CAP 6619 - Deep Learning

Summer 2021 - Dr Marques

Assignment 1 Asam Mahmood

Handwritten Digit Classifier Using the MNIST Dataset

Useful references and sources:

- https://www.tensorflow.org/datasets/catalog/mnist
- https://en.wikipedia.org/wiki/MNIST_database
- https://keras.io/examples/vision/mnist_convnet/
- https://github.com/the-deep-learners/deep-learning-illustrated/blob/master/notebooks/shallow_net_in_keras.ipynb

(OPTIONAL) TODO 1

Add your own sources and references here.

Below you can see some libs i had to pull in to help build and run code aand help time performance on execution

absl-py==0.13.0 appdirs==1.4.4 argon2-cffi==20.1.0 as==0.1 astunparse==1.6.3 async-generator==1.10 attrs==21.2.0 backcall==0.2.0 bleach==3.3.0 blis==0.7.4 cachetools==4.2.2 catalogue==2.0.4 certifi==2021.5.30 cffi==1.14.5 chardet==4.0.0 click==7.1.2 colorama==0.4.4 cycler==0.10.0 cymem==2.0.5 decorator==5.0.9 defusedxml==0.7.1 entrypoints==0.3 et-xmlfile==1.1.0 flatbuffers==1.12 gast==0.4.0 google-auth==1.32.0 google-auth-oauthlib==0.4.4 google-pasta==0.2.0 grpcio==1.34.1 h5py==3.1.0 idna==2.10 ipykernel==5.5.5 ipython==7.23.1 ipython-genutils==0.2.0 ipywidgets==7.6.3 jedi==0.18.0 Jinja2==3.0.1 joblib==1.0.1 jsonschema==3.2.0 jupyter==1.0.0 jupyter-client==6.1.12 jupyter-console==6.4.0 jupyter-core==4.7.1 jupyterlab-pygments==0.1.2 jupyterlab-widgets==1.0.0 keras-nightly==2.5.0.dev2021032900 Keras-Preprocessing==1.1.2 keras-visualizer==2.4 kiwisolver==1.3.1 Markdown==3.3.4 MarkupSafe==2.0.1 matplotlib==3.4.2 matplotlib-inline==0.1.2 mistune==0.8.4 murmurhash==1.0.5 nbclient==0.5.3 nbconvert==6.0.7 nbformat==5.1.3 nest-asyncio==1.5.1 nltk==3.6.2 notebook==6.4.0 notebook-as-pdf==0.5.0 numpy==1.19.5 oauthlib==3.1.1 openpyxl==3.0.7 opt-einsum==3.3.0 packaging==20.9 pandas==1.2.4 pandoc==1.0.2 pandocfilters==1.4.3 parso==0.8.2 pathy==0.5.2 pickleshare==0.7.5 Pillow==8.2.0 ply==3.11 preshed==3.0.5 prometheus-client==0.10.1 prompt-toolkit==3.0.18 protobuf==3.17.3 pyasn1==0.4.8 pyasn1-modules==0.2.8 pycparser==2.20 pydantic==1.7.4 pyee==8.1.0 Pygments==2.9.0 pyparsing==2.4.7 PyPDF2==1.26.0 pyppeteer==0.2.5 pyrsistent==0.17.3 python-dateutil==2.8.1 pytz==2021.1 pywin32==300 pywinpty==1.1.1 pyzmq==22.0.3 qtconsole==5.1.0 QtPy==1.9.0 regex==2021.4.4 requests==2.25.1 requests-oauthlib==1.3.0 rsa==4.7.2 scikit-learn==0.24.2 scipy==1.6.3 seaborn==0.11.1 Send2Trash==1.5.0 six==1.15.0 smart-open==3.0.0 sns==0.1 spacy==3.0.6 spacy-legacy==3.0.6 srsly==2.4.1 tensorboard==2.5.0 tensorboard-data-server==0.6.1 tensorboard-plugin-wit==1.8.0 tensorflow==2.5.0 tensorflow-estimator==2.5.0 termcolor==1.1.0 terminado==0.10.0 testpath==0.5.0 thinc==8.0.6 threadpoolctl==2.1.0 tornado==6.1 tqdm==4.61.1 traitlets==5.0.5 typer==0.3.2 typing-extensions==3.7.4.3 urllib3==1.26.5 visualizer==0.0.10 wasabi==0.8.2 wcwidth==0.2.5 webencodings==0.5.1 websockets==8.1 Werkzeug==2.0.1 widgetsnbextension==3.5.1 wordcloud==1.8.1 wrapt==1.12.1 xlrd==2.0.1

