Import Python Libraries

In [1]:
```
import numpy as np
import time
import random
```

In [2]:
```
from sklearn.ensemble import RandomForestClassifier
import sklearn.metrics as metrics
```

In [3]:
```
import tensorflow as tf
import matplotlib.pyplot as plt

print(tf.__version__)
```

```
2.2.0
```

FASHION data

Label Class 0 T-shirt/top 1 Trouser 2 Pullover 3 Dress 4 Coat 5 Sandal 6 Shirt 7 Sneaker 8 Bag 9 Ankle boot

In [4]:
```
#Loan in Fashion Data
mnist = tf.keras.datasets.fashion_mnist # 28x28 Fashion Image Data

class_names = ['T-shirt/top', 'Trouser', 'Pullover', 'Dress', 'Coa
t', 'Sandal', 'Shirt', 'Sneaker', 'Bag', 'Ankle boot' ]
```

NUMBER data

In [5]:
```
#Load in Data
#mnist = tf.keras.datasets.mnist # 28x28 Handwritten Digits 0-9
```

In [6]:
```
(x_train, y_train), (x_test, y_test) = mnist.load_data()

# Normalize the Data
#x_train = tf.keras.utils.normalize(x_train, axis=1)
#x_test = tf.keras.utils.normalize(x_test, axis=1)

x_train = x_train/255
x_test = x_test/255
```

In [7]:
```
print(type(x_train))
print(x_train.shape)

print(type(y_train))
print(y_train.shape)
```

```
<class 'numpy.ndarray'>
(60000, 28, 28)
<class 'numpy.ndarray'>
(60000,)
```

In [8]:
```
INPUT_SHAPE = x_train[0].shape
print("Shape = ", INPUT_SHAPE )

TOTAL_SIZE = INPUT_SHAPE[0] * INPUT_SHAPE[1]
print("TOTAL SIZE = ", TOTAL_SIZE)
#multiplication of the height and length gives the number of pixel
s, aka total size
```

```
Shape =  (28, 28)
TOTAL SIZE =  784
```

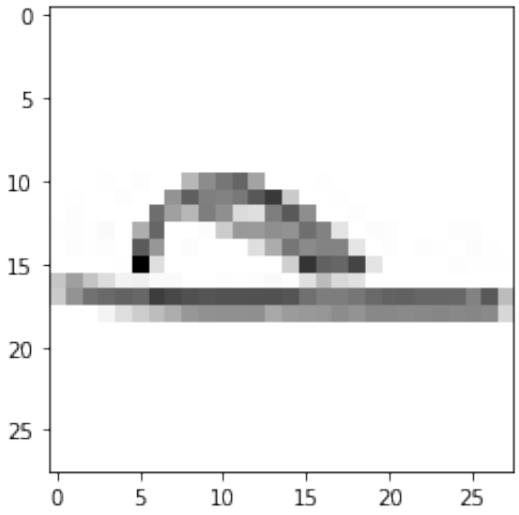
Our data us 28 by 28 and has an area of 784

In [9]:
```
def getRandomIndex( DATA ) :
    return random.randint(0, DATA.shape[0] )
```

In [12]:
```
who=0
who=getRandomIndex(x_train)

print("who=", who)

print(y_train[who])
#print(x_train[who])

#for black and white plot
plt.imshow(x_train[who], plt.cm.binary)

#for color plot
#plt.imshow(x_train[who])
```

```
who= 27360
5
```

Out[12]: <matplotlib.image.AxesImage at 0x7fe6d8a06890>



SOLVE USING RANDOM FORESTS

Random Forest model needs the data to be flatten so we will first need to flatten our data as below:

In [13]:
```
new_x_train = []
for i in x_train :
    new_x_train.append(i.flatten())
new_x_train = np.array(new_x_train)

new_x_test = []
for i in x_test :
    new_x_test.append(i.flatten())
new_x_test = np.array(new_x_test)

print(x_train.shape)
print(new_x_train.shape)
```

```
(60000, 28, 28)
(60000, 784)
```

In [14]:
```
start_time = time.time()

theTrees = int(2*TOTAL_SIZE)

clf = RandomForestClassifier(n_estimators = theTrees)
clf.fit(new_x_train, y_train)

print("Execution Time = ", (time.time()-start_time))
```

```
Execution Time =  1443.4419178962708
```

In [15]:
```
pred_train = clf.predict(new_x_train)
print(pred_train[0])
RF_acc_train = metrics.accuracy_score(y_train, pred_train)
print("train accuracy", RF_acc_train)

pred_test = clf.predict(new_x_test)
print(pred_test[0])
RF_acc = metrics.accuracy_score(y_test, pred_test)
print("test accuracy", RF_acc)
```

```
9
train accuracy 1.0
9
test accuracy 0.8785
```

Random Forest model was able to get 100% accuracy on our training data.

Random Forest that we ran for our test data which also gave an output of 9 showed 88% accuracy. Even though 88% accuracy is decent, we hope to get a test data accuracy of above 90%.

SOLVE USING TENSOR FLOW NEURAL NETWORKS

In [38]:
```
theEpochs = 500

theActivation = tf.keras.activations.relu

units_01 = int(2*TOTAL_SIZE )
units_02 = units_01

DENSE_LAYER_01 = tf.keras.layers.Dense( units=units_01, activation
=theActivation )
DENSE_LAYER_02 = tf.keras.layers.Dense( units=units_02, activation
=theActivation )
DENSE_LAYER_XX = tf.keras.layers.Dense(10, activation=tf.nn.softma
x )

DROPOUT_LAYER = tf.keras.layers.Dropout(0.2)


theOptimizer = tf.keras.optimizers.Adam()
theLossMetric = tf.keras.losses.SparseCategoricalCrossentropy()

theSplit = 0.2
theBatchSize = 16
verboseFlag = True

theTensorFlowSaveFile = "TF_Number_Model"
```

The model was ran with 500 Epochs, two layers, with 20%/80% split and 16 batches. The 16 batches were introduced for time and model efficiency.

