

1/1 [=====] - 0s 207ms/step - loss: 0.0985 - accuracy: 0.2249

Epoch 5/500

1/1 [=====] - 0s 203ms/step - loss: 0.0901 - accuracy: 0.2295

Epoch 6/500

1/1 [=====] - 0s 191ms/step - loss: 0.0794 - accuracy: 0.2307

Epoch 7/500

1/1 [=====] - 0s 200ms/step - loss: 0.0666 - accuracy: 0.2319

Epoch 8/500

1/1 [=====] - 0s 200ms/step - loss: 0.0527 - accuracy: 0.2341

Epoch 9/500

1/1 [=====] - 0s 211ms/step - loss: 0.0401 - accuracy: 0.2345

Epoch 10/500

1/1 [=====] - 0s 211ms/step - loss: 0.0329 - accuracy: 0.2347

Epoch 11/500

1/1 [=====] - 0s 200ms/step - loss: 0.0346 - accuracy: 0.2347

Epoch 12/500

1/1 [=====] - 0s 224ms/step - loss: 0.0359 - accuracy: 0.2352

```
Epoch 13/500
1/1 [=====] - 0s 209ms/step - loss: 0.0305 - accuracy: 0.2360
Epoch 14/500
1/1 [=====] - 0s 206ms/step - loss: 0.0230 - accuracy: 0.2324
Epoch 15/500
1/1 [=====] - 0s 294ms/step - loss: 0.0177 - accuracy: 0.2288
Epoch 16/500
1/1 [=====] - 0s 264ms/step - loss: 0.0155 - accuracy: 0.2222
Epoch 17/500
1/1 [=====] - 0s 214ms/step - loss: 0.0151 - accuracy: 0.2663
Epoch 18/500
1/1 [=====] - 0s 204ms/step - loss: 0.0150 - accuracy: 0.4998
Epoch 19/500
1/1 [=====] - 0s 204ms/step - loss: 0.0146 - accuracy: 0.5315
Epoch 20/500
1/1 [=====] - 0s 213ms/step - loss: 0.0138 - accuracy: 0.5323
Epoch 21/500
1/1 [=====] - 0s 222ms/step - loss: 0.0131 - accuracy: 0.5324
Epoch 22/500
1/1 [=====] - 0s 210ms/step - loss: 0.0128 - accuracy: 0.5324
Epoch 23/500
1/1 [=====] - 0s 196ms/step - loss: 0.0132 - accuracy: 0.5324
Epoch 24/500
1/1 [=====] - 0s 209ms/step - loss: 0.0139 - accuracy: 0.5324
Epoch 25/500
1/1 [=====] - 0s 209ms/step - loss: 0.0142 - accuracy: 0.5324
Epoch 26/500
1/1 [=====] - 0s 214ms/step - loss: 0.0138 - accuracy: 0.5326
Epoch 27/500
1/1 [=====] - 0s 204ms/step - loss: 0.0129 - accuracy: 0.5329
Epoch 28/500
1/1 [=====] - 0s 189ms/step - loss: 0.0119 - accuracy: 0.5347
Epoch 29/500
1/1 [=====] - 0s 342ms/step - loss: 0.0111 - accuracy: 0.5389
Epoch 30/500
1/1 [=====] - 0s 346ms/step - loss: 0.0106 - accuracy: 0.5545
Epoch 31/500
1/1 [=====] - 0s 322ms/step - loss: 0.0103 - accuracy: 0.5731
Epoch 32/500
1/1 [=====] - 0s 378ms/step - loss: 0.0099 - accuracy: 0.5839
Epoch 33/500
1/1 [=====] - 0s 406ms/step - loss: 0.0092 - accuracy: 0.6040
Epoch 34/500
1/1 [=====] - 0s 351ms/step - loss: 0.0084 - accuracy: 0.6186
Epoch 35/500
1/1 [=====] - 0s 358ms/step - loss: 0.0078 - accuracy: 0.6225
Epoch 36/500
1/1 [=====] - 1s 502ms/step - loss: 0.0074 - accuracy: 0.6250
Epoch 37/500
1/1 [=====] - 0s 383ms/step - loss: 0.0073 - accuracy: 0.6259
Epoch 38/500
1/1 [=====] - 0s 343ms/step - loss: 0.0071 - accuracy: 0.6275
Epoch 39/500
1/1 [=====] - 0s 386ms/step - loss: 0.0068 - accuracy: 0.6306
Epoch 40/500
1/1 [=====] - 0s 408ms/step - loss: 0.0065 - accuracy: 0.6336
Epoch 41/500
1/1 [=====] - 1s 509ms/step - loss: 0.0065 - accuracy: 0.6374
Epoch 42/500
1/1 [=====] - 0s 490ms/step - loss: 0.0065 - accuracy: 0.6392
Epoch 43/500
1/1 [=====] - 0s 450ms/step - loss: 0.0063 - accuracy: 0.6400
Epoch 44/500
1/1 [=====] - 0s 422ms/step - loss: 0.0061 - accuracy: 0.6391
Epoch 45/500
1/1 [=====] - 0s 465ms/step - loss: 0.0060 - accuracy: 0.6382
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Epoch 46/500  
1/1 [=====] - 0s 324ms/step - loss: 0.0060 - accuracy: 0.6391  
Epoch 47/500  
1/1 [=====] - 0s 345ms/step - loss: 0.0059 - accuracy: 0.6419  
Epoch 48/500  
1/1 [=====] - 0s 331ms/step - loss: 0.0057 - accuracy: 0.6462  
Epoch 49/500  
1/1 [=====] - 0s 371ms/step - loss: 0.0057 - accuracy: 0.6495  
Epoch 50/500  
1/1 [=====] - 0s 371ms/step - loss: 0.0058 - accuracy: 0.6512  
Epoch 51/500  
1/1 [=====] - 0s 391ms/step - loss: 0.0057 - accuracy: 0.6506  
Epoch 52/500  
1/1 [=====] - 0s 334ms/step - loss: 0.0056 - accuracy: 0.6488  
Epoch 53/500  
1/1 [=====] - 0s 362ms/step - loss: 0.0056 - accuracy: 0.6465  
Epoch 54/500  
1/1 [=====] - 0s 392ms/step - loss: 0.0055 - accuracy: 0.6443  
Epoch 55/500  
1/1 [=====] - 0s 400ms/step - loss: 0.0054 - accuracy: 0.6435  
Epoch 56/500  
1/1 [=====] - 0s 385ms/step - loss: 0.0054 - accuracy: 0.6435  
Epoch 57/500  
1/1 [=====] - 0s 360ms/step - loss: 0.0054 - accuracy: 0.6444  
Epoch 58/500  
1/1 [=====] - 0s 280ms/step - loss: 0.0054 - accuracy: 0.6445  
Epoch 59/500  
1/1 [=====] - 0s 394ms/step - loss: 0.0053 - accuracy: 0.6439  
Epoch 60/500  
1/1 [=====] - 0s 357ms/step - loss: 0.0053 - accuracy: 0.6431  
Epoch 61/500  
1/1 [=====] - 0s 371ms/step - loss: 0.0052 - accuracy: 0.6431  
Epoch 62/500  
1/1 [=====] - 0s 358ms/step - loss: 0.0052 - accuracy: 0.6455  
Epoch 63/500  
1/1 [=====] - 0s 303ms/step - loss: 0.0051 - accuracy: 0.6473  
Epoch 64/500  
1/1 [=====] - 1s 560ms/step - loss: 0.0051 - accuracy: 0.6497  
Epoch 65/500  
1/1 [=====] - 0s 406ms/step - loss: 0.0051 - accuracy: 0.6504  
Epoch 66/500  
1/1 [=====] - 0s 378ms/step - loss: 0.0050 - accuracy: 0.6512  
Epoch 67/500  
1/1 [=====] - 0s 332ms/step - loss: 0.0050 - accuracy: 0.6514  
Epoch 68/500  
1/1 [=====] - 0s 323ms/step - loss: 0.0050 - accuracy: 0.6517  
Epoch 69/500  
1/1 [=====] - 0s 355ms/step - loss: 0.0050 - accuracy: 0.6527  
Epoch 70/500  
1/1 [=====] - 0s 343ms/step - loss: 0.0049 - accuracy: 0.6533  
Epoch 71/500  
1/1 [=====] - 0s 323ms/step - loss: 0.0049 - accuracy: 0.6537  
Epoch 72/500  
1/1 [=====] - 0s 425ms/step - loss: 0.0049 - accuracy: 0.6536  
Epoch 73/500  
1/1 [=====] - 1s 560ms/step - loss: 0.0048 - accuracy: 0.6532  
Epoch 74/500  
1/1 [=====] - 1s 596ms/step - loss: 0.0048 - accuracy: 0.6527  
Epoch 75/500  
1/1 [=====] - 1s 612ms/step - loss: 0.0048 - accuracy: 0.6533  
Epoch 76/500  
1/1 [=====] - 1s 555ms/step - loss: 0.0048 - accuracy: 0.6542  
Epoch 77/500  
1/1 [=====] - 0s 384ms/step - loss: 0.0047 - accuracy: 0.6556  
Epoch 78/500  
1/1 [=====] - 0s 387ms/step - loss: 0.0047 - accuracy: 0.6561