Setup

In [88]:
```python
from tensorflow import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense
import  keras.metrics
from tensorflow.keras.optimizers import RMSprop
import tensorflow
from keras_visualizer import visualizer
from keras.utils import np_utils
from tensorflow.keras import layers

from matplotlib import pyplot as plt
import seaborn as sns
from sklearn.metrics import classification_report, confusion_matrix
import numpy as np
```

Load and prepare the data

In [75]:
```python
# Model / data parameters
num_classes = 10
input_shape = (28, 28, 1)

# the data, split between train and validation sets
(X_train, y_train), (X_valid, y_valid) = mnist.load_data()
```

In [76]:
```python
X_train.shape
```

Out[76]: `(60000, 28, 28)`

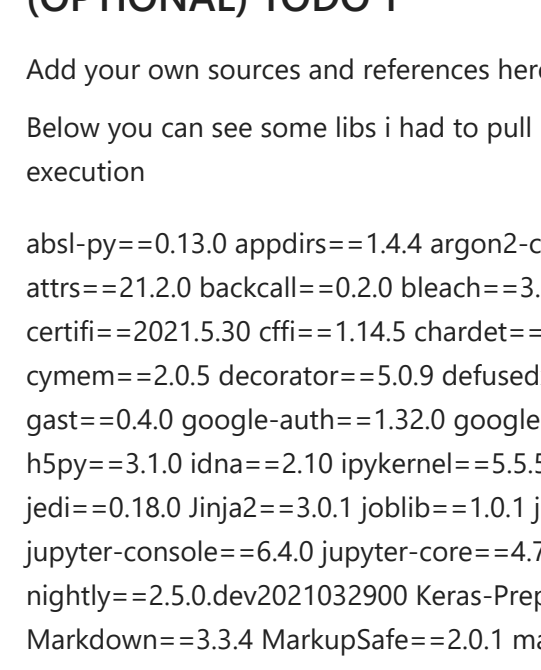
In [77]:
```python
y_train.shape
```

Out[77]: `(60000,)`

In [78]:
```python
y_train[0:12]
```

Out[78]: `array([5, 0, 4, 1, 9, 2, 1, 3, 1, 4, 3, 5], dtype=uint8)`

In [79]:
```python
plt.figure(figsize=(5,5))
for k in range(12):
    plt.subplot(3, 4, k+1)
    plt.imshow(X_train[k], cmap='Greys')
    plt.axis('off')
plt.tight_layout()
plt.show()
```



In [80]:
```python
X_valid.shape
```

Out[80]: `(10000, 28, 28)`

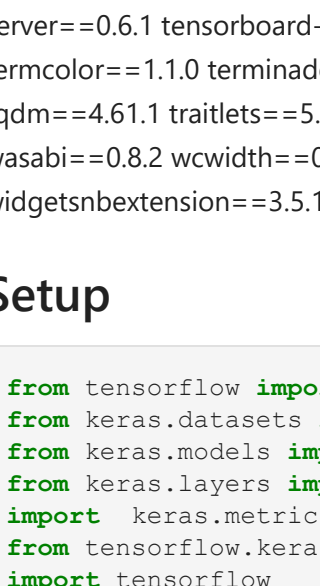
In [81]:
```python
y_valid.shape
```

Out[81]: `(10000,)`

In [82]:
```python
y_valid[0]
```

Out[82]: `7`

In [83]:
```python
plt.imshow(X_valid[0], cmap='Greys')
plt.axis('off')
plt.show()
```