In [39]:
```
# Build the Model

start_time = time.time()

model = tf.keras.models.Sequential()
model.add( tf.keras.layers.Flatten( input_shape=INPUT_SHAPE ) )
model.add( DENSE_LAYER_01 )
model.add( DROPOUT_LAYER )
model.add( DENSE_LAYER_02 )
model.add( DENSE_LAYER_XX )
model.compile( optimizer=theOptimizer, loss=theLossMetric )

model.compile( optimizer=theOptimizer, loss=theLossMetric, metrics
=['accuracy'] )
#model.fit(x_train, y_train, epochs=theEpochs, verbose = verboseFl
ag )

model.fit(x_train, y_train, epochs=theEpochs, validation_split=the
Split, batch_size=theBatchSize, verbose = verboseFlag )

print("Execution Time = ", (time.time()-start_time))
```

```
Epoch 1/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.5279 - accuracy: 0.8093 - val_loss: 0.4216 - val_accuracy: 0.
8460
Epoch 2/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.4150 - accuracy: 0.8509 - val_loss: 0.4174 - val_accuracy: 0.
8336
Epoch 3/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.3829 - accuracy: 0.8596 - val_loss: 0.3484 - val_accuracy: 0.
8688
Epoch 4/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.3624 - accuracy: 0.8658 - val_loss: 0.3409 - val_accuracy: 0.
8763
Epoch 5/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.3416 - accuracy: 0.8760 - val_loss: 0.3921 - val_accuracy: 0.
8505
Epoch 6/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.3292 - accuracy: 0.8783 - val_loss: 0.3493 - val_accuracy: 0.
8742
Epoch 7/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.3261 - accuracy: 0.8783 - val_loss: 0.3346 - val_accuracy: 0.
8804
Epoch 8/500
```

```
3000/3000 [==============================] - 82s 27ms/step - loss
: 0.3142 - accuracy: 0.8837 - val_loss: 0.3292 - val_accuracy: 0.
8834
Epoch 9/500
3000/3000 [==============================] - 78s 26ms/step - loss
: 0.3070 - accuracy: 0.8864 - val_loss: 0.3316 - val_accuracy: 0.
8814
Epoch 10/500
3000/3000 [==============================] - 87s 29ms/step - loss
: 0.3021 - accuracy: 0.8887 - val_loss: 0.3378 - val_accuracy: 0.
8800
Epoch 11/500
3000/3000 [==============================] - 81s 27ms/step - loss
: 0.2919 - accuracy: 0.8915 - val_loss: 0.3357 - val_accuracy: 0.
8826
Epoch 12/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.2914 - accuracy: 0.8925 - val_loss: 0.3347 - val_accuracy: 0.
8810
Epoch 13/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.2864 - accuracy: 0.8940 - val_loss: 0.3219 - val_accuracy: 0.
8892
Epoch 14/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.2815 - accuracy: 0.8955 - val_loss: 0.3298 - val_accuracy: 0.
8846
Epoch 15/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.2774 - accuracy: 0.8969 - val_loss: 0.3419 - val_accuracy: 0.
8825
Epoch 16/500
3000/3000 [==============================] - 77s 26ms/step - loss
: 0.2699 - accuracy: 0.9004 - val_loss: 0.3570 - val_accuracy: 0.
8818
Epoch 17/500
3000/3000 [==============================] - 79s 26ms/step - loss
: 0.2684 - accuracy: 0.9022 - val_loss: 0.3231 - val_accuracy: 0.
8916
Epoch 18/500
3000/3000 [==============================] - 85s 28ms/step - loss
: 0.2666 - accuracy: 0.9011 - val_loss: 0.3840 - val_accuracy: 0.
8872
Epoch 19/500
3000/3000 [==============================] - 83s 28ms/step - loss
: 0.2627 - accuracy: 0.9035 - val_loss: 0.3578 - val_accuracy: 0.
8854
Epoch 20/500
3000/3000 [==============================] - 83s 28ms/step - loss
: 0.2571 - accuracy: 0.9055 - val_loss: 0.3519 - val_accuracy: 0.
8916
Epoch 21/500
```

```
3000/3000 [==============================] - 85s 28ms/step - loss
: 0.2599 - accuracy: 0.9061 - val_loss: 0.3397 - val_accuracy: 0.
8925
Epoch 22/500
3000/3000 [==============================] - 79s 26ms/step - loss
: 0.2514 - accuracy: 0.9061 - val_loss: 0.3443 - val_accuracy: 0.
8922
Epoch 23/500
3000/3000 [==============================] - 74s 25ms/step - loss
: 0.2496 - accuracy: 0.9081 - val_loss: 0.3702 - val_accuracy: 0.
8799
Epoch 24/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.2463 - accuracy: 0.9086 - val_loss: 0.3354 - val_accuracy: 0.
8917
Epoch 25/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.2424 - accuracy: 0.9107 - val_loss: 0.3633 - val_accuracy: 0.
8903
Epoch 26/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.2439 - accuracy: 0.9104 - val_loss: 0.3634 - val_accuracy: 0.
8883
Epoch 27/500
3000/3000 [==============================] - 73s 24ms/step - loss
: 0.2378 - accuracy: 0.9127 - val_loss: 0.3815 - val_accuracy: 0.
8916
Epoch 28/500
3000/3000 [==============================] - 77s 26ms/step - loss
: 0.2348 - accuracy: 0.9137 - val_loss: 0.3707 - val_accuracy: 0.
8894
Epoch 29/500
3000/3000 [==============================] - 78s 26ms/step - loss
: 0.2405 - accuracy: 0.9129 - val_loss: 0.3642 - val_accuracy: 0.
8896
Epoch 30/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.2373 - accuracy: 0.9129 - val_loss: 0.3756 - val_accuracy: 0.
8903
Epoch 31/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.2302 - accuracy: 0.9154 - val_loss: 0.3692 - val_accuracy: 0.
8954
Epoch 32/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.2269 - accuracy: 0.9159 - val_loss: 0.3518 - val_accuracy: 0.
8978
Epoch 33/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.2311 - accuracy: 0.9149 - val_loss: 0.3714 - val_accuracy: 0.
8916
Epoch 34/500
```

```
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.2262 - accuracy: 0.9160 - val_loss: 0.3600 - val_accuracy: 0.
8941
Epoch 35/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.2247 - accuracy: 0.9173 - val_loss: 0.3426 - val_accuracy: 0.
8980
Epoch 36/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.2212 - accuracy: 0.9178 - val_loss: 0.3462 - val_accuracy: 0.
8957
Epoch 37/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.2238 - accuracy: 0.9198 - val_loss: 0.3666 - val_accuracy: 0.
8953
Epoch 38/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.2201 - accuracy: 0.9191 - val_loss: 0.3831 - val_accuracy: 0.
8949
Epoch 39/500
3000/3000 [==============================] - 73s 24ms/step - loss
: 0.2226 - accuracy: 0.9188 - val_loss: 0.3755 - val_accuracy: 0.
8942
Epoch 40/500
3000/3000 [==============================] - 78s 26ms/step - loss
: 0.2124 - accuracy: 0.9207 - val_loss: 0.3779 - val_accuracy: 0.
8928
Epoch 41/500
3000/3000 [==============================] - 75s 25ms/step - loss
: 0.2140 - accuracy: 0.9224 - val_loss: 0.4242 - val_accuracy: 0.
8928
Epoch 42/500
3000/3000 [==============================] - 82s 27ms/step - loss
: 0.2161 - accuracy: 0.9233 - val_loss: 0.3939 - val_accuracy: 0.
8948
Epoch 43/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.2084 - accuracy: 0.9240 - val_loss: 0.4090 - val_accuracy: 0.
8910
Epoch 44/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.2108 - accuracy: 0.9221 - val_loss: 0.4127 - val_accuracy: 0.
8952
Epoch 45/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.2070 - accuracy: 0.9250 - val_loss: 0.4090 - val_accuracy: 0.
8950
Epoch 46/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.2006 - accuracy: 0.9249 - val_loss: 0.4398 - val_accuracy: 0.
8970
Epoch 47/500
```

```
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.2046 - accuracy: 0.9252 - val_loss: 0.4226 - val_accuracy: 0.
8944
Epoch 48/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.2071 - accuracy: 0.9253 - val_loss: 0.4499 - val_accuracy: 0.
8879
Epoch 49/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1976 - accuracy: 0.9268 - val_loss: 0.4364 - val_accuracy: 0.
8951
Epoch 50/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.2064 - accuracy: 0.9254 - val_loss: 0.4369 - val_accuracy: 0.
8954
Epoch 51/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1963 - accuracy: 0.9280 - val_loss: 0.4076 - val_accuracy: 0.
8980
Epoch 52/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1980 - accuracy: 0.9281 - val_loss: 0.4509 - val_accuracy: 0.
8947
Epoch 53/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1912 - accuracy: 0.9294 - val_loss: 0.4905 - val_accuracy: 0.
8943
Epoch 54/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1982 - accuracy: 0.9284 - val_loss: 0.4380 - val_accuracy: 0.
8938
Epoch 55/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1974 - accuracy: 0.9292 - val_loss: 0.4385 - val_accuracy: 0.
8953
Epoch 56/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1907 - accuracy: 0.9315 - val_loss: 0.4642 - val_accuracy: 0.
8913
Epoch 57/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1890 - accuracy: 0.9305 - val_loss: 0.4805 - val_accuracy: 0.
8953
Epoch 58/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1908 - accuracy: 0.9314 - val_loss: 0.4444 - val_accuracy: 0.
8937
Epoch 59/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1886 - accuracy: 0.9319 - val_loss: 0.5296 - val_accuracy: 0.
8917
Epoch 60/500
```

```
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1835 - accuracy: 0.9331 - val_loss: 0.5120 - val_accuracy: 0.
8912
Epoch 61/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1912 - accuracy: 0.9319 - val_loss: 0.4652 - val_accuracy: 0.
8974
Epoch 62/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1863 - accuracy: 0.9319 - val_loss: 0.4898 - val_accuracy: 0.
8899
Epoch 63/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1914 - accuracy: 0.9318 - val_loss: 0.5441 - val_accuracy: 0.
8921
Epoch 64/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1892 - accuracy: 0.9343 - val_loss: 0.4449 - val_accuracy: 0.
8972
Epoch 65/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1814 - accuracy: 0.9335 - val_loss: 0.4828 - val_accuracy: 0.
8891
Epoch 66/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1784 - accuracy: 0.9356 - val_loss: 0.4623 - val_accuracy: 0.
8932
Epoch 67/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1851 - accuracy: 0.9332 - val_loss: 0.4586 - val_accuracy: 0.
8892
Epoch 68/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1810 - accuracy: 0.9336 - val_loss: 0.5110 - val_accuracy: 0.
8930
Epoch 69/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1801 - accuracy: 0.9340 - val_loss: 0.4735 - val_accuracy: 0.
8928
Epoch 70/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1793 - accuracy: 0.9346 - val_loss: 0.5241 - val_accuracy: 0.
8971
Epoch 71/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1781 - accuracy: 0.9361 - val_loss: 0.5105 - val_accuracy: 0.
8980
Epoch 72/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1804 - accuracy: 0.9341 - val_loss: 0.4823 - val_accuracy: 0.
8987
Epoch 73/500
```

```
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1807 - accuracy: 0.9356 - val_loss: 0.5353 - val_accuracy: 0.
8931
Epoch 74/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1709 - accuracy: 0.9393 - val_loss: 0.5177 - val_accuracy: 0.
9003
Epoch 75/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1807 - accuracy: 0.9361 - val_loss: 0.5672 - val_accuracy: 0.
8957
Epoch 76/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1698 - accuracy: 0.9379 - val_loss: 0.5036 - val_accuracy: 0.
8947
Epoch 77/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1685 - accuracy: 0.9368 - val_loss: 0.5466 - val_accuracy: 0.
8957
Epoch 78/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1708 - accuracy: 0.9384 - val_loss: 0.5907 - val_accuracy: 0.
8928
Epoch 79/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1666 - accuracy: 0.9392 - val_loss: 0.5166 - val_accuracy: 0.
8945
Epoch 80/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1701 - accuracy: 0.9383 - val_loss: 0.5449 - val_accuracy: 0.
8968
Epoch 81/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1694 - accuracy: 0.9385 - val_loss: 0.5482 - val_accuracy: 0.
8955
Epoch 82/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1661 - accuracy: 0.9400 - val_loss: 0.6021 - val_accuracy: 0.
8940
Epoch 83/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1661 - accuracy: 0.9415 - val_loss: 0.5773 - val_accuracy: 0.
8993
Epoch 84/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1758 - accuracy: 0.9381 - val_loss: 0.6141 - val_accuracy: 0.
8930
Epoch 85/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1678 - accuracy: 0.9394 - val_loss: 0.5421 - val_accuracy: 0.
9004
Epoch 86/500
```

```
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1686 - accuracy: 0.9397 - val_loss: 0.5903 - val_accuracy: 0.
8978
Epoch 87/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1603 - accuracy: 0.9415 - val_loss: 0.5902 - val_accuracy: 0.
8992
Epoch 88/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1690 - accuracy: 0.9410 - val_loss: 0.5593 - val_accuracy: 0.
8998
Epoch 89/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1588 - accuracy: 0.9419 - val_loss: 0.5558 - val_accuracy: 0.
8959
Epoch 90/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1630 - accuracy: 0.9417 - val_loss: 0.5516 - val_accuracy: 0.
8969
Epoch 91/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1630 - accuracy: 0.9410 - val_loss: 0.5769 - val_accuracy: 0.
8957
Epoch 92/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1629 - accuracy: 0.9425 - val_loss: 0.6090 - val_accuracy: 0.
8959
Epoch 93/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.1656 - accuracy: 0.9435 - val_loss: 0.6107 - val_accuracy: 0.
8959
Epoch 94/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1573 - accuracy: 0.9433 - val_loss: 0.5753 - val_accuracy: 0.
8960
Epoch 95/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1559 - accuracy: 0.9435 - val_loss: 0.6858 - val_accuracy: 0.
8944
Epoch 96/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1590 - accuracy: 0.9445 - val_loss: 0.6873 - val_accuracy: 0.
8959
Epoch 97/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.1521 - accuracy: 0.9451 - val_loss: 0.5984 - val_accuracy: 0.
8939
Epoch 98/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1510 - accuracy: 0.9439 - val_loss: 0.6479 - val_accuracy: 0.
8978
Epoch 99/500
```

```
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1641 - accuracy: 0.9414 - val_loss: 0.6251 - val_accuracy: 0.
8929
Epoch 100/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1577 - accuracy: 0.9440 - val_loss: 0.6312 - val_accuracy: 0.
8958
Epoch 101/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1536 - accuracy: 0.9452 - val_loss: 0.7086 - val_accuracy: 0.
9003
Epoch 102/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1586 - accuracy: 0.9446 - val_loss: 0.5885 - val_accuracy: 0.
8890
Epoch 103/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1544 - accuracy: 0.9456 - val_loss: 0.5958 - val_accuracy: 0.
8979
Epoch 104/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1616 - accuracy: 0.9448 - val_loss: 0.6254 - val_accuracy: 0.
8974
Epoch 105/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1523 - accuracy: 0.9452 - val_loss: 0.6685 - val_accuracy: 0.
8801
Epoch 106/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1508 - accuracy: 0.9464 - val_loss: 0.6436 - val_accuracy: 0.
8980
Epoch 107/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1489 - accuracy: 0.9461 - val_loss: 0.6139 - val_accuracy: 0.
8982
Epoch 108/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1488 - accuracy: 0.9466 - val_loss: 0.6499 - val_accuracy: 0.
8909
Epoch 109/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1558 - accuracy: 0.9461 - val_loss: 0.6096 - val_accuracy: 0.
8988
Epoch 110/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1462 - accuracy: 0.9473 - val_loss: 0.6810 - val_accuracy: 0.
8977
Epoch 111/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1484 - accuracy: 0.9475 - val_loss: 0.6589 - val_accuracy: 0.
9003
Epoch 112/500
```

```
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1519 - accuracy: 0.9474 - val_loss: 0.7178 - val_accuracy: 0.
8957
Epoch 113/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1475 - accuracy: 0.9494 - val_loss: 0.6898 - val_accuracy: 0.
8942
Epoch 114/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1462 - accuracy: 0.9477 - val_loss: 0.7486 - val_accuracy: 0.
8976
Epoch 115/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1472 - accuracy: 0.9460 - val_loss: 0.6843 - val_accuracy: 0.
8963
Epoch 116/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1423 - accuracy: 0.9488 - val_loss: 0.6161 - val_accuracy: 0.
8988
Epoch 117/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1447 - accuracy: 0.9490 - val_loss: 0.6352 - val_accuracy: 0.
8990
Epoch 118/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1493 - accuracy: 0.9480 - val_loss: 0.6841 - val_accuracy: 0.
8993
Epoch 119/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1430 - accuracy: 0.9496 - val_loss: 0.7132 - val_accuracy: 0.
8977
Epoch 120/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1461 - accuracy: 0.9484 - val_loss: 0.6934 - val_accuracy: 0.
8970
Epoch 121/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1414 - accuracy: 0.9505 - val_loss: 0.6984 - val_accuracy: 0.
8975
Epoch 122/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1458 - accuracy: 0.9499 - val_loss: 0.7347 - val_accuracy: 0.
8985
Epoch 123/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1406 - accuracy: 0.9488 - val_loss: 0.7050 - val_accuracy: 0.
8931
Epoch 124/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1428 - accuracy: 0.9496 - val_loss: 0.7083 - val_accuracy: 0.
8995
Epoch 125/500
```