```
Epoch 79/500
1/1 [=====] - 0s 384ms/step - loss: 0.0047 - accuracy: 0.6563
Epoch 80/500
1/1 [=====] - 0s 369ms/step - loss: 0.0047 - accuracy: 0.6562
Epoch 81/500
1/1 [=====] - 0s 356ms/step - loss: 0.0046 - accuracy: 0.6562
Epoch 82/500
1/1 [=====] - 0s 353ms/step - loss: 0.0046 - accuracy: 0.6561
Epoch 83/500
1/1 [=====] - 0s 360ms/step - loss: 0.0046 - accuracy: 0.6560
Epoch 84/500
1/1 [=====] - 0s 384ms/step - loss: 0.0046 - accuracy: 0.6558
Epoch 85/500
1/1 [=====] - 0s 361ms/step - loss: 0.0045 - accuracy: 0.6561
Epoch 86/500
1/1 [=====] - 0s 221ms/step - loss: 0.0045 - accuracy: 0.6566
Epoch 87/500
1/1 [=====] - 0s 206ms/step - loss: 0.0045 - accuracy: 0.6579
Epoch 88/500
1/1 [=====] - 0s 209ms/step - loss: 0.0045 - accuracy: 0.6597
Epoch 89/500
1/1 [=====] - 0s 193ms/step - loss: 0.0045 - accuracy: 0.6609
Epoch 90/500
1/1 [=====] - 0s 193ms/step - loss: 0.0044 - accuracy: 0.6621
Epoch 91/500
1/1 [=====] - 0s 195ms/step - loss: 0.0044 - accuracy: 0.6631
Epoch 92/500
1/1 [=====] - 0s 196ms/step - loss: 0.0044 - accuracy: 0.6638
Epoch 93/500
1/1 [=====] - 0s 214ms/step - loss: 0.0044 - accuracy: 0.6647
Epoch 94/500
1/1 [=====] - 0s 208ms/step - loss: 0.0044 - accuracy: 0.6647
Epoch 95/500
1/1 [=====] - 0s 197ms/step - loss: 0.0043 - accuracy: 0.6647
Epoch 96/500
1/1 [=====] - 0s 197ms/step - loss: 0.0043 - accuracy: 0.6649
Epoch 97/500
1/1 [=====] - 0s 200ms/step - loss: 0.0043 - accuracy: 0.6654
Epoch 98/500
1/1 [=====] - 0s 212ms/step - loss: 0.0043 - accuracy: 0.6660
Epoch 99/500
1/1 [=====] - 0s 204ms/step - loss: 0.0043 - accuracy: 0.6669
Epoch 100/500
1/1 [=====] - 0s 207ms/step - loss: 0.0042 - accuracy: 0.6678
Epoch 101/500
1/1 [=====] - 0s 207ms/step - loss: 0.0042 - accuracy: 0.6688
Epoch 102/500
1/1 [=====] - 0s 208ms/step - loss: 0.0042 - accuracy: 0.6703
Epoch 103/500
1/1 [=====] - 0s 218ms/step - loss: 0.0042 - accuracy: 0.6721
Epoch 104/500
1/1 [=====] - 0s 201ms/step - loss: 0.0042 - accuracy: 0.6737
Epoch 105/500
1/1 [=====] - 0s 196ms/step - loss: 0.0042 - accuracy: 0.6745
Epoch 106/500
1/1 [=====] - 0s 199ms/step - loss: 0.0041 - accuracy: 0.6752
Epoch 107/500
1/1 [=====] - 0s 204ms/step - loss: 0.0041 - accuracy: 0.6757
Epoch 108/500
1/1 [=====] - 0s 214ms/step - loss: 0.0041 - accuracy: 0.6763
Epoch 109/500
1/1 [=====] - 0s 212ms/step - loss: 0.0041 - accuracy: 0.6770
Epoch 110/500
1/1 [=====] - 0s 215ms/step - loss: 0.0041 - accuracy: 0.6776
Epoch 111/500
1/1 [=====] - 0s 205ms/step - loss: 0.0041 - accuracy: 0.6781
```

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AutoEncoders\_image\_Reconstruction.ipynb - Colaboratory