In [84]:
```python
# Reshape (flatten) images
X_train_reshaped = X_train.reshape(60000, 784).astype('float32')
X_valid_reshaped = X_valid.reshape(10000, 784).astype('float32')

# Scale images to the [0, 1] range
X_train_scaled_reshaped = X_train_reshaped / 255
X_valid_scaled_reshaped = X_valid_reshaped / 255

# Renaming for conciseness
X_training = X_train_scaled_reshaped
X_validation = X_valid_scaled_reshaped

print("X_training shape (after reshaping + scaling):", X_training.shape)
print(X_training.shape[0], "train samples")
print("X_validation shape (after reshaping + scaling):", X_validation.shape)
print(X_validation.shape[0], "validation samples")
```

```
X_training shape (after reshaping + scaling): (60000, 784)
60000 train samples
X_validation shape (after reshaping + scaling): (10000, 784)
10000 validation samples
```

In [90]:
```python
# convert class vectors to binary class matrices
y_training = keras.utils.np_utils.to_categorical(y_train, num_classes)
y_validation = keras.utils.np_utils.to_categorical(y_valid, num_classes)
```

In [91]:
```python
print(y_valid[0])
print(y_validation[0])
```

```
7
[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
```

Question 1

X_training and Y_training variables represents the data that will be used as the training data for our model. This is the data from which the algorithm will learn from for all weights in our network.It will also help to predict the output you architect your model to determine.

X_validation and Y_validation these variables represent/hold the unseen data. Data that will be given to the model to report performance metrics. It's also considered test data sets helps validate model. This will also help determine overfitting underfitting and validation.

PART 1 - Shallow neural network architecture

In [92]:
```python
model = Sequential()
model.add(Dense(64, activation='sigmoid', input_shape=(784,)))
model.add(Dense(10, activation='softmax'))
```

In [93]:
```python
model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
dense_2 (Dense)              (None, 64)                50240     
_________________________________________________________________
dense_3 (Dense)              (None, 10)                650       
=================================================================
Total params: 50,890
Trainable params: 50,890
Non-trainable params: 0
_________________________________________________________________
```

Question 2

2A The Summary() Method shows the structure of the neural network. the nueral network we defined above. In the settings above you can see we feed the in the input layer with 784 nodes.The inputes represent a single pixel fomr the images. It also shows us param information.The parameter count is the amount of parameters that can be manipulated in the model. This also means the total dimensions of the optimization problem.

2B the NN has a single hidden layer which is why we call it the shallow nueral network.A shallow nueral network usually has 1 or 2 hidden layers.Also itt has 64 nodes. When we connect all nodes in the input layer to all the nodes in the hidden layer the nueral network will hgave 50240 parameters which you can validate with calulations below.

2C The final layer displays the the output layer it has 10 nodes because of the 10 classes.

In [94]:
```python
(64*784)
```

Out[94]: `50176`

In [95]:
```python
(64*784)+64
```

Out[95]: `50240`

In [96]:
```python
(10*64)+10
```

Out[96]: `650`

Configure model

In [99]:
```python
model.compile(
    loss='mean_squared_error',
    optimizer="sgd",
    metrics=['accuracy']
)
```

In [ ]:

(OPTIONAL) TODO 2

Try different options for `loss` and `optimizer`, for example:

```
model.compile(
  optimizer='adam',
  loss='categorical_crossentropy',
  metrics=['accuracy']
)
```

1-options

In [47]:
```python
model.compile(
    optimizer='adam',
    loss='mean_squared_error',
    metrics=[
        keras.metrics.MeanSquaredError(),
        keras.metrics.AUC(),
    ]
)
```

2-options

In [48]:
```python
model.compile(
    optimizer='adam',
    loss='mean_squared_error',
    metrics=[
        keras.metrics.MeanSquaredError(name='my_mse'),
        keras.metrics.AUC(name='my_auc'),
    ]
)
```

3-options

In [49]:
```python
model.compile(
    optimizer='adam',
    loss='mean_squared_error',
    metrics=[
        'MeanSquaredError',
        'AUC',
    ]
)
```

Train!