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3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1570 - accuracy: 0.9480 - val_loss: 0.6940 - val_accuracy: 0.
8971
Epoch 126/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1413 - accuracy: 0.9496 - val_loss: 0.7465 - val_accuracy: 0.
8976
Epoch 127/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1437 - accuracy: 0.9513 - val_loss: 0.7197 - val_accuracy: 0.
8967
Epoch 128/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1421 - accuracy: 0.9505 - val_loss: 0.7655 - val_accuracy: 0.
8886
Epoch 129/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1398 - accuracy: 0.9503 - val_loss: 0.8309 - val_accuracy: 0.
8939
Epoch 130/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1383 - accuracy: 0.9513 - val_loss: 0.7577 - val_accuracy: 0.
8956
Epoch 131/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1415 - accuracy: 0.9497 - val_loss: 0.7980 - val_accuracy: 0.
8999
Epoch 132/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1394 - accuracy: 0.9512 - val_loss: 0.7459 - val_accuracy: 0.
8969
Epoch 133/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1412 - accuracy: 0.9520 - val_loss: 0.6931 - val_accuracy: 0.
8969
Epoch 134/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1340 - accuracy: 0.9514 - val_loss: 0.7096 - val_accuracy: 0.
8963
Epoch 135/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1378 - accuracy: 0.9520 - val_loss: 0.7224 - val_accuracy: 0.
8967
Epoch 136/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1378 - accuracy: 0.9509 - val_loss: 0.7234 - val_accuracy: 0.
8960
Epoch 137/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1361 - accuracy: 0.9516 - val_loss: 0.8272 - val_accuracy: 0.
8990
Epoch 138/500
```

```
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1379 - accuracy: 0.9513 - val_loss: 0.7709 - val_accuracy: 0.
8958
Epoch 139/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1336 - accuracy: 0.9524 - val_loss: 0.7529 - val_accuracy: 0.
8963
Epoch 140/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1326 - accuracy: 0.9527 - val_loss: 0.7824 - val_accuracy: 0.
8941
Epoch 141/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1357 - accuracy: 0.9519 - val_loss: 0.7083 - val_accuracy: 0.
8988
Epoch 142/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1403 - accuracy: 0.9538 - val_loss: 0.8154 - val_accuracy: 0.
8937
Epoch 143/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1302 - accuracy: 0.9547 - val_loss: 0.8268 - val_accuracy: 0.
8953
Epoch 144/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1328 - accuracy: 0.9536 - val_loss: 0.7088 - val_accuracy: 0.
8933
Epoch 145/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1360 - accuracy: 0.9529 - val_loss: 0.8390 - val_accuracy: 0.
8970
Epoch 146/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1359 - accuracy: 0.9532 - val_loss: 0.7182 - val_accuracy: 0.
8978
Epoch 147/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1292 - accuracy: 0.9532 - val_loss: 0.7467 - val_accuracy: 0.
8938
Epoch 148/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1317 - accuracy: 0.9534 - val_loss: 0.7918 - val_accuracy: 0.
9000
Epoch 149/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1359 - accuracy: 0.9526 - val_loss: 0.7818 - val_accuracy: 0.
8921
Epoch 150/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1291 - accuracy: 0.9557 - val_loss: 0.7948 - val_accuracy: 0.
8951
Epoch 151/500
```

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3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1259 - accuracy: 0.9562 - val_loss: 0.7980 - val_accuracy: 0.
8978
Epoch 152/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1356 - accuracy: 0.9528 - val_loss: 0.7438 - val_accuracy: 0.
8970
Epoch 153/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1355 - accuracy: 0.9516 - val_loss: 0.7726 - val_accuracy: 0.
8965
Epoch 154/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1292 - accuracy: 0.9551 - val_loss: 0.8002 - val_accuracy: 0.
8938
Epoch 155/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1245 - accuracy: 0.9549 - val_loss: 0.8099 - val_accuracy: 0.
8996
Epoch 156/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1291 - accuracy: 0.9546 - val_loss: 0.8620 - val_accuracy: 0.
8945
Epoch 157/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1291 - accuracy: 0.9538 - val_loss: 0.8037 - val_accuracy: 0.
8989
Epoch 158/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1237 - accuracy: 0.9562 - val_loss: 0.8280 - val_accuracy: 0.
8988
Epoch 159/500
3000/3000 [==============================] - 69s 23ms/step - loss
: 0.1278 - accuracy: 0.9544 - val_loss: 0.8505 - val_accuracy: 0.
8998
Epoch 160/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1345 - accuracy: 0.9551 - val_loss: 0.8099 - val_accuracy: 0.
8981
Epoch 161/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1268 - accuracy: 0.9564 - val_loss: 0.8546 - val_accuracy: 0.
8972
Epoch 162/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.1278 - accuracy: 0.9555 - val_loss: 0.8960 - val_accuracy: 0.
8960
Epoch 163/500
3000/3000 [==============================] - 76s 25ms/step - loss
: 0.1204 - accuracy: 0.9573 - val_loss: 0.8536 - val_accuracy: 0.
8986
Epoch 164/500
```

```
3000/3000 [==============================] - 78s 26ms/step - loss
: 0.1210 - accuracy: 0.9563 - val_loss: 0.8945 - val_accuracy: 0.
8981
Epoch 165/500
3000/3000 [==============================] - 84s 28ms/step - loss
: 0.1284 - accuracy: 0.9566 - val_loss: 0.8747 - val_accuracy: 0.
8986
Epoch 166/500
3000/3000 [==============================] - 86s 29ms/step - loss
: 0.1253 - accuracy: 0.9569 - val_loss: 0.8219 - val_accuracy: 0.
8940
Epoch 167/500
3000/3000 [==============================] - 81s 27ms/step - loss
: 0.1226 - accuracy: 0.9582 - val_loss: 0.9267 - val_accuracy: 0.
8947
Epoch 168/500
3000/3000 [==============================] - 77s 26ms/step - loss
: 0.1217 - accuracy: 0.9572 - val_loss: 1.0221 - val_accuracy: 0.
8982
Epoch 169/500
3000/3000 [==============================] - 74s 25ms/step - loss
: 0.1328 - accuracy: 0.9569 - val_loss: 1.0059 - val_accuracy: 0.
8915
Epoch 170/500
3000/3000 [==============================] - 75s 25ms/step - loss
: 0.1247 - accuracy: 0.9584 - val_loss: 1.0522 - val_accuracy: 0.
8925
Epoch 171/500
3000/3000 [==============================] - 85s 28ms/step - loss
: 0.1320 - accuracy: 0.9560 - val_loss: 0.9600 - val_accuracy: 0.
8985
Epoch 172/500
3000/3000 [==============================] - 78s 26ms/step - loss
: 0.1225 - accuracy: 0.9591 - val_loss: 1.0123 - val_accuracy: 0.
8979
Epoch 173/500
3000/3000 [==============================] - 85s 28ms/step - loss
: 0.1266 - accuracy: 0.9567 - val_loss: 0.8886 - val_accuracy: 0.
8972
Epoch 174/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1198 - accuracy: 0.9593 - val_loss: 0.8628 - val_accuracy: 0.
8984
Epoch 175/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.1234 - accuracy: 0.9578 - val_loss: 0.9643 - val_accuracy: 0.
8967
Epoch 176/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1155 - accuracy: 0.9592 - val_loss: 0.9453 - val_accuracy: 0.
8945
Epoch 177/500
```