```
1/1 [=====] - 0s 203ms/step - loss: 0.0040 - accuracy: 0.6783
Epoch 112/500
1/1 [=====] - 0s 206ms/step - loss: 0.0040 - accuracy: 0.6787
Epoch 113/500
1/1 [=====] - 0s 202ms/step - loss: 0.0040 - accuracy: 0.6791
Epoch 114/500
1/1 [=====] - 0s 223ms/step - loss: 0.0040 - accuracy: 0.6792
Epoch 116/500
1/1 [=====] - 0s 203ms/step - loss: 0.0040 - accuracy: 0.6790
Epoch 117/500
1/1 [=====] - 0s 234ms/step - loss: 0.0039 - accuracy: 0.6787
Epoch 118/500
1/1 [=====] - 0s 290ms/step - loss: 0.0039 - accuracy: 0.6781
Epoch 119/500
1/1 [=====] - 0s 326ms/step - loss: 0.0039 - accuracy: 0.6778
Epoch 120/500
1/1 [=====] - 0s 387ms/step - loss: 0.0039 - accuracy: 0.6774
Epoch 121/500
1/1 [=====] - 0s 367ms/step - loss: 0.0039 - accuracy: 0.6770
Epoch 122/500
1/1 [=====] - 0s 318ms/step - loss: 0.0039 - accuracy: 0.6768
Epoch 123/500
1/1 [=====] - 0s 327ms/step - loss: 0.0038 - accuracy: 0.6767
Epoch 124/500
1/1 [=====] - 0s 327ms/step - loss: 0.0038 - accuracy: 0.6768
Epoch 125/500
1/1 [=====] - 0s 320ms/step - loss: 0.0038 - accuracy: 0.6768
Epoch 126/500
1/1 [=====] - 0s 202ms/step - loss: 0.0038 - accuracy: 0.6768
Epoch 127/500
1/1 [=====] - 0s 196ms/step - loss: 0.0038 - accuracy: 0.6770
Epoch 128/500
1/1 [=====] - 0s 223ms/step - loss: 0.0037 - accuracy: 0.6779
Epoch 129/500
1/1 [=====] - 0s 214ms/step - loss: 0.0037 - accuracy: 0.6787
Epoch 130/500
1/1 [=====] - 0s 222ms/step - loss: 0.0037 - accuracy: 0.6797
Epoch 131/500
1/1 [=====] - 0s 191ms/step - loss: 0.0037 - accuracy: 0.6810
Epoch 132/500
1/1 [=====] - 0s 216ms/step - loss: 0.0037 - accuracy: 0.6823
Epoch 133/500
1/1 [=====] - 0s 212ms/step - loss: 0.0037 - accuracy: 0.6832
Epoch 134/500
1/1 [=====] - 0s 199ms/step - loss: 0.0036 - accuracy: 0.6838
Epoch 135/500
1/1 [=====] - 0s 209ms/step - loss: 0.0036 - accuracy: 0.6842
Epoch 136/500
1/1 [=====] - 0s 209ms/step - loss: 0.0036 - accuracy: 0.6843
Epoch 137/500
1/1 [=====] - 0s 222ms/step - loss: 0.0036 - accuracy: 0.6846
Epoch 138/500
1/1 [=====] - 0s 207ms/step - loss: 0.0036 - accuracy: 0.6846
Epoch 139/500
1/1 [=====] - 0s 202ms/step - loss: 0.0035 - accuracy: 0.6846
Epoch 140/500
1/1 [=====] - 0s 213ms/step - loss: 0.0035 - accuracy: 0.6846
Epoch 141/500
1/1 [=====] - 0s 204ms/step - loss: 0.0035 - accuracy: 0.6851
Epoch 142/500
1/1 [=====] - 0s 214ms/step - loss: 0.0035 - accuracy: 0.6856
Epoch 143/500
1/1 [=====] - 0s 208ms/step - loss: 0.0035 - accuracy: 0.6858
Epoch 144/500
```

```
1/1 [=====] - 0s 206ms/step - loss: 0.0035 - accuracy: 0.6860
Epoch 145/500
1/1 [=====] - 0s 206ms/step - loss: 0.0034 - accuracy: 0.6860
Epoch 146/500
1/1 [=====] - 0s 208ms/step - loss: 0.0034 - accuracy: 0.6865
Epoch 147/500
1/1 [=====] - 0s 215ms/step - loss: 0.0034 - accuracy: 0.6865
Epoch 148/500
1/1 [=====] - 0s 209ms/step - loss: 0.0034 - accuracy: 0.6869
Epoch 149/500
1/1 [=====] - 0s 216ms/step - loss: 0.0034 - accuracy: 0.6869
Epoch 150/500
1/1 [=====] - 0s 203ms/step - loss: 0.0034 - accuracy: 0.6867
Epoch 151/500
1/1 [=====] - 0s 215ms/step - loss: 0.0033 - accuracy: 0.6880
Epoch 152/500
1/1 [=====] - 0s 231ms/step - loss: 0.0033 - accuracy: 0.6878
Epoch 153/500
1/1 [=====] - 0s 206ms/step - loss: 0.0033 - accuracy: 0.6902
Epoch 154/500
1/1 [=====] - 0s 209ms/step - loss: 0.0033 - accuracy: 0.6912
Epoch 155/500
1/1 [=====] - 0s 191ms/step - loss: 0.0033 - accuracy: 0.6916
Epoch 156/500
1/1 [=====] - 0s 197ms/step - loss: 0.0033 - accuracy: 0.6929
Epoch 157/500
1/1 [=====] - 0s 230ms/step - loss: 0.0032 - accuracy: 0.6933
Epoch 158/500
1/1 [=====] - 0s 224ms/step - loss: 0.0032 - accuracy: 0.6938
Epoch 159/500
1/1 [=====] - 0s 212ms/step - loss: 0.0032 - accuracy: 0.6951
Epoch 160/500
1/1 [=====] - 0s 283ms/step - loss: 0.0032 - accuracy: 0.6950
Epoch 161/500
1/1 [=====] - 0s 313ms/step - loss: 0.0032 - accuracy: 0.6962
Epoch 162/500
1/1 [=====] - 0s 337ms/step - loss: 0.0032 - accuracy: 0.6971
Epoch 163/500
1/1 [=====] - 0s 360ms/step - loss: 0.0032 - accuracy: 0.6976
Epoch 164/500
1/1 [=====] - 0s 366ms/step - loss: 0.0031 - accuracy: 0.6988
Epoch 165/500
1/1 [=====] - 0s 337ms/step - loss: 0.0031 - accuracy: 0.7005
Epoch 166/500
1/1 [=====] - 0s 355ms/step - loss: 0.0031 - accuracy: 0.7020
Epoch 167/500
1/1 [=====] - 0s 372ms/step - loss: 0.0031 - accuracy: 0.7034
Epoch 168/500
1/1 [=====] - 0s 345ms/step - loss: 0.0031 - accuracy: 0.7061
Epoch 169/500
1/1 [=====] - 0s 321ms/step - loss: 0.0031 - accuracy: 0.7078
Epoch 170/500
1/1 [=====] - 0s 376ms/step - loss: 0.0030 - accuracy: 0.7108
Epoch 171/500
1/1 [=====] - 0s 321ms/step - loss: 0.0030 - accuracy: 0.7129
Epoch 172/500
1/1 [=====] - 0s 346ms/step - loss: 0.0030 - accuracy: 0.7163
Epoch 173/500
1/1 [=====] - 0s 300ms/step - loss: 0.0030 - accuracy: 0.7203
Epoch 174/500
1/1 [=====] - 0s 339ms/step - loss: 0.0030 - accuracy: 0.7234
Epoch 175/500
1/1 [=====] - 0s 347ms/step - loss: 0.0029 - accuracy: 0.7312
Epoch 176/500
1/1 [=====] - 0s 206ms/step - loss: 0.0029 - accuracy: 0.7334
Epoch 177/500
```