Plot learning curves

In [100…
```python
batch_size=128
epochs=500

history = model.fit(
  X_training, # training data
  y_training, # training targets
  epochs=epochs,
  batch_size=batch_size,
  verbose=1,
  validation_data=(X_validation, y_validation)
)
```

```
Epoch 1/500
469/469 [==============================] - 1s 1ms/step - loss: 0.0958 - accuracy: 0.09
69 - val_loss: 0.0922 - val_accuracy: 0.0958
Epoch 2/500
469/469 [==============================] - 0s 778us/step - loss: 0.0918 - accuracy: 0.
0974 - val_loss: 0.0911 - val_accuracy: 0.0959
Epoch 3/500
469/469 [==============================] - 0s 703us/step - loss: 0.0910 - accuracy: 0.
0991 - val_loss: 0.0906 - val_accuracy: 0.1035
Epoch 4/500
469/469 [==============================] - 0s 697us/step - loss: 0.0905 - accuracy: 0.
1102 - val_loss: 0.0903 - val_accuracy: 0.1297
Epoch 5/500
469/469 [==============================] - 0s 702us/step - loss: 0.0902 - accuracy: 0.
1414 - val_loss: 0.0899 - val_accuracy: 0.1682
Epoch 6/500
469/469 [==============================] - 0s 688us/step - loss: 0.0899 - accuracy: 0.
1787 - val_loss: 0.0896 - val_accuracy: 0.2083
Epoch 7/500
469/469 [==============================] - 0s 688us/step - loss: 0.0896 - accuracy: 0.
2139 - val_loss: 0.0893 - val_accuracy: 0.2412
Epoch 8/500
469/469 [==============================] - 0s 691us/step - loss: 0.0893 - accuracy: 0.
2440 - val_loss: 0.0891 - val_accuracy: 0.2707
Epoch 9/500
469/469 [==============================] - 0s 699us/step - loss: 0.0890 - accuracy: 0.
2670 - val_loss: 0.0888 - val_accuracy: 0.2912
Epoch 10/500
469/469 [==============================] - 0s 697us/step - loss: 0.0887 - accuracy: 0.
2832 - val_loss: 0.0885 - val_accuracy: 0.3076
Epoch 11/500
469/469 [==============================] - 0s 686us/step - loss: 0.0885 - accuracy: 0.
2986 - val_loss: 0.0882 - val_accuracy: 0.3198
Epoch 12/500
469/469 [==============================] - 0s 737us/step - loss: 0.0882 - accuracy: 0.
3129 - val_loss: 0.0879 - val_accuracy: 0.3303
Epoch 13/500
469/469 [==============================] - 0s 700us/step - loss: 0.0879 - accuracy: 0.
3203 - val_loss: 0.0876 - val_accuracy: 0.3371
Epoch 14/500
469/469 [==============================] - 0s 695us/step - loss: 0.0876 - accuracy: 0.
3302 - val_loss: 0.0873 - val_accuracy: 0.3430
Epoch 15/500
469/469 [==============================] - 0s 695us/step - loss: 0.0874 - accuracy: 0.
3322 - val_loss: 0.0870 - val_accuracy: 0.3482
Epoch 16/500
469/469 [==============================] - 0s 695us/step - loss: 0.0870 - accuracy: 0.
3391 - val_loss: 0.0867 - val_accuracy: 0.3518
Epoch 17/500
469/469 [==============================] - 0s 688us/step - loss: 0.0867 - accuracy: 0.
3459 - val_loss: 0.0864 - val_accuracy: 0.3557
Epoch 18/500
469/469 [==============================] - 0s 684us/step - loss: 0.0865 - accuracy: 0.
3472 - val_loss: 0.0861 - val_accuracy: 0.3578
Epoch 19/500
469/469 [==============================] - 0s 683us/step - loss: 0.0861 - accuracy: 0.
3514 - val_loss: 0.0858 - val_accuracy: 0.3657
Epoch 20/500
469/469 [==============================] - 0s 684us/step - loss: 0.0859 - accuracy: 0.
3615 - val_loss: 0.0855 - val_accuracy: 0.3842
Epoch 21/500