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3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1231 - accuracy: 0.9572 - val_loss: 1.0228 - val_accuracy: 0.
8953
Epoch 178/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.1269 - accuracy: 0.9581 - val_loss: 0.8316 - val_accuracy: 0.
8979
Epoch 179/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.1157 - accuracy: 0.9603 - val_loss: 0.8457 - val_accuracy: 0.
8999
Epoch 180/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1235 - accuracy: 0.9574 - val_loss: 0.9765 - val_accuracy: 0.
8993
Epoch 181/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1210 - accuracy: 0.9600 - val_loss: 1.0012 - val_accuracy: 0.
8970
Epoch 182/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1185 - accuracy: 0.9585 - val_loss: 0.9405 - val_accuracy: 0.
8940
Epoch 183/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1248 - accuracy: 0.9584 - val_loss: 0.9316 - val_accuracy: 0.
8981
Epoch 184/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1199 - accuracy: 0.9600 - val_loss: 0.9313 - val_accuracy: 0.
8953
Epoch 185/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1133 - accuracy: 0.9599 - val_loss: 0.9426 - val_accuracy: 0.
8967
Epoch 186/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1217 - accuracy: 0.9579 - val_loss: 0.8450 - val_accuracy: 0.
8962
Epoch 187/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1217 - accuracy: 0.9595 - val_loss: 0.9088 - val_accuracy: 0.
8989
Epoch 188/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1138 - accuracy: 0.9604 - val_loss: 1.0136 - val_accuracy: 0.
8989
Epoch 189/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1221 - accuracy: 0.9568 - val_loss: 0.9233 - val_accuracy: 0.
8958
Epoch 190/500
```

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3000/3000 [==============================] - 69s 23ms/step - loss
: 0.1110 - accuracy: 0.9601 - val_loss: 0.9209 - val_accuracy: 0.
8953
Epoch 191/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1128 - accuracy: 0.9603 - val_loss: 0.9382 - val_accuracy: 0.
8992
Epoch 192/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1130 - accuracy: 0.9598 - val_loss: 0.9437 - val_accuracy: 0.
8944
Epoch 193/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1270 - accuracy: 0.9582 - val_loss: 0.8780 - val_accuracy: 0.
8988
Epoch 194/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1189 - accuracy: 0.9600 - val_loss: 0.9130 - val_accuracy: 0.
8964
Epoch 195/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1115 - accuracy: 0.9611 - val_loss: 1.0752 - val_accuracy: 0.
8994
Epoch 196/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1271 - accuracy: 0.9589 - val_loss: 1.0511 - val_accuracy: 0.
8887
Epoch 197/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1182 - accuracy: 0.9592 - val_loss: 1.0099 - val_accuracy: 0.
8972
Epoch 198/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1180 - accuracy: 0.9602 - val_loss: 1.0148 - val_accuracy: 0.
8994
Epoch 199/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1204 - accuracy: 0.9595 - val_loss: 0.9926 - val_accuracy: 0.
8981
Epoch 200/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1178 - accuracy: 0.9603 - val_loss: 0.9496 - val_accuracy: 0.
9002
Epoch 201/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1065 - accuracy: 0.9622 - val_loss: 1.1122 - val_accuracy: 0.
8956
Epoch 202/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1143 - accuracy: 0.9611 - val_loss: 0.9928 - val_accuracy: 0.
8905
Epoch 203/500
```

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3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1176 - accuracy: 0.9604 - val_loss: 1.0764 - val_accuracy: 0.
8974
Epoch 204/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1152 - accuracy: 0.9611 - val_loss: 1.1335 - val_accuracy: 0.
8985
Epoch 205/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1121 - accuracy: 0.9619 - val_loss: 1.0381 - val_accuracy: 0.
8964
Epoch 206/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1095 - accuracy: 0.9624 - val_loss: 1.0995 - val_accuracy: 0.
8950
Epoch 207/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1118 - accuracy: 0.9617 - val_loss: 1.1553 - val_accuracy: 0.
8972
Epoch 208/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1171 - accuracy: 0.9600 - val_loss: 1.0325 - val_accuracy: 0.
8961
Epoch 209/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1210 - accuracy: 0.9599 - val_loss: 0.9516 - val_accuracy: 0.
8957
Epoch 210/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1063 - accuracy: 0.9620 - val_loss: 1.1309 - val_accuracy: 0.
8972
Epoch 211/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1110 - accuracy: 0.9621 - val_loss: 1.0132 - val_accuracy: 0.
8975
Epoch 212/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1135 - accuracy: 0.9605 - val_loss: 1.0233 - val_accuracy: 0.
8957
Epoch 213/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1092 - accuracy: 0.9617 - val_loss: 1.1142 - val_accuracy: 0.
8995
Epoch 214/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1147 - accuracy: 0.9608 - val_loss: 1.0093 - val_accuracy: 0.
8996
Epoch 215/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1047 - accuracy: 0.9635 - val_loss: 1.0933 - val_accuracy: 0.
8956
Epoch 216/500
```

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3000/3000 [==============================] - 77s 26ms/step - loss
: 0.1153 - accuracy: 0.9605 - val_loss: 1.1344 - val_accuracy: 0.
8934
Epoch 217/500
3000/3000 [==============================] - 76s 25ms/step - loss
: 0.1083 - accuracy: 0.9637 - val_loss: 0.9922 - val_accuracy: 0.
8958
Epoch 218/500
3000/3000 [==============================] - 69s 23ms/step - loss
: 0.1142 - accuracy: 0.9608 - val_loss: 1.0704 - val_accuracy: 0.
8959
Epoch 219/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1102 - accuracy: 0.9628 - val_loss: 1.0017 - val_accuracy: 0.
8994
Epoch 220/500
3000/3000 [==============================] - 70s 23ms/step - loss
: 0.1087 - accuracy: 0.9624 - val_loss: 0.9710 - val_accuracy: 0.
8993
Epoch 221/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1214 - accuracy: 0.9622 - val_loss: 0.9173 - val_accuracy: 0.
8988
Epoch 222/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1071 - accuracy: 0.9635 - val_loss: 1.0250 - val_accuracy: 0.
8921
Epoch 223/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.1133 - accuracy: 0.9612 - val_loss: 0.9599 - val_accuracy: 0.
8979
Epoch 224/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1151 - accuracy: 0.9613 - val_loss: 0.8713 - val_accuracy: 0.
8972
Epoch 225/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1075 - accuracy: 0.9636 - val_loss: 1.0269 - val_accuracy: 0.
8942
Epoch 226/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1086 - accuracy: 0.9627 - val_loss: 1.0908 - val_accuracy: 0.
8975
Epoch 227/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1071 - accuracy: 0.9639 - val_loss: 1.1007 - val_accuracy: 0.
8973
Epoch 228/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1160 - accuracy: 0.9624 - val_loss: 1.0688 - val_accuracy: 0.
8962
Epoch 229/500
```