```
1/1 [=====] - 0s 197ms/step - loss: 0.0029 - accuracy: 0.7411
Epoch 178/500
1/1 [=====] - 0s 213ms/step - loss: 0.0029 - accuracy: 0.7415
Epoch 179/500
1/1 [=====] - 0s 205ms/step - loss: 0.0029 - accuracy: 0.7487
Epoch 180/500
1/1 [=====] - 0s 204ms/step - loss: 0.0028 - accuracy: 0.7473
Epoch 181/500
1/1 [=====] - 0s 214ms/step - loss: 0.0028 - accuracy: 0.7566
Epoch 182/500
1/1 [=====] - 0s 214ms/step - loss: 0.0028 - accuracy: 0.7552
Epoch 183/500
1/1 [=====] - 0s 191ms/step - loss: 0.0028 - accuracy: 0.7657
Epoch 184/500
1/1 [=====] - 0s 215ms/step - loss: 0.0028 - accuracy: 0.7676
Epoch 185/500
1/1 [=====] - 0s 201ms/step - loss: 0.0027 - accuracy: 0.7732
Epoch 186/500
1/1 [=====] - 0s 227ms/step - loss: 0.0027 - accuracy: 0.7768
Epoch 187/500
1/1 [=====] - 0s 209ms/step - loss: 0.0027 - accuracy: 0.7794
Epoch 188/500
1/1 [=====] - 0s 208ms/step - loss: 0.0027 - accuracy: 0.7834
Epoch 189/500
1/1 [=====] - 0s 211ms/step - loss: 0.0027 - accuracy: 0.7845
Epoch 190/500
1/1 [=====] - 0s 202ms/step - loss: 0.0026 - accuracy: 0.7905
Epoch 191/500
1/1 [=====] - 0s 210ms/step - loss: 0.0026 - accuracy: 0.7890
Epoch 192/500
1/1 [=====] - 0s 225ms/step - loss: 0.0026 - accuracy: 0.7952
Epoch 193/500
1/1 [=====] - 0s 215ms/step - loss: 0.0026 - accuracy: 0.7922
Epoch 194/500
1/1 [=====] - 0s 204ms/step - loss: 0.0025 - accuracy: 0.7951
Epoch 195/500
1/1 [=====] - 0s 206ms/step - loss: 0.0025 - accuracy: 0.7984
Epoch 196/500
1/1 [=====] - 0s 210ms/step - loss: 0.0025 - accuracy: 0.7950
Epoch 197/500
1/1 [=====] - 0s 203ms/step - loss: 0.0025 - accuracy: 0.8012
Epoch 198/500
1/1 [=====] - 0s 201ms/step - loss: 0.0025 - accuracy: 0.8012
Epoch 199/500
1/1 [=====] - 0s 206ms/step - loss: 0.0025 - accuracy: 0.8011
Epoch 200/500
1/1 [=====] - 0s 203ms/step - loss: 0.0025 - accuracy: 0.8063
Epoch 201/500
1/1 [=====] - 0s 219ms/step - loss: 0.0024 - accuracy: 0.8048
Epoch 202/500
1/1 [=====] - 0s 197ms/step - loss: 0.0024 - accuracy: 0.8057
Epoch 203/500
1/1 [=====] - 0s 205ms/step - loss: 0.0024 - accuracy: 0.8076
Epoch 204/500
1/1 [=====] - 0s 198ms/step - loss: 0.0024 - accuracy: 0.8061
Epoch 205/500
1/1 [=====] - 0s 193ms/step - loss: 0.0024 - accuracy: 0.8084
Epoch 206/500
1/1 [=====] - 0s 206ms/step - loss: 0.0024 - accuracy: 0.8104
Epoch 207/500
1/1 [=====] - 0s 202ms/step - loss: 0.0024 - accuracy: 0.8087
Epoch 208/500
1/1 [=====] - 0s 189ms/step - loss: 0.0023 - accuracy: 0.8131
Epoch 209/500
1/1 [=====] - 0s 212ms/step - loss: 0.0023 - accuracy: 0.8131
Epoch 210/500
```

```
[...]
1/1 [=====] - 0s 207ms/step - loss: 0.0023 - accuracy: 0.8120
Epoch 211/500
1/1 [=====] - 0s 220ms/step - loss: 0.0023 - accuracy: 0.8170
Epoch 212/500
1/1 [=====] - 0s 204ms/step - loss: 0.0023 - accuracy: 0.8138
Epoch 213/500
1/1 [=====] - 0s 194ms/step - loss: 0.0023 - accuracy: 0.8151
Epoch 214/500
1/1 [=====] - 0s 207ms/step - loss: 0.0023 - accuracy: 0.8198
Epoch 215/500
1/1 [=====] - 0s 200ms/step - loss: 0.0023 - accuracy: 0.8153
Epoch 216/500
1/1 [=====] - 0s 209ms/step - loss: 0.0023 - accuracy: 0.8188
Epoch 217/500
1/1 [=====] - 0s 202ms/step - loss: 0.0023 - accuracy: 0.8205
Epoch 218/500
1/1 [=====] - 0s 212ms/step - loss: 0.0022 - accuracy: 0.8169
Epoch 219/500
1/1 [=====] - 0s 201ms/step - loss: 0.0022 - accuracy: 0.8224
Epoch 220/500
1/1 [=====] - 0s 204ms/step - loss: 0.0022 - accuracy: 0.8211
Epoch 221/500
1/1 [=====] - 0s 210ms/step - loss: 0.0022 - accuracy: 0.8197
Epoch 222/500
1/1 [=====] - 0s 210ms/step - loss: 0.0022 - accuracy: 0.8237
Epoch 223/500
1/1 [=====] - 0s 245ms/step - loss: 0.0022 - accuracy: 0.8215
Epoch 224/500
1/1 [=====] - 0s 312ms/step - loss: 0.0022 - accuracy: 0.8238
Epoch 225/500
1/1 [=====] - 0s 374ms/step - loss: 0.0022 - accuracy: 0.8254
Epoch 226/500
1/1 [=====] - 0s 314ms/step - loss: 0.0022 - accuracy: 0.8237
Epoch 227/500
1/1 [=====] - 0s 308ms/step - loss: 0.0022 - accuracy: 0.8278
Epoch 228/500
1/1 [=====] - 0s 299ms/step - loss: 0.0022 - accuracy: 0.8253
Epoch 229/500
1/1 [=====] - 0s 328ms/step - loss: 0.0022 - accuracy: 0.8288
Epoch 230/500
1/1 [=====] - 0s 307ms/step - loss: 0.0021 - accuracy: 0.8302
Epoch 231/500
1/1 [=====] - 0s 306ms/step - loss: 0.0021 - accuracy: 0.8288
Epoch 232/500
1/1 [=====] - 0s 204ms/step - loss: 0.0021 - accuracy: 0.8330
Epoch 233/500
1/1 [=====] - 0s 213ms/step - loss: 0.0021 - accuracy: 0.8302
Epoch 234/500
1/1 [=====] - 0s 212ms/step - loss: 0.0021 - accuracy: 0.8348
Epoch 235/500
1/1 [=====] - 0s 209ms/step - loss: 0.0021 - accuracy: 0.8319
Epoch 236/500
1/1 [=====] - 0s 229ms/step - loss: 0.0021 - accuracy: 0.8371
Epoch 237/500
1/1 [=====] - 0s 207ms/step - loss: 0.0021 - accuracy: 0.8345
Epoch 238/500
1/1 [=====] - 0s 202ms/step - loss: 0.0021 - accuracy: 0.8380
Epoch 239/500
1/1 [=====] - 0s 210ms/step - loss: 0.0021 - accuracy: 0.8385
Epoch 240/500
1/1 [=====] - 0s 205ms/step - loss: 0.0021 - accuracy: 0.8390
Epoch 241/500
1/1 [=====] - 0s 224ms/step - loss: 0.0021 - accuracy: 0.8402
Epoch 242/500
1/1 [=====] - 0s 189ms/step - loss: 0.0021 - accuracy: 0.8404
[...]
```