469/469 [==============================] - 0s 688us/step - loss: 0.0855 - accuracy: 0.
3795 - val_loss: 0.0851 - val_accuracy: 0.4085
Epoch 22/500
469/469 [==============================] - 0s 680us/step - loss: 0.0852 - accuracy: 0.
4058 - val_loss: 0.0848 - val_accuracy: 0.4334
Epoch 23/500
469/469 [==============================] - 0s 690us/step - loss: 0.0848 - accuracy: 0.
4286 - val_loss: 0.0845 - val_accuracy: 0.4519
Epoch 24/500
469/469 [==============================] - 0s 699us/step - loss: 0.0846 - accuracy: 0.
4445 - val_loss: 0.0841 - val_accuracy: 0.4643
Epoch 25/500
469/469 [==============================] - 0s 688us/step - loss: 0.0842 - accuracy: 0.
4589 - val_loss: 0.0838 - val_accuracy: 0.4746
Epoch 26/500
469/469 [==============================] - 0s 686us/step - loss: 0.0838 - accuracy: 0.
4652 - val_loss: 0.0834 - val_accuracy: 0.4831
Epoch 27/500
469/469 [==============================] - 0s 680us/step - loss: 0.0835 - accuracy: 0.
4765 - val_loss: 0.0831 - val_accuracy: 0.4912
Epoch 28/500
469/469 [==============================] - 0s 699us/step - loss: 0.0831 - accuracy: 0.
4850 - val_loss: 0.0827 - val_accuracy: 0.4998
Epoch 29/500
469/469 [==============================] - 0s 684us/step - loss: 0.0828 - accuracy: 0.
4901 - val_loss: 0.0823 - val_accuracy: 0.5095
Epoch 30/500
469/469 [==============================] - 0s 686us/step - loss: 0.0824 - accuracy: 0.
5014 - val_loss: 0.0820 - val_accuracy: 0.5176
Epoch 31/500
469/469 [==============================] - 0s 678us/step - loss: 0.0821 - accuracy: 0.
5058 - val_loss: 0.0816 - val_accuracy: 0.5237
Epoch 32/500
469/469 [==============================] - 0s 695us/step - loss: 0.0816 - accuracy: 0.
5119 - val_loss: 0.0812 - val_accuracy: 0.5308
Epoch 33/500
469/469 [==============================] - 0s 694us/step - loss: 0.0813 - accuracy: 0.
5158 - val_loss: 0.0808 - val_accuracy: 0.5353
Epoch 34/500
469/469 [==============================] - 0s 692us/step - loss: 0.0809 - accuracy: 0.
5265 - val_loss: 0.0804 - val_accuracy: 0.5412
Epoch 35/500
469/469 [==============================] - 0s 695us/step - loss: 0.0805 - accuracy: 0.
5336 - val_loss: 0.0800 - val_accuracy: 0.5476
Epoch 36/500
469/469 [==============================] - 0s 703us/step - loss: 0.0801 - accuracy: 0.
5372 - val_loss: 0.0796 - val_accuracy: 0.5518
Epoch 37/500
469/469 [==============================] - 0s 690us/step - loss: 0.0797 - accuracy: 0.
5428 - val_loss: 0.0791 - val_accuracy: 0.5568
Epoch 38/500
469/469 [==============================] - 0s 688us/step - loss: 0.0792 - accuracy: 0.
5489 - val_loss: 0.0787 - val_accuracy: 0.5621
Epoch 39/500
469/469 [==============================] - 0s 693us/step - loss: 0.0788 - accuracy: 0.
5568 - val_loss: 0.0783 - val_accuracy: 0.5672
Epoch 40/500
469/469 [==============================] - 0s 690us/step - loss: 0.0784 - accuracy: 0.
5593 - val_loss: 0.0778 - val_accuracy: 0.5723
Epoch 41/500
469/469 [==============================] - 0s 695us/step - loss: 0.0779 - accuracy: 0.
5630 - val_loss: 0.0774 - val_accuracy: 0.5759
Epoch 42/500
469/469 [==============================] - 0s 694us/step - loss: 0.0776 - accuracy: 0.
5684 - val_loss: 0.0769 - val_accuracy: 0.5795