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3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1115 - accuracy: 0.9636 - val_loss: 1.0899 - val_accuracy: 0.
8993
Epoch 230/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1103 - accuracy: 0.9632 - val_loss: 0.9699 - val_accuracy: 0.
8941
Epoch 231/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1122 - accuracy: 0.9619 - val_loss: 1.0184 - val_accuracy: 0.
8983
Epoch 232/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1129 - accuracy: 0.9634 - val_loss: 1.0839 - val_accuracy: 0.
8972
Epoch 233/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1143 - accuracy: 0.9615 - val_loss: 0.9524 - val_accuracy: 0.
8981
Epoch 234/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1002 - accuracy: 0.9644 - val_loss: 1.0992 - val_accuracy: 0.
9003
Epoch 235/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1180 - accuracy: 0.9625 - val_loss: 0.9515 - val_accuracy: 0.
8948
Epoch 236/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1072 - accuracy: 0.9647 - val_loss: 1.1708 - val_accuracy: 0.
8994
Epoch 237/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1043 - accuracy: 0.9643 - val_loss: 0.9644 - val_accuracy: 0.
8988
Epoch 238/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.1080 - accuracy: 0.9638 - val_loss: 1.0863 - val_accuracy: 0.
8959
Epoch 239/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1081 - accuracy: 0.9639 - val_loss: 1.1400 - val_accuracy: 0.
8983
Epoch 240/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1062 - accuracy: 0.9642 - val_loss: 1.0482 - val_accuracy: 0.
8976
Epoch 241/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1024 - accuracy: 0.9647 - val_loss: 1.0758 - val_accuracy: 0.
8957
Epoch 242/500
```

```
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1039 - accuracy: 0.9640 - val_loss: 1.0999 - val_accuracy: 0.
8957
Epoch 243/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1079 - accuracy: 0.9650 - val_loss: 1.1141 - val_accuracy: 0.
8957
Epoch 244/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1063 - accuracy: 0.9645 - val_loss: 1.1181 - val_accuracy: 0.
8992
Epoch 245/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1031 - accuracy: 0.9647 - val_loss: 1.0432 - val_accuracy: 0.
8923
Epoch 246/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1063 - accuracy: 0.9646 - val_loss: 1.0706 - val_accuracy: 0.
8946
Epoch 247/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1035 - accuracy: 0.9657 - val_loss: 1.0317 - val_accuracy: 0.
8966
Epoch 248/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1035 - accuracy: 0.9647 - val_loss: 1.0802 - val_accuracy: 0.
8960
Epoch 249/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1065 - accuracy: 0.9650 - val_loss: 1.0715 - val_accuracy: 0.
8916
Epoch 250/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1055 - accuracy: 0.9640 - val_loss: 1.2082 - val_accuracy: 0.
8987
Epoch 251/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0997 - accuracy: 0.9655 - val_loss: 1.1920 - val_accuracy: 0.
9003
Epoch 252/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1150 - accuracy: 0.9640 - val_loss: 1.0614 - val_accuracy: 0.
8974
Epoch 253/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1028 - accuracy: 0.9661 - val_loss: 1.0522 - val_accuracy: 0.
8968
Epoch 254/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1112 - accuracy: 0.9652 - val_loss: 1.1311 - val_accuracy: 0.
8961
Epoch 255/500
```

```
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1005 - accuracy: 0.9655 - val_loss: 1.1312 - val_accuracy: 0.
8988
Epoch 256/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0983 - accuracy: 0.9659 - val_loss: 1.1702 - val_accuracy: 0.
8992
Epoch 257/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.0964 - accuracy: 0.9670 - val_loss: 1.0816 - val_accuracy: 0.
8945
Epoch 258/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1025 - accuracy: 0.9652 - val_loss: 1.3084 - val_accuracy: 0.
8914
Epoch 259/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1090 - accuracy: 0.9646 - val_loss: 1.2039 - val_accuracy: 0.
8998
Epoch 260/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0965 - accuracy: 0.9674 - val_loss: 1.1065 - val_accuracy: 0.
8988
Epoch 261/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0976 - accuracy: 0.9669 - val_loss: 1.1258 - val_accuracy: 0.
8992
Epoch 262/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0994 - accuracy: 0.9659 - val_loss: 1.1727 - val_accuracy: 0.
8963
Epoch 263/500
3000/3000 [==============================] - 73s 24ms/step - loss
: 0.0984 - accuracy: 0.9669 - val_loss: 1.1665 - val_accuracy: 0.
9002
Epoch 264/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1054 - accuracy: 0.9664 - val_loss: 1.1496 - val_accuracy: 0.
8947
Epoch 265/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1004 - accuracy: 0.9667 - val_loss: 1.1281 - val_accuracy: 0.
8967
Epoch 266/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1016 - accuracy: 0.9665 - val_loss: 1.0907 - val_accuracy: 0.
8975
Epoch 267/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.0960 - accuracy: 0.9669 - val_loss: 1.3166 - val_accuracy: 0.
8984
Epoch 268/500
```

```
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.1126 - accuracy: 0.9665 - val_loss: 1.0810 - val_accuracy: 0.
9012
Epoch 269/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1033 - accuracy: 0.9669 - val_loss: 1.3118 - val_accuracy: 0.
8968
Epoch 270/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.1061 - accuracy: 0.9668 - val_loss: 1.1807 - val_accuracy: 0.
8952
Epoch 271/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0981 - accuracy: 0.9673 - val_loss: 1.3110 - val_accuracy: 0.
8974
Epoch 272/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0994 - accuracy: 0.9661 - val_loss: 1.1320 - val_accuracy: 0.
8995
Epoch 273/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.1028 - accuracy: 0.9670 - val_loss: 1.2094 - val_accuracy: 0.
8970
Epoch 274/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1023 - accuracy: 0.9663 - val_loss: 1.1767 - val_accuracy: 0.
8942
Epoch 275/500
3000/3000 [==============================] - 69s 23ms/step - loss
: 0.1082 - accuracy: 0.9678 - val_loss: 1.3182 - val_accuracy: 0.
8944
Epoch 276/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1030 - accuracy: 0.9676 - val_loss: 1.1830 - val_accuracy: 0.
8965
Epoch 277/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1005 - accuracy: 0.9666 - val_loss: 1.2012 - val_accuracy: 0.
8966
Epoch 278/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0973 - accuracy: 0.9662 - val_loss: 1.2600 - val_accuracy: 0.
8954
Epoch 279/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1136 - accuracy: 0.9654 - val_loss: 1.3647 - val_accuracy: 0.
8992
Epoch 280/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0971 - accuracy: 0.9677 - val_loss: 1.2438 - val_accuracy: 0.
8975
Epoch 281/500
```

```
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1082 - accuracy: 0.9667 - val_loss: 1.3242 - val_accuracy: 0.
8951
Epoch 282/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0938 - accuracy: 0.9686 - val_loss: 1.2371 - val_accuracy: 0.
8958
Epoch 283/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0955 - accuracy: 0.9684 - val_loss: 1.1967 - val_accuracy: 0.
8956
Epoch 284/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.1006 - accuracy: 0.9678 - val_loss: 1.2762 - val_accuracy: 0.
8962
Epoch 285/500
3000/3000 [==============================] - 79s 26ms/step - loss
: 0.0924 - accuracy: 0.9687 - val_loss: 1.1750 - val_accuracy: 0.
8974
Epoch 286/500
3000/3000 [==============================] - 76s 25ms/step - loss
: 0.0960 - accuracy: 0.9687 - val_loss: 1.2337 - val_accuracy: 0.
8977
Epoch 287/500
3000/3000 [==============================] - 81s 27ms/step - loss
: 0.0935 - accuracy: 0.9683 - val_loss: 1.2402 - val_accuracy: 0.
8963
Epoch 288/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.0934 - accuracy: 0.9691 - val_loss: 1.4128 - val_accuracy: 0.
8992
Epoch 289/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0894 - accuracy: 0.9693 - val_loss: 1.3300 - val_accuracy: 0.
8972
Epoch 290/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1012 - accuracy: 0.9668 - val_loss: 1.3555 - val_accuracy: 0.
8964
Epoch 291/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1034 - accuracy: 0.9674 - val_loss: 1.3543 - val_accuracy: 0.
8986
Epoch 292/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0916 - accuracy: 0.9682 - val_loss: 1.2559 - val_accuracy: 0.
9005
Epoch 293/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.0948 - accuracy: 0.9689 - val_loss: 1.4524 - val_accuracy: 0.
8978
Epoch 294/500
```

```
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1012 - accuracy: 0.9672 - val_loss: 1.1947 - val_accuracy: 0.
8956
Epoch 295/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.1001 - accuracy: 0.9671 - val_loss: 1.2103 - val_accuracy: 0.
8968
Epoch 296/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0952 - accuracy: 0.9686 - val_loss: 1.2369 - val_accuracy: 0.
8986
Epoch 297/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0963 - accuracy: 0.9680 - val_loss: 1.2826 - val_accuracy: 0.
8978
Epoch 298/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1078 - accuracy: 0.9681 - val_loss: 1.3195 - val_accuracy: 0.
8981
Epoch 299/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0891 - accuracy: 0.9694 - val_loss: 1.2641 - val_accuracy: 0.
9003
Epoch 300/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0945 - accuracy: 0.9677 - val_loss: 1.3616 - val_accuracy: 0.
8960
Epoch 301/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1049 - accuracy: 0.9668 - val_loss: 1.1334 - val_accuracy: 0.
8981
Epoch 302/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0905 - accuracy: 0.9687 - val_loss: 1.2587 - val_accuracy: 0.
8934
Epoch 303/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0903 - accuracy: 0.9693 - val_loss: 1.3143 - val_accuracy: 0.
8963
Epoch 304/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1094 - accuracy: 0.9679 - val_loss: 1.4280 - val_accuracy: 0.
8970
Epoch 305/500
3000/3000 [==============================] - 70s 23ms/step - loss
: 0.0985 - accuracy: 0.9694 - val_loss: 1.2914 - val_accuracy: 0.
8974
Epoch 306/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.0988 - accuracy: 0.9696 - val_loss: 1.3671 - val_accuracy: 0.
8965
Epoch 307/500
```