```
Epoch 243/500
1/1 [=====] - 0s 204ms/step - loss: 0.0021 - accuracy: 0.8433
Epoch 244/500
1/1 [=====] - 0s 189ms/step - loss: 0.0021 - accuracy: 0.8404
Epoch 245/500
1/1 [=====] - 0s 197ms/step - loss: 0.0021 - accuracy: 0.8450
Epoch 246/500
1/1 [=====] - 0s 205ms/step - loss: 0.0020 - accuracy: 0.8411
Epoch 247/500
1/1 [=====] - 0s 195ms/step - loss: 0.0020 - accuracy: 0.8452
Epoch 248/500
1/1 [=====] - 0s 217ms/step - loss: 0.0020 - accuracy: 0.8424
Epoch 249/500
1/1 [=====] - 0s 206ms/step - loss: 0.0020 - accuracy: 0.8459
Epoch 250/500
1/1 [=====] - 0s 209ms/step - loss: 0.0020 - accuracy: 0.8436
Epoch 251/500
1/1 [=====] - 0s 236ms/step - loss: 0.0020 - accuracy: 0.8475
Epoch 252/500
1/1 [=====] - 0s 210ms/step - loss: 0.0020 - accuracy: 0.8444
Epoch 253/500
1/1 [=====] - 0s 214ms/step - loss: 0.0020 - accuracy: 0.8481
Epoch 254/500
1/1 [=====] - 0s 216ms/step - loss: 0.0020 - accuracy: 0.8459
Epoch 255/500
1/1 [=====] - 0s 222ms/step - loss: 0.0020 - accuracy: 0.8492
Epoch 256/500
1/1 [=====] - 0s 195ms/step - loss: 0.0020 - accuracy: 0.8465
Epoch 257/500
1/1 [=====] - 0s 215ms/step - loss: 0.0020 - accuracy: 0.8510
Epoch 258/500
1/1 [=====] - 0s 197ms/step - loss: 0.0020 - accuracy: 0.8476
Epoch 259/500
1/1 [=====] - 0s 190ms/step - loss: 0.0020 - accuracy: 0.8520
Epoch 260/500
1/1 [=====] - 0s 208ms/step - loss: 0.0020 - accuracy: 0.8483
Epoch 261/500
1/1 [=====] - 0s 220ms/step - loss: 0.0020 - accuracy: 0.8536
Epoch 262/500
1/1 [=====] - 0s 198ms/step - loss: 0.0020 - accuracy: 0.8477
Epoch 263/500
1/1 [=====] - 0s 201ms/step - loss: 0.0020 - accuracy: 0.8553
Epoch 264/500
1/1 [=====] - 0s 194ms/step - loss: 0.0020 - accuracy: 0.8479
Epoch 265/500
1/1 [=====] - 0s 201ms/step - loss: 0.0020 - accuracy: 0.8545
Epoch 266/500
1/1 [=====] - 0s 197ms/step - loss: 0.0020 - accuracy: 0.8512
Epoch 267/500
1/1 [=====] - 0s 188ms/step - loss: 0.0020 - accuracy: 0.8533
Epoch 268/500
1/1 [=====] - 0s 197ms/step - loss: 0.0019 - accuracy: 0.8546
Epoch 269/500
1/1 [=====] - 0s 210ms/step - loss: 0.0019 - accuracy: 0.8529
Epoch 270/500
1/1 [=====] - 0s 223ms/step - loss: 0.0019 - accuracy: 0.8562
Epoch 271/500
1/1 [=====] - 0s 204ms/step - loss: 0.0019 - accuracy: 0.8530
Epoch 272/500
1/1 [=====] - 0s 199ms/step - loss: 0.0019 - accuracy: 0.8566
Epoch 273/500
1/1 [=====] - 0s 192ms/step - loss: 0.0019 - accuracy: 0.8535
Epoch 274/500
1/1 [=====] - 0s 207ms/step - loss: 0.0019 - accuracy: 0.8574
Epoch 275/500
1/1 [=====] - 0s 212ms/step - loss: 0.0019 - accuracy: 0.8552
```

Epoch 276/500  
1/1 [=====] - 0s 214ms/step - loss: 0.0019 - accuracy: 0.8565  
Epoch 277/500  
1/1 [=====] - 0s 203ms/step - loss: 0.0019 - accuracy: 0.8577  
Epoch 278/500  
1/1 [=====] - 0s 210ms/step - loss: 0.0019 - accuracy: 0.8546  
Epoch 279/500  
1/1 [=====] - 0s 284ms/step - loss: 0.0019 - accuracy: 0.8585  
Epoch 280/500  
1/1 [=====] - 0s 324ms/step - loss: 0.0019 - accuracy: 0.8554  
Epoch 281/500  
1/1 [=====] - 0s 337ms/step - loss: 0.0019 - accuracy: 0.8592  
Epoch 282/500  
1/1 [=====] - 0s 324ms/step - loss: 0.0019 - accuracy: 0.8564  
Epoch 283/500  
1/1 [=====] - 0s 338ms/step - loss: 0.0019 - accuracy: 0.8592  
Epoch 284/500  
1/1 [=====] - 0s 300ms/step - loss: 0.0019 - accuracy: 0.8570  
Epoch 285/500  
1/1 [=====] - 0s 310ms/step - loss: 0.0019 - accuracy: 0.8593  
Epoch 286/500  
1/1 [=====] - 0s 322ms/step - loss: 0.0019 - accuracy: 0.8590  
Epoch 287/500  
1/1 [=====] - 0s 287ms/step - loss: 0.0019 - accuracy: 0.8591  
Epoch 288/500  
1/1 [=====] - 0s 200ms/step - loss: 0.0019 - accuracy: 0.8603  
Epoch 289/500  
1/1 [=====] - 0s 213ms/step - loss: 0.0019 - accuracy: 0.8588  
Epoch 290/500  
1/1 [=====] - 0s 215ms/step - loss: 0.0019 - accuracy: 0.8610  
Epoch 291/500  
1/1 [=====] - 0s 209ms/step - loss: 0.0019 - accuracy: 0.8589  
Epoch 292/500  
1/1 [=====] - 0s 203ms/step - loss: 0.0019 - accuracy: 0.8613  
Epoch 293/500  
1/1 [=====] - 0s 200ms/step - loss: 0.0019 - accuracy: 0.8601  
Epoch 294/500  
1/1 [=====] - 0s 201ms/step - loss: 0.0019 - accuracy: 0.8619  
Epoch 295/500  
1/1 [=====] - 0s 218ms/step - loss: 0.0019 - accuracy: 0.8608  
Epoch 296/500  
1/1 [=====] - 0s 206ms/step - loss: 0.0019 - accuracy: 0.8618  
Epoch 297/500  
1/1 [=====] - 0s 213ms/step - loss: 0.0019 - accuracy: 0.8610  
Epoch 298/500  
1/1 [=====] - 0s 218ms/step - loss: 0.0019 - accuracy: 0.8621  
Epoch 299/500  
1/1 [=====] - 0s 217ms/step - loss: 0.0018 - accuracy: 0.8618  
Epoch 300/500  
1/1 [=====] - 0s 221ms/step - loss: 0.0018 - accuracy: 0.8625  
Epoch 301/500  
1/1 [=====] - 0s 204ms/step - loss: 0.0018 - accuracy: 0.8613  
Epoch 302/500  
1/1 [=====] - 0s 195ms/step - loss: 0.0018 - accuracy: 0.8625  
Epoch 303/500  
1/1 [=====] - 0s 202ms/step - loss: 0.0018 - accuracy: 0.8614  
Epoch 304/500  
1/1 [=====] - 0s 209ms/step - loss: 0.0018 - accuracy: 0.8635  
Epoch 305/500  
1/1 [=====] - 0s 219ms/step - loss: 0.0018 - accuracy: 0.8605  
Epoch 306/500  
1/1 [=====] - 0s 207ms/step - loss: 0.0018 - accuracy: 0.8648  
Epoch 307/500  
1/1 [=====] - 0s 209ms/step - loss: 0.0018 - accuracy: 0.8575  
Epoch 308/500  
1/1 [=====] - 0s 205ms/step - loss: 0.0019 - accuracy: 0.8662