```
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.0969 - accuracy: 0.9694 - val_loss: 1.2724 - val_accuracy: 0.
8977
Epoch 308/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0949 - accuracy: 0.9696 - val_loss: 1.4029 - val_accuracy: 0.
8978
Epoch 309/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0956 - accuracy: 0.9691 - val_loss: 1.3649 - val_accuracy: 0.
8942
Epoch 310/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0993 - accuracy: 0.9686 - val_loss: 1.2730 - val_accuracy: 0.
8967
Epoch 311/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0904 - accuracy: 0.9714 - val_loss: 1.3800 - val_accuracy: 0.
8953
Epoch 312/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0912 - accuracy: 0.9693 - val_loss: 1.2781 - val_accuracy: 0.
8935
Epoch 313/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1053 - accuracy: 0.9659 - val_loss: 1.3293 - val_accuracy: 0.
8978
Epoch 314/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1019 - accuracy: 0.9693 - val_loss: 1.3099 - val_accuracy: 0.
8968
Epoch 315/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0908 - accuracy: 0.9705 - val_loss: 1.3875 - val_accuracy: 0.
8976
Epoch 316/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0952 - accuracy: 0.9694 - val_loss: 1.3051 - val_accuracy: 0.
8990
Epoch 317/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0948 - accuracy: 0.9695 - val_loss: 1.3614 - val_accuracy: 0.
8956
Epoch 318/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0957 - accuracy: 0.9685 - val_loss: 1.3632 - val_accuracy: 0.
8972
Epoch 319/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0932 - accuracy: 0.9696 - val_loss: 1.3558 - val_accuracy: 0.
8967
Epoch 320/500
```

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3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0932 - accuracy: 0.9690 - val_loss: 1.3860 - val_accuracy: 0.
8973
Epoch 321/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0886 - accuracy: 0.9700 - val_loss: 1.5336 - val_accuracy: 0.
8950
Epoch 322/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0905 - accuracy: 0.9701 - val_loss: 1.4323 - val_accuracy: 0.
8939
Epoch 323/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0970 - accuracy: 0.9690 - val_loss: 1.2956 - val_accuracy: 0.
8947
Epoch 324/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0936 - accuracy: 0.9706 - val_loss: 1.4800 - val_accuracy: 0.
8963
Epoch 325/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0974 - accuracy: 0.9699 - val_loss: 1.4215 - val_accuracy: 0.
8958
Epoch 326/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0926 - accuracy: 0.9704 - val_loss: 1.3169 - val_accuracy: 0.
8995
Epoch 327/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0929 - accuracy: 0.9700 - val_loss: 1.3825 - val_accuracy: 0.
8965
Epoch 328/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0919 - accuracy: 0.9706 - val_loss: 1.3511 - val_accuracy: 0.
9007
Epoch 329/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0905 - accuracy: 0.9700 - val_loss: 1.4400 - val_accuracy: 0.
8985
Epoch 330/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0899 - accuracy: 0.9701 - val_loss: 1.2148 - val_accuracy: 0.
8976
Epoch 331/500
3000/3000 [==============================] - 70s 23ms/step - loss
: 0.0887 - accuracy: 0.9709 - val_loss: 1.4092 - val_accuracy: 0.
8997
Epoch 332/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0995 - accuracy: 0.9708 - val_loss: 1.2735 - val_accuracy: 0.
8972
Epoch 333/500
```

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3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0958 - accuracy: 0.9708 - val_loss: 1.6651 - val_accuracy: 0.
8948
Epoch 334/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0859 - accuracy: 0.9715 - val_loss: 1.4529 - val_accuracy: 0.
8955
Epoch 335/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1069 - accuracy: 0.9692 - val_loss: 1.4135 - val_accuracy: 0.
8941
Epoch 336/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0866 - accuracy: 0.9715 - val_loss: 1.3736 - val_accuracy: 0.
8967
Epoch 337/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0886 - accuracy: 0.9703 - val_loss: 1.4594 - val_accuracy: 0.
8972
Epoch 338/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0828 - accuracy: 0.9718 - val_loss: 1.3887 - val_accuracy: 0.
8965
Epoch 339/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0940 - accuracy: 0.9696 - val_loss: 1.4988 - val_accuracy: 0.
8983
Epoch 340/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0985 - accuracy: 0.9702 - val_loss: 1.3693 - val_accuracy: 0.
8972
Epoch 341/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0912 - accuracy: 0.9713 - val_loss: 1.4501 - val_accuracy: 0.
8958
Epoch 342/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0821 - accuracy: 0.9722 - val_loss: 1.3588 - val_accuracy: 0.
8987
Epoch 343/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0839 - accuracy: 0.9729 - val_loss: 1.6236 - val_accuracy: 0.
8946
Epoch 344/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0966 - accuracy: 0.9718 - val_loss: 1.3962 - val_accuracy: 0.
8977
Epoch 345/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0856 - accuracy: 0.9718 - val_loss: 1.5001 - val_accuracy: 0.
8997
Epoch 346/500
```

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3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0946 - accuracy: 0.9705 - val_loss: 1.5330 - val_accuracy: 0.
8953
Epoch 347/500
3000/3000 [==============================] - 68s 23ms/step - loss
: 0.0889 - accuracy: 0.9714 - val_loss: 1.5839 - val_accuracy: 0.
8944
Epoch 348/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0959 - accuracy: 0.9716 - val_loss: 1.4795 - val_accuracy: 0.
8997
Epoch 349/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0922 - accuracy: 0.9718 - val_loss: 1.5809 - val_accuracy: 0.
8953
Epoch 350/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0884 - accuracy: 0.9711 - val_loss: 1.5288 - val_accuracy: 0.
8950
Epoch 351/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0942 - accuracy: 0.9715 - val_loss: 1.5368 - val_accuracy: 0.
8928
Epoch 352/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0905 - accuracy: 0.9721 - val_loss: 1.3858 - val_accuracy: 0.
8974
Epoch 353/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0885 - accuracy: 0.9713 - val_loss: 1.4851 - val_accuracy: 0.
8983
Epoch 354/500
3000/3000 [==============================] - 86s 29ms/step - loss
: 0.0854 - accuracy: 0.9719 - val_loss: 1.4371 - val_accuracy: 0.
8963
Epoch 355/500
3000/3000 [==============================] - 79s 26ms/step - loss
: 0.0889 - accuracy: 0.9713 - val_loss: 1.5036 - val_accuracy: 0.
8963
Epoch 356/500
3000/3000 [==============================] - 75s 25ms/step - loss
: 0.0848 - accuracy: 0.9721 - val_loss: 1.3379 - val_accuracy: 0.
8974
Epoch 357/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0848 - accuracy: 0.9720 - val_loss: 1.4973 - val_accuracy: 0.
9017
Epoch 358/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0919 - accuracy: 0.9716 - val_loss: 1.4620 - val_accuracy: 0.
8970
Epoch 359/500
```

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3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0968 - accuracy: 0.9716 - val_loss: 1.5467 - val_accuracy: 0.
8961
Epoch 360/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0863 - accuracy: 0.9726 - val_loss: 1.4283 - val_accuracy: 0.
8990
Epoch 361/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0937 - accuracy: 0.9703 - val_loss: 1.4688 - val_accuracy: 0.
8973
Epoch 362/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0810 - accuracy: 0.9729 - val_loss: 1.4366 - val_accuracy: 0.
8990
Epoch 363/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0932 - accuracy: 0.9729 - val_loss: 1.6148 - val_accuracy: 0.
8965
Epoch 364/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0843 - accuracy: 0.9723 - val_loss: 1.5455 - val_accuracy: 0.
9000
Epoch 365/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0855 - accuracy: 0.9723 - val_loss: 1.5232 - val_accuracy: 0.
8988
Epoch 366/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0910 - accuracy: 0.9714 - val_loss: 1.4376 - val_accuracy: 0.
8936
Epoch 367/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.1052 - accuracy: 0.9705 - val_loss: 1.5396 - val_accuracy: 0.
8975
Epoch 368/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0877 - accuracy: 0.9731 - val_loss: 1.5111 - val_accuracy: 0.
8952
Epoch 369/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0897 - accuracy: 0.9719 - val_loss: 1.4399 - val_accuracy: 0.
8963
Epoch 370/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0970 - accuracy: 0.9706 - val_loss: 1.4173 - val_accuracy: 0.
8976
Epoch 371/500
3000/3000 [==============================] - 67s 22ms/step - loss
: 0.0857 - accuracy: 0.9727 - val_loss: 1.3425 - val_accuracy: 0.
8969
Epoch 372/500
```

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3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0892 - accuracy: 0.9715 - val_loss: 1.3654 - val_accuracy: 0.
8964
Epoch 373/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0815 - accuracy: 0.9738 - val_loss: 1.6092 - val_accuracy: 0.
8978
Epoch 374/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0816 - accuracy: 0.9731 - val_loss: 1.5146 - val_accuracy: 0.
8982
Epoch 375/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0845 - accuracy: 0.9731 - val_loss: 1.5550 - val_accuracy: 0.
8944
Epoch 376/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0956 - accuracy: 0.9722 - val_loss: 1.5351 - val_accuracy: 0.
8935
Epoch 377/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0978 - accuracy: 0.9725 - val_loss: 1.6172 - val_accuracy: 0.
8945
Epoch 378/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0823 - accuracy: 0.9741 - val_loss: 1.7978 - val_accuracy: 0.
8942
Epoch 379/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0838 - accuracy: 0.9727 - val_loss: 1.5305 - val_accuracy: 0.
8953
Epoch 380/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0835 - accuracy: 0.9719 - val_loss: 1.5884 - val_accuracy: 0.
8972
Epoch 381/500
3000/3000 [==============================] - 73s 24ms/step - loss
: 0.0909 - accuracy: 0.9725 - val_loss: 1.5086 - val_accuracy: 0.
8991
Epoch 382/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.0908 - accuracy: 0.9718 - val_loss: 1.5082 - val_accuracy: 0.
8983
Epoch 383/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.0881 - accuracy: 0.9719 - val_loss: 1.7177 - val_accuracy: 0.
8930
Epoch 384/500
3000/3000 [==============================] - 72s 24ms/step - loss
: 0.0871 - accuracy: 0.9734 - val_loss: 1.5598 - val_accuracy: 0.
8956
Epoch 385/500
```

```
3000/3000 [==============================] - 69s 23ms/step - loss
: 0.0856 - accuracy: 0.9726 - val_loss: 1.6374 - val_accuracy: 0.
8963
Epoch 386/500
3000/3000 [==============================] - 69s 23ms/step - loss
: 0.0806 - accuracy: 0.9733 - val_loss: 1.7281 - val_accuracy: 0.
8963
Epoch 387/500
3000/3000 [==============================] - 71s 24ms/step - loss
: 0.0898 - accuracy: 0.9730 - val_loss: 1.5474 - val_accuracy: 0.
8956
Epoch 388/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0830 - accuracy: 0.9741 - val_loss: 1.5904 - val_accuracy: 0.
8975
Epoch 389/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0846 - accuracy: 0.9743 - val_loss: 1.4616 - val_accuracy: 0.
8938
Epoch 390/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0871 - accuracy: 0.9725 - val_loss: 1.5198 - val_accuracy: 0.
8962
Epoch 391/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0892 - accuracy: 0.9730 - val_loss: 1.5934 - val_accuracy: 0.
8983
Epoch 392/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0975 - accuracy: 0.9732 - val_loss: 1.5123 - val_accuracy: 0.
8958
Epoch 393/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0844 - accuracy: 0.9734 - val_loss: 1.4615 - val_accuracy: 0.
8963
Epoch 394/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0933 - accuracy: 0.9726 - val_loss: 1.5993 - val_accuracy: 0.
8967
Epoch 395/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0953 - accuracy: 0.9736 - val_loss: 1.3382 - val_accuracy: 0.
8990
Epoch 396/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0831 - accuracy: 0.9736 - val_loss: 1.7730 - val_accuracy: 0.
8989
Epoch 397/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0791 - accuracy: 0.9736 - val_loss: 1.5711 - val_accuracy: 0.
8978
Epoch 398/500
```

```
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0905 - accuracy: 0.9717 - val_loss: 1.6038 - val_accuracy: 0.
8928
Epoch 399/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0792 - accuracy: 0.9737 - val_loss: 1.6984 - val_accuracy: 0.
8952
Epoch 400/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0806 - accuracy: 0.9734 - val_loss: 1.6014 - val_accuracy: 0.
8968
Epoch 401/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0783 - accuracy: 0.9750 - val_loss: 1.6426 - val_accuracy: 0.
8917
Epoch 402/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.0790 - accuracy: 0.9738 - val_loss: 1.5363 - val_accuracy: 0.
8968
Epoch 403/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0809 - accuracy: 0.9738 - val_loss: 1.6502 - val_accuracy: 0.
9001
Epoch 404/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0846 - accuracy: 0.9748 - val_loss: 1.6460 - val_accuracy: 0.
8980
Epoch 405/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0816 - accuracy: 0.9741 - val_loss: 1.5960 - val_accuracy: 0.
8978
Epoch 406/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0834 - accuracy: 0.9740 - val_loss: 1.9791 - val_accuracy: 0.
8950
Epoch 407/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0870 - accuracy: 0.9741 - val_loss: 1.7823 - val_accuracy: 0.
8955
Epoch 408/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0845 - accuracy: 0.9743 - val_loss: 1.6373 - val_accuracy: 0.
8911
Epoch 409/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0785 - accuracy: 0.9749 - val_loss: 1.7712 - val_accuracy: 0.
8993
Epoch 410/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0867 - accuracy: 0.9731 - val_loss: 1.7570 - val_accuracy: 0.
8963
Epoch 411/500
```

```
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0868 - accuracy: 0.9755 - val_loss: 1.8473 - val_accuracy: 0.
8970
Epoch 412/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0732 - accuracy: 0.9761 - val_loss: 1.9917 - val_accuracy: 0.
8955
Epoch 413/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0862 - accuracy: 0.9733 - val_loss: 1.6667 - val_accuracy: 0.
8969
Epoch 414/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0852 - accuracy: 0.9734 - val_loss: 1.8352 - val_accuracy: 0.
8971
Epoch 415/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0874 - accuracy: 0.9738 - val_loss: 1.6079 - val_accuracy: 0.
8975
Epoch 416/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0810 - accuracy: 0.9745 - val_loss: 1.7346 - val_accuracy: 0.
8978
Epoch 417/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0822 - accuracy: 0.9737 - val_loss: 1.8134 - val_accuracy: 0.
8946
Epoch 418/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0862 - accuracy: 0.9729 - val_loss: 1.5199 - val_accuracy: 0.
8968
Epoch 419/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0778 - accuracy: 0.9748 - val_loss: 1.8763 - val_accuracy: 0.
8934
Epoch 420/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0923 - accuracy: 0.9724 - val_loss: 1.7884 - val_accuracy: 0.
8992
Epoch 421/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0771 - accuracy: 0.9769 - val_loss: 1.9096 - val_accuracy: 0.
8944
Epoch 422/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0893 - accuracy: 0.9729 - val_loss: 1.9309 - val_accuracy: 0.
8973
Epoch 423/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0837 - accuracy: 0.9746 - val_loss: 1.8832 - val_accuracy: 0.
8954
Epoch 424/500
```

```
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0786 - accuracy: 0.9747 - val_loss: 1.7977 - val_accuracy: 0.
8971
Epoch 425/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0798 - accuracy: 0.9752 - val_loss: 1.8601 - val_accuracy: 0.
8972
Epoch 426/500
3000/3000 [==============================] - 66s 22ms/step - loss
: 0.0828 - accuracy: 0.9753 - val_loss: 1.7876 - val_accuracy: 0.
8996
Epoch 427/500
3000/3000 [==============================] - 65s 22ms/step - loss
: 0.0868 - accuracy: 0.9737 - val_loss: 1.8488 - val_accuracy: 0.
8963
Epoch 428/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.0861 - accuracy: 0.9745 - val_loss: 1.9794 - val_accuracy: 0.
8975
Epoch 429/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0742 - accuracy: 0.9758 - val_loss: 1.8301 - val_accuracy: 0.
8962
Epoch 430/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0822 - accuracy: 0.9749 - val_loss: 1.9451 - val_accuracy: 0.
8943
Epoch 431/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0765 - accuracy: 0.9752 - val_loss: 1.9881 - val_accuracy: 0.
8987
Epoch 432/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0837 - accuracy: 0.9748 - val_loss: 1.8521 - val_accuracy: 0.
8973
Epoch 433/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0837 - accuracy: 0.9746 - val_loss: 1.9065 - val_accuracy: 0.
8972
Epoch 434/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0729 - accuracy: 0.9756 - val_loss: 1.9793 - val_accuracy: 0.
8900
Epoch 435/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.1011 - accuracy: 0.9724 - val_loss: 1.7440 - val_accuracy: 0.
8956
Epoch 436/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0754 - accuracy: 0.9764 - val_loss: 1.7583 - val_accuracy: 0.
9012
Epoch 437/500
```

```
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0717 - accuracy: 0.9761 - val_loss: 1.9231 - val_accuracy: 0.
8978
Epoch 438/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0892 - accuracy: 0.9736 - val_loss: 1.8972 - val_accuracy: 0.
8971
Epoch 439/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0723 - accuracy: 0.9761 - val_loss: 2.1089 - val_accuracy: 0.
8975
Epoch 440/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0779 - accuracy: 0.9752 - val_loss: 1.8823 - val_accuracy: 0.
8962
Epoch 441/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0826 - accuracy: 0.9756 - val_loss: 2.1876 - val_accuracy: 0.
8959
Epoch 442/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0838 - accuracy: 0.9736 - val_loss: 2.1137 - val_accuracy: 0.
8951
Epoch 443/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0832 - accuracy: 0.9750 - val_loss: 2.0055 - val_accuracy: 0.
8968
Epoch 444/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0789 - accuracy: 0.9751 - val_loss: 1.9294 - val_accuracy: 0.
8942
Epoch 445/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0834 - accuracy: 0.9751 - val_loss: 2.0420 - val_accuracy: 0.
8967
Epoch 446/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0775 - accuracy: 0.9764 - val_loss: 1.8056 - val_accuracy: 0.
8967
Epoch 447/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.1030 - accuracy: 0.9730 - val_loss: 1.8144 - val_accuracy: 0.
8986
Epoch 448/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0792 - accuracy: 0.9758 - val_loss: 1.6309 - val_accuracy: 0.
8928
Epoch 449/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0787 - accuracy: 0.9757 - val_loss: 1.6962 - val_accuracy: 0.
8990
Epoch 450/500
```

```
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0748 - accuracy: 0.9756 - val_loss: 1.7160 - val_accuracy: 0.
8953
Epoch 451/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0868 - accuracy: 0.9740 - val_loss: 1.7725 - val_accuracy: 0.
8965
Epoch 452/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0784 - accuracy: 0.9756 - val_loss: 1.8789 - val_accuracy: 0.
9002
Epoch 453/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0836 - accuracy: 0.9756 - val_loss: 1.8037 - val_accuracy: 0.
8960
Epoch 454/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0824 - accuracy: 0.9764 - val_loss: 1.9496 - val_accuracy: 0.
8944
Epoch 455/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0800 - accuracy: 0.9748 - val_loss: 1.8970 - val_accuracy: 0.
8976
Epoch 456/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0793 - accuracy: 0.9755 - val_loss: 1.8706 - val_accuracy: 0.
8972
Epoch 457/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0719 - accuracy: 0.9765 - val_loss: 2.0838 - val_accuracy: 0.
8960
Epoch 458/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0899 - accuracy: 0.9750 - val_loss: 1.9904 - val_accuracy: 0.
8963
Epoch 459/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0856 - accuracy: 0.9762 - val_loss: 2.0672 - val_accuracy: 0.
8963
Epoch 460/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0811 - accuracy: 0.9747 - val_loss: 1.9913 - val_accuracy: 0.
8977
Epoch 461/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0787 - accuracy: 0.9757 - val_loss: 1.9351 - val_accuracy: 0.
8977
Epoch 462/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0945 - accuracy: 0.9733 - val_loss: 1.9220 - val_accuracy: 0.
8969
Epoch 463/500
```

```
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0681 - accuracy: 0.9788 - val_loss: 2.1967 - val_accuracy: 0.
8962
Epoch 464/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0854 - accuracy: 0.9747 - val_loss: 2.0901 - val_accuracy: 0.
8983
Epoch 465/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0804 - accuracy: 0.9755 - val_loss: 2.0070 - val_accuracy: 0.
8913
Epoch 466/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0728 - accuracy: 0.9775 - val_loss: 1.9479 - val_accuracy: 0.
8982
Epoch 467/500
3000/3000 [==============================] - 64s 21ms/step - loss
: 0.0781 - accuracy: 0.9766 - val_loss: 1.9630 - val_accuracy: 0.
8929
Epoch 468/500
3000/3000 [==============================] - 63s 21ms/step - loss
: 0.0892 - accuracy: 0.9744 - val_loss: 2.1782 - val_accuracy: 0.
8945
Epoch 469/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0780 - accuracy: 0.9765 - val_loss: 1.9546 - val_accuracy: 0.
8965
Epoch 470/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0754 - accuracy: 0.9771 - val_loss: 1.9952 - val_accuracy: 0.
8930
Epoch 471/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0805 - accuracy: 0.9758 - val_loss: 1.9179 - val_accuracy: 0.
8974
Epoch 472/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0764 - accuracy: 0.9768 - val_loss: 2.0858 - val_accuracy: 0.
8982
Epoch 473/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0756 - accuracy: 0.9764 - val_loss: 1.9336 - val_accuracy: 0.
8949
Epoch 474/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0772 - accuracy: 0.9750 - val_loss: 2.0229 - val_accuracy: 0.
8985
Epoch 475/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0770 - accuracy: 0.9771 - val_loss: 1.9136 - val_accuracy: 0.
8955
Epoch 476/500
```

```
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0810 - accuracy: 0.9755 - val_loss: 2.2556 - val_accuracy: 0.
8966
Epoch 477/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0874 - accuracy: 0.9755 - val_loss: 1.9668 - val_accuracy: 0.
8953
Epoch 478/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0842 - accuracy: 0.9758 - val_loss: 2.0352 - val_accuracy: 0.
8943
Epoch 479/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0868 - accuracy: 0.9758 - val_loss: 2.0120 - val_accuracy: 0.
8982
Epoch 480/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0776 - accuracy: 0.9771 - val_loss: 2.0445 - val_accuracy: 0.
8947
Epoch 481/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0840 - accuracy: 0.9762 - val_loss: 2.0147 - val_accuracy: 0.
8981
Epoch 482/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0923 - accuracy: 0.9747 - val_loss: 1.9601 - val_accuracy: 0.
8991
Epoch 483/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0812 - accuracy: 0.9769 - val_loss: 1.9735 - val_accuracy: 0.
8894
Epoch 484/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0822 - accuracy: 0.9757 - val_loss: 2.2785 - val_accuracy: 0.
8948
Epoch 485/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0717 - accuracy: 0.9771 - val_loss: 2.1689 - val_accuracy: 0.
8963
Epoch 486/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0688 - accuracy: 0.9783 - val_loss: 2.2156 - val_accuracy: 0.
8937
Epoch 487/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0749 - accuracy: 0.9764 - val_loss: 1.9700 - val_accuracy: 0.
8983
Epoch 488/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0770 - accuracy: 0.9769 - val_loss: 2.2423 - val_accuracy: 0.
8972
Epoch 489/500
```

```
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0793 - accuracy: 0.9765 - val_loss: 2.0906 - val_accuracy: 0.
8967
Epoch 490/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0725 - accuracy: 0.9780 - val_loss: 2.0240 - val_accuracy: 0.
8965
Epoch 491/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0929 - accuracy: 0.9766 - val_loss: 2.1628 - val_accuracy: 0.
8949
Epoch 492/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0761 - accuracy: 0.9766 - val_loss: 2.1236 - val_accuracy: 0.
8981
Epoch 493/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0751 - accuracy: 0.9766 - val_loss: 2.0604 - val_accuracy: 0.
8971
Epoch 494/500
3000/3000 [==============================] - 62s 21ms/step - loss
: 0.0759 - accuracy: 0.9766 - val_loss: 2.2414 - val_accuracy: 0.
8967
Epoch 495/500
3000/3000 [==============================] - 61s 20ms/step - loss
: 0.0776 - accuracy: 0.9777 - val_loss: 2.1907 - val_accuracy: 0.
8942
Epoch 496/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0755 - accuracy: 0.9769 - val_loss: 2.0772 - val_accuracy: 0.
8956
Epoch 497/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0785 - accuracy: 0.9780 - val_loss: 2.3503 - val_accuracy: 0.
8992
Epoch 498/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0750 - accuracy: 0.9768 - val_loss: 2.0977 - val_accuracy: 0.
8975
Epoch 499/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0914 - accuracy: 0.9751 - val_loss: 2.1641 - val_accuracy: 0.
8927
Epoch 500/500
3000/3000 [==============================] - 60s 20ms/step - loss
: 0.0798 - accuracy: 0.9761 - val_loss: 2.0307 - val_accuracy: 0.
8963
Execution Time =  32607.207696914673
```