```
Epoch 309/500
1/1 [=====] - 0s 204ms/step - loss: 0.0019 - accuracy: 0.8516
Epoch 310/500
1/1 [=====] - 0s 215ms/step - loss: 0.0019 - accuracy: 0.8674
Epoch 311/500
1/1 [=====] - 0s 203ms/step - loss: 0.0019 - accuracy: 0.8576
Epoch 312/500
1/1 [=====] - 0s 211ms/step - loss: 0.0018 - accuracy: 0.8663
Epoch 313/500
1/1 [=====] - 0s 213ms/step - loss: 0.0018 - accuracy: 0.8656
Epoch 314/500
1/1 [=====] - 0s 206ms/step - loss: 0.0018 - accuracy: 0.8603
Epoch 315/500
1/1 [=====] - 0s 204ms/step - loss: 0.0018 - accuracy: 0.8676
Epoch 316/500
1/1 [=====] - 0s 203ms/step - loss: 0.0018 - accuracy: 0.8637
Epoch 317/500
1/1 [=====] - 0s 203ms/step - loss: 0.0018 - accuracy: 0.8636
Epoch 318/500
1/1 [=====] - 0s 192ms/step - loss: 0.0018 - accuracy: 0.8671
Epoch 319/500
1/1 [=====] - 0s 198ms/step - loss: 0.0018 - accuracy: 0.8631
Epoch 320/500
1/1 [=====] - 0s 220ms/step - loss: 0.0018 - accuracy: 0.8657
Epoch 321/500
1/1 [=====] - 0s 192ms/step - loss: 0.0018 - accuracy: 0.8664
Epoch 322/500
1/1 [=====] - 0s 193ms/step - loss: 0.0018 - accuracy: 0.8643
Epoch 323/500
1/1 [=====] - 0s 209ms/step - loss: 0.0018 - accuracy: 0.8665
Epoch 324/500
1/1 [=====] - 0s 211ms/step - loss: 0.0018 - accuracy: 0.8644
Epoch 325/500
1/1 [=====] - 0s 226ms/step - loss: 0.0018 - accuracy: 0.8667
Epoch 326/500
1/1 [=====] - 0s 197ms/step - loss: 0.0018 - accuracy: 0.8660
Epoch 327/500
1/1 [=====] - 0s 217ms/step - loss: 0.0018 - accuracy: 0.8630
Epoch 328/500
1/1 [=====] - 0s 208ms/step - loss: 0.0018 - accuracy: 0.8681
Epoch 329/500
1/1 [=====] - 0s 212ms/step - loss: 0.0018 - accuracy: 0.8645
Epoch 330/500
1/1 [=====] - 0s 198ms/step - loss: 0.0018 - accuracy: 0.8653
Epoch 331/500
1/1 [=====] - 0s 201ms/step - loss: 0.0018 - accuracy: 0.8685
Epoch 332/500
1/1 [=====] - 0s 215ms/step - loss: 0.0018 - accuracy: 0.8636
Epoch 333/500
1/1 [=====] - 0s 214ms/step - loss: 0.0018 - accuracy: 0.8673
Epoch 334/500
1/1 [=====] - 0s 236ms/step - loss: 0.0018 - accuracy: 0.8679
Epoch 335/500
1/1 [=====] - 0s 294ms/step - loss: 0.0018 - accuracy: 0.8649
Epoch 336/500
1/1 [=====] - 0s 331ms/step - loss: 0.0018 - accuracy: 0.8684
Epoch 337/500
1/1 [=====] - 0s 352ms/step - loss: 0.0018 - accuracy: 0.8670
Epoch 338/500
1/1 [=====] - 0s 325ms/step - loss: 0.0018 - accuracy: 0.8663
Epoch 339/500
1/1 [=====] - 0s 338ms/step - loss: 0.0018 - accuracy: 0.8675
Epoch 340/500
1/1 [=====] - 0s 320ms/step - loss: 0.0018 - accuracy: 0.8672
Epoch 341/500
1/1 [=====] - 0s 297ms/step - loss: 0.0018 - accuracy: 0.8667
```

Epoch 342/500  
1/1 [=====] - 0s 313ms/step - loss: 0.0017 - accuracy: 0.8675  
Epoch 343/500  
1/1 [=====] - 0s 197ms/step - loss: 0.0017 - accuracy: 0.8682  
Epoch 344/500  
1/1 [=====] - 0s 201ms/step - loss: 0.0017 - accuracy: 0.8658  
Epoch 345/500  
1/1 [=====] - 0s 199ms/step - loss: 0.0017 - accuracy: 0.8683  
Epoch 346/500  
1/1 [=====] - 0s 205ms/step - loss: 0.0017 - accuracy: 0.8684  
Epoch 347/500  
1/1 [=====] - 0s 209ms/step - loss: 0.0017 - accuracy: 0.8658  
Epoch 348/500  
1/1 [=====] - 0s 193ms/step - loss: 0.0017 - accuracy: 0.8690  
Epoch 349/500  
1/1 [=====] - 0s 207ms/step - loss: 0.0017 - accuracy: 0.8676  
Epoch 350/500  
1/1 [=====] - 0s 216ms/step - loss: 0.0017 - accuracy: 0.8670  
Epoch 351/500  
1/1 [=====] - 0s 206ms/step - loss: 0.0017 - accuracy: 0.8693  
Epoch 352/500  
1/1 [=====] - 0s 206ms/step - loss: 0.0017 - accuracy: 0.8676  
Epoch 353/500  
1/1 [=====] - 0s 195ms/step - loss: 0.0017 - accuracy: 0.8676  
Epoch 354/500  
1/1 [=====] - 0s 193ms/step - loss: 0.0017 - accuracy: 0.8693  
Epoch 355/500  
1/1 [=====] - 0s 243ms/step - loss: 0.0017 - accuracy: 0.8680  
Epoch 356/500  
1/1 [=====] - 0s 210ms/step - loss: 0.0017 - accuracy: 0.8677  
Epoch 357/500  
1/1 [=====] - 0s 212ms/step - loss: 0.0017 - accuracy: 0.8700  
Epoch 358/500  
1/1 [=====] - 0s 202ms/step - loss: 0.0017 - accuracy: 0.8670  
Epoch 359/500  
1/1 [=====] - 0s 216ms/step - loss: 0.0017 - accuracy: 0.8699  
Epoch 360/500  
1/1 [=====] - 0s 204ms/step - loss: 0.0017 - accuracy: 0.8689  
Epoch 361/500  
1/1 [=====] - 0s 206ms/step - loss: 0.0017 - accuracy: 0.8694  
Epoch 362/500  
1/1 [=====] - 0s 199ms/step - loss: 0.0017 - accuracy: 0.8690  
Epoch 363/500  
1/1 [=====] - 0s 192ms/step - loss: 0.0017 - accuracy: 0.8708  
Epoch 364/500  
1/1 [=====] - 0s 214ms/step - loss: 0.0017 - accuracy: 0.8666  
Epoch 365/500  
1/1 [=====] - 0s 215ms/step - loss: 0.0017 - accuracy: 0.8720  
Epoch 366/500  
1/1 [=====] - 0s 221ms/step - loss: 0.0017 - accuracy: 0.8668  
Epoch 367/500  
1/1 [=====] - 0s 204ms/step - loss: 0.0017 - accuracy: 0.8718  
Epoch 368/500  
1/1 [=====] - 0s 205ms/step - loss: 0.0017 - accuracy: 0.8677  
Epoch 369/500  
1/1 [=====] - 0s 221ms/step - loss: 0.0017 - accuracy: 0.8716  
Epoch 370/500  
1/1 [=====] - 0s 204ms/step - loss: 0.0017 - accuracy: 0.8698  
Epoch 371/500  
1/1 [=====] - 0s 215ms/step - loss: 0.0017 - accuracy: 0.8712  
Epoch 372/500  
1/1 [=====] - 0s 210ms/step - loss: 0.0017 - accuracy: 0.8718  
Epoch 373/500  
1/1 [=====] - 0s 197ms/step - loss: 0.0017 - accuracy: 0.8668  
Epoch 374/500

2/14/24, 10:48 PM

AutoEncoders\_image\_Reconstruction.ipynb - Colaboratory

```
1/1 [=====] - 0s 213ms/step - loss: 0.001 - accuracy: 0.8/28
Epoch 375/500
1/1 [=====] - 0s 203ms/step - loss: 0.0017 - accuracy: 0.8702
Epoch 376/500
1/1 [=====] - 0s 214ms/step - loss: 0.0017 - accuracy: 0.8712
Epoch 377/500
1/1 [=====] - 0s 210ms/step - loss: 0.0017 - accuracy: 0.8722
Epoch 378/500
1/1 [=====] - 0s 205ms/step - loss: 0.0017 - accuracy: 0.8692
Epoch 379/500
1/1 [=====] - 0s 211ms/step - loss: 0.0017 - accuracy: 0.8724
Epoch 380/500
1/1 [=====] - 0s 205ms/step - loss: 0.0017 - accuracy: 0.8696
Epoch 381/500
1/1 [=====] - 0s 211ms/step - loss: 0.0017 - accuracy: 0.8724
Epoch 382/500
1/1 [=====] - 0s 208ms/step - loss: 0.0017 - accuracy: 0.8714
Epoch 383/500
1/1 [=====] - 0s 214ms/step - loss: 0.0017 - accuracy: 0.8720
Epoch 384/500
1/1 [=====] - 0s 216ms/step - loss: 0.0017 - accuracy: 0.8727
Epoch 385/500
1/1 [=====] - 0s 214ms/step - loss: 0.0017 - accuracy: 0.8696
Epoch 386/500
1/1 [=====] - 0s 215ms/step - loss: 0.0017 - accuracy: 0.8730
Epoch 387/500
1/1 [=====] - 0s 200ms/step - loss: 0.0017 - accuracy: 0.8697
Epoch 388/500
1/1 [=====] - 0s 208ms/step - loss: 0.0017 - accuracy: 0.8732
Epoch 389/500
1/1 [=====] - 0s 215ms/step - loss: 0.0017 - accuracy: 0.8724
Epoch 390/500
1/1 [=====] - 0s 336ms/step - loss: 0.0017 - accuracy: 0.8717
Epoch 391/500
1/1 [=====] - 0s 340ms/step - loss: 0.0017 - accuracy: 0.8732
Epoch 392/500
1/1 [=====] - 0s 342ms/step - loss: 0.0017 - accuracy: 0.8709
Epoch 393/500
1/1 [=====] - 0s 345ms/step - loss: 0.0017 - accuracy: 0.8736
Epoch 394/500
1/1 [=====] - 0s 323ms/step - loss: 0.0017 - accuracy: 0.8717
Epoch 395/500
1/1 [=====] - 0s 323ms/step - loss: 0.0017 - accuracy: 0.8737
Epoch 396/500
1/1 [=====] - 0s 337ms/step - loss: 0.0017 - accuracy: 0.8728
Epoch 397/500
1/1 [=====] - 0s 259ms/step - loss: 0.0016 - accuracy: 0.8732
Epoch 398/500
1/1 [=====] - 0s 196ms/step - loss: 0.0016 - accuracy: 0.8728
Epoch 399/500
1/1 [=====] - 0s 231ms/step - loss: 0.0016 - accuracy: 0.8727
Epoch 400/500
1/1 [=====] - 0s 223ms/step - loss: 0.0016 - accuracy: 0.8738
Epoch 401/500
1/1 [=====] - 0s 206ms/step - loss: 0.0016 - accuracy: 0.8723
Epoch 402/500
1/1 [=====] - 0s 205ms/step - loss: 0.0016 - accuracy: 0.8748
Epoch 403/500
1/1 [=====] - 0s 212ms/step - loss: 0.0016 - accuracy: 0.8708
Epoch 404/500
1/1 [=====] - 0s 219ms/step - loss: 0.0016 - accuracy: 0.8749
Epoch 405/500
1/1 [=====] - 0s 201ms/step - loss: 0.0016 - accuracy: 0.8728
Epoch 406/500
1/1 [=====] - 0s 205ms/step - loss: 0.0016 - accuracy: 0.8745
Epoch 407/500
```

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1/1 [=====] - 0s 216ms/step - loss: 0.0016 - accuracy: 0.8738
Epoch 408/500
1/1 [=====] - 0s 225ms/step - loss: 0.0016 - accuracy: 0.8742
Epoch 409/500
1/1 [=====] - 0s 204ms/step - loss: 0.0016 - accuracy: 0.8745
Epoch 410/500
1/1 [=====] - 0s 199ms/step - loss: 0.0016 - accuracy: 0.8740
Epoch 411/500
1/1 [=====] - 0s 193ms/step - loss: 0.0016 - accuracy: 0.8746
Epoch 412/500
1/1 [=====] - 0s 213ms/step - loss: 0.0016 - accuracy: 0.8741
Epoch 413/500
1/1 [=====] - 0s 225ms/step - loss: 0.0016 - accuracy: 0.8750
Epoch 414/500
1/1 [=====] - 0s 206ms/step - loss: 0.0016 - accuracy: 0.8737
Epoch 415/500
1/1 [=====] - 0s 214ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 416/500
1/1 [=====] - 0s 205ms/step - loss: 0.0016 - accuracy: 0.8725
Epoch 417/500
1/1 [=====] - 0s 195ms/step - loss: 0.0016 - accuracy: 0.8761
Epoch 418/500
1/1 [=====] - 0s 207ms/step - loss: 0.0016 - accuracy: 0.8725
Epoch 419/500
1/1 [=====] - 0s 208ms/step - loss: 0.0016 - accuracy: 0.8761
Epoch 420/500
1/1 [=====] - 0s 203ms/step - loss: 0.0016 - accuracy: 0.8737
Epoch 421/500
1/1 [=====] - 0s 213ms/step - loss: 0.0016 - accuracy: 0.8763
Epoch 422/500
1/1 [=====] - 0s 207ms/step - loss: 0.0016 - accuracy: 0.8743
Epoch 423/500
1/1 [=====] - 0s 227ms/step - loss: 0.0016 - accuracy: 0.8762
Epoch 424/500
1/1 [=====] - 0s 197ms/step - loss: 0.0016 - accuracy: 0.8731
Epoch 425/500
1/1 [=====] - 0s 213ms/step - loss: 0.0016 - accuracy: 0.8766
Epoch 426/500
1/1 [=====] - 0s 192ms/step - loss: 0.0016 - accuracy: 0.8743
Epoch 427/500
1/1 [=====] - 0s 219ms/step - loss: 0.0016 - accuracy: 0.8757
Epoch 428/500
1/1 [=====] - 0s 213ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 429/500
1/1 [=====] - 0s 212ms/step - loss: 0.0016 - accuracy: 0.8739
Epoch 430/500
1/1 [=====] - 0s 203ms/step - loss: 0.0016 - accuracy: 0.8771
Epoch 431/500
1/1 [=====] - 0s 200ms/step - loss: 0.0016 - accuracy: 0.8728
Epoch 432/500
1/1 [=====] - 0s 221ms/step - loss: 0.0016 - accuracy: 0.8771
Epoch 433/500
1/1 [=====] - 0s 219ms/step - loss: 0.0016 - accuracy: 0.8745
Epoch 434/500
1/1 [=====] - 0s 209ms/step - loss: 0.0016 - accuracy: 0.8766
Epoch 435/500
1/1 [=====] - 0s 210ms/step - loss: 0.0016 - accuracy: 0.8760
Epoch 436/500
1/1 [=====] - 0s 204ms/step - loss: 0.0016 - accuracy: 0.8768
Epoch 437/500
1/1 [=====] - 0s 218ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 438/500