In [50]:
```
print('The NN model took',round((32607.207696914673/60)/60,0),'hou
rs to completely run')
```

```
The NN model took 9.0 hours to completely run
```

In [40]:
```
probs = model.predict(x_test)

pred_list = []
for p in probs :
    pred_list.append(np.argmax(p))
pred = np.array(pred_list)
acc_score = metrics.accuracy_score(y_test, pred)

for i in range(5):
    who = getRandomIndex(x_test)
    print("WHO = ", who, " Predicte =", pred[who], " Actual = ", y
_test[who])

print(" --------- ")
print("accuracy = ", acc_score)
```

```
WHO =  3521  Predicte = 5  Actual =  5
WHO =  8600  Predicte = 8  Actual =  8
WHO =  1982  Predicte = 9  Actual =  9
WHO =  6810  Predicte = 5  Actual =  5
WHO =  1628  Predicte = 3  Actual =  3
 ---------
accuracy =  0.8939
```

In [41]:
```
NN_loss, NN_acc = model.evaluate(x_test, y_test)
print("loss=", NN_loss)
print("accuracy", NN_acc)
```

```
313/313 [==============================] - 3s 9ms/step - loss: 2.
5527 - accuracy: 0.8939
loss= 2.552696466445923
accuracy 0.8938999772071838
```

The model has 89.3% accuracy with a loss factor of 2.55.

In [42]:
```
model.save( theTensorFlowSaveFile )
```

```
INFO:tensorflow:Assets written to: TF_Number_Model/assets
```

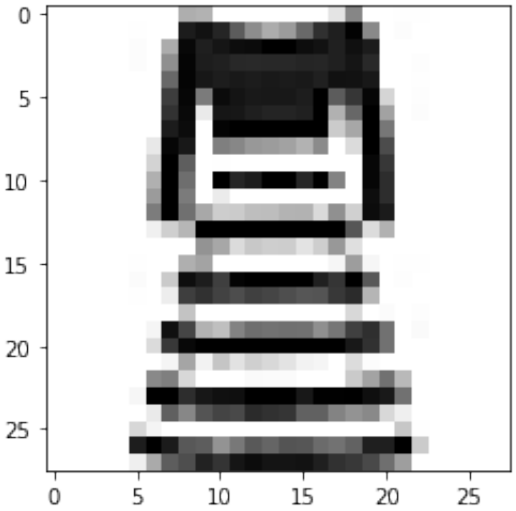
In [43]:
```
new_model= tf.keras.models.load_model( theTensorFlowSaveFile )
```

In [44]:
```
predictions = new_model.predict(x_test)
```

In [45]:
```
# get a random index from our test set
who=getRandomIndex(x_test)
print( predictions[who]) # probability score
result = np.argmax(list(predictions[who]))
print("predict=",result,"actual=",y_test[who])
plt.imshow(x_test[who], plt.cm.binary)
#plt.show()
```

```
[4.7263020e-01 0.0000000e+00 2.6649794e-35 5.2736974e-01 0.000000
0e+00
 0.0000000e+00 1.4931778e-15 0.0000000e+00 0.0000000e+00 0.000000
0e+00]
predict= 3 actual= 3
```

Out[45]: <matplotlib.image.AxesImage at 0x7fe546cf2710>



Accuracy of RANDOM FOREST and NEURAL NETWORK

In [46]:
```
print("RF accuracy", RF_acc )
print("NN accuracy",NN_acc)
```

```
RF accuracy 0.8785
NN accuracy 0.8938999772071838
```

We observe a 2% improvement in accuracy between our Random Forest Model and Tensor Flow NN model.