1/1 [=====] - 0s 208ms/step - loss: 0.0016 - accuracy: 0.8767
Epoch 439/500
1/1 [=====] - 0s 198ms/step - loss: 0.0016 - accuracy: 0.8749
Epoch 440/500
```

```
1/1 [=====] - 0s 200ms/step - loss: 0.0016 - accuracy: 0.8774
Epoch 441/500
1/1 [=====] - 0s 214ms/step - loss: 0.0016 - accuracy: 0.8752
Epoch 442/500
1/1 [=====] - 0s 201ms/step - loss: 0.0016 - accuracy: 0.8769
Epoch 443/500
1/1 [=====] - 0s 199ms/step - loss: 0.0016 - accuracy: 0.8768
Epoch 444/500
1/1 [=====] - 0s 257ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 445/500
1/1 [=====] - 0s 324ms/step - loss: 0.0016 - accuracy: 0.8779
Epoch 446/500
1/1 [=====] - 0s 355ms/step - loss: 0.0016 - accuracy: 0.8748
Epoch 447/500
1/1 [=====] - 0s 299ms/step - loss: 0.0016 - accuracy: 0.8780
Epoch 448/500
1/1 [=====] - 0s 323ms/step - loss: 0.0016 - accuracy: 0.8748
Epoch 449/500
1/1 [=====] - 0s 320ms/step - loss: 0.0016 - accuracy: 0.8783
Epoch 450/500
1/1 [=====] - 0s 299ms/step - loss: 0.0016 - accuracy: 0.8757
Epoch 451/500
1/1 [=====] - 0s 303ms/step - loss: 0.0016 - accuracy: 0.8776
Epoch 452/500
1/1 [=====] - 0s 322ms/step - loss: 0.0016 - accuracy: 0.8757
Epoch 453/500
1/1 [=====] - 0s 209ms/step - loss: 0.0016 - accuracy: 0.8778
Epoch 454/500
1/1 [=====] - 0s 208ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 455/500
1/1 [=====] - 0s 199ms/step - loss: 0.0016 - accuracy: 0.8780
Epoch 456/500
1/1 [=====] - 0s 203ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 457/500
1/1 [=====] - 0s 232ms/step - loss: 0.0016 - accuracy: 0.8782
Epoch 458/500
1/1 [=====] - 0s 214ms/step - loss: 0.0016 - accuracy: 0.8772
Epoch 459/500
1/1 [=====] - 0s 193ms/step - loss: 0.0016 - accuracy: 0.8763
Epoch 460/500
1/1 [=====] - 0s 204ms/step - loss: 0.0016 - accuracy: 0.8785
Epoch 461/500
1/1 [=====] - 0s 214ms/step - loss: 0.0016 - accuracy: 0.8743
Epoch 462/500
1/1 [=====] - 0s 231ms/step - loss: 0.0016 - accuracy: 0.8788
Epoch 463/500
1/1 [=====] - 0s 219ms/step - loss: 0.0016 - accuracy: 0.8749
Epoch 464/500
1/1 [=====] - 0s 204ms/step - loss: 0.0016 - accuracy: 0.8787
Epoch 465/500
1/1 [=====] - 0s 205ms/step - loss: 0.0016 - accuracy: 0.8774
Epoch 466/500
1/1 [=====] - 0s 206ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 467/500
1/1 [=====] - 0s 223ms/step - loss: 0.0016 - accuracy: 0.8786
Epoch 468/500
1/1 [=====] - 0s 200ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 469/500
1/1 [=====] - 0s 493ms/step - loss: 0.0016 - accuracy: 0.8786
Epoch 470/500
1/1 [=====] - 0s 298ms/step - loss: 0.0016 - accuracy: 0.8776
Epoch 471/500
1/1 [=====] - 0s 215ms/step - loss: 0.0016 - accuracy: 0.8771
Epoch 472/500
1/1 [=====] - 0s 216ms/step - loss: 0.0016 - accuracy: 0.8777
Epoch 473/500
```

```
[GPU0] 4/5/500
1/1 [=====] - 0s 202ms/step - loss: 0.0016 - accuracy: 0.8783
Epoch 474/500
1/1 [=====] - 0s 204ms/step - loss: 0.0016 - accuracy: 0.8763
Epoch 475/500
1/1 [=====] - 0s 222ms/step - loss: 0.0016 - accuracy: 0.8790
Epoch 476/500
1/1 [=====] - 0s 221ms/step - loss: 0.0016 - accuracy: 0.8762
Epoch 477/500
1/1 [=====] - 0s 211ms/step - loss: 0.0016 - accuracy: 0.8792
Epoch 478/500
1/1 [=====] - 0s 202ms/step - loss: 0.0016 - accuracy: 0.8785
Epoch 479/500
1/1 [=====] - 0s 210ms/step - loss: 0.0016 - accuracy: 0.8765
Epoch 480/500
1/1 [=====] - 0s 219ms/step - loss: 0.0016 - accuracy: 0.8792
Epoch 481/500
1/1 [=====] - 0s 206ms/step - loss: 0.0016 - accuracy: 0.8759
Epoch 482/500
1/1 [=====] - 0s 209ms/step - loss: 0.0016 - accuracy: 0.8797
Epoch 483/500
1/1 [=====] - 0s 215ms/step - loss: 0.0016 - accuracy: 0.8779
Epoch 484/500
1/1 [=====] - 0s 221ms/step - loss: 0.0016 - accuracy: 0.8778
Epoch 485/500
1/1 [=====] - 0s 208ms/step - loss: 0.0016 - accuracy: 0.8788
Epoch 486/500
1/1 [=====] - 0s 205ms/step - loss: 0.0016 - accuracy: 0.8778
Epoch 487/500
1/1 [=====] - 0s 208ms/step - loss: 0.0016 - accuracy: 0.8780
Epoch 488/500
1/1 [=====] - 0s 205ms/step - loss: 0.0015 - accuracy: 0.8795
Epoch 489/500
1/1 [=====] - 0s 221ms/step - loss: 0.0015 - accuracy: 0.8760
Epoch 490/500
1/1 [=====] - 0s 211ms/step - loss: 0.0016 - accuracy: 0.8801
Epoch 491/500
1/1 [=====] - 0s 212ms/step - loss: 0.0015 - accuracy: 0.8763
Epoch 492/500
1/1 [=====] - 0s 194ms/step - loss: 0.0015 - accuracy: 0.8800
Epoch 493/500
1/1 [=====] - 0s 215ms/step - loss: 0.0015 - accuracy: 0.8791
Epoch 494/500
1/1 [=====] - 0s 229ms/step - loss: 0.0015 - accuracy: 0.8772
Epoch 495/500
1/1 [=====] - 0s 207ms/step - loss: 0.0015 - accuracy: 0.8788
Epoch 496/500
1/1 [=====] - 0s 201ms/step - loss: 0.0015 - accuracy: 0.8783
Epoch 497/500
1/1 [=====] - 0s 246ms/step - loss: 0.0015 - accuracy: 0.8783
Epoch 498/500
1/1 [=====] - 0s 347ms/step - loss: 0.0015 - accuracy: 0.8799
Epoch 499/500
1/1 [=====] - 0s 306ms/step - loss: 0.0015 - accuracy: 0.8759
Epoch 500/500
1/1 [=====] - 0s 338ms/step - loss: 0.0015 - accuracy: 0.8805
Neural network output
1/1 [=====] - 0s 204ms/step
<matplotlib.image.AxesImage at 0x7f06719feb30>
```