Epoch 43/500
469/469 [==============================] - 0s 693us/step - loss: 0.0771 - accuracy: 0.
5721 - val_loss: 0.0764 - val_accuracy: 0.5843
Epoch 44/500
469/469 [==============================] - 0s 688us/step - loss: 0.0767 - accuracy: 0.
5728 - val_loss: 0.0760 - val_accuracy: 0.5880
Epoch 45/500
469/469 [==============================] - 0s 693us/step - loss: 0.0761 - accuracy: 0.
5779 - val_loss: 0.0755 - val_accuracy: 0.5935
Epoch 46/500
469/469 [==============================] - 0s 689us/step - loss: 0.0756 - accuracy: 0.
5844 - val_loss: 0.0750 - val_accuracy: 0.5965
Epoch 47/500
469/469 [==============================] - 0s 690us/step - loss: 0.0753 - accuracy: 0.
5841 - val_loss: 0.0745 - val_accuracy: 0.5991
Epoch 48/500
469/469 [==============================] - 0s 693us/step - loss: 0.0749 - accuracy: 0.
5866 - val_loss: 0.0740 - val_accuracy: 0.6023
Epoch 49/500
469/469 [==============================] - 0s 695us/step - loss: 0.0743 - accuracy: 0.
5905 - val_loss: 0.0735 - val_accuracy: 0.6064
Epoch 50/500
469/469 [==============================] - 0s 693us/step - loss: 0.0738 - accuracy: 0.
5941 - val_loss: 0.0730 - val_accuracy: 0.6093
Epoch 51/500
469/469 [==============================] - 0s 697us/step - loss: 0.0732 - accuracy: 0.
5992 - val_loss: 0.0725 - val_accuracy: 0.6121
Epoch 52/500
469/469 [==============================] - 0s 690us/step - loss: 0.0728 - accuracy: 0.
6008 - val_loss: 0.0720 - val_accuracy: 0.6154
Epoch 53/500
469/469 [==============================] - 0s 680us/step - loss: 0.0723 - accuracy: 0.
6028 - val_loss: 0.0715 - val_accuracy: 0.6170
Epoch 54/500
469/469 [==============================] - 0s 689us/step - loss: 0.0719 - accuracy: 0.
6050 - val_loss: 0.0710 - val_accuracy: 0.6189
Epoch 55/500
469/469 [==============================] - 0s 689us/step - loss: 0.0712 - accuracy: 0.
6072 - val_loss: 0.0704 - val_accuracy: 0.6229
Epoch 56/500
469/469 [==============================] - 0s 714us/step - loss: 0.0708 - accuracy: 0.
6108 - val_loss: 0.0699 - val_accuracy: 0.6247
Epoch 57/500
469/469 [==============================] - 0s 713us/step - loss: 0.0703 - accuracy: 0.
6122 - val_loss: 0.0694 - val_accuracy: 0.6271
Epoch 58/500
469/469 [==============================] - 0s 697us/step - loss: 0.0698 - accuracy: 0.
6138 - val_loss: 0.0688 - val_accuracy: 0.6296
Epoch 59/500
469/469 [==============================] - 0s 690us/step - loss: 0.0692 - accuracy: 0.
6187 - val_loss: 0.0683 - val_accuracy: 0.6315
Epoch 60/500
469/469 [==============================] - 0s 692us/step - loss: 0.0686 - accuracy: 0.
6206 - val_loss: 0.0678 - val_accuracy: 0.6335
Epoch 61/500
469/469 [==============================] - 0s 690us/step - loss: 0.0682 - accuracy: 0.
6234 - val_loss: 0.0672 - val_accuracy: 0.6354
Epoch 62/500
469/469 [==============================] - 0s 680us/step - loss: 0.0676 - accuracy: 0.
6255 - val_loss: 0.0667 - val_accuracy: 0.6371
Epoch 63/500
469/469 [==============================] - 0s 701us/step - loss: 0.0671 - accuracy: 0.
6270 - val_loss: 0.0661 - val_accuracy: 0.6391
Epoch 64/500
469/469 [==============================] - 0s 695us/step - loss: 0.0666 - accuracy: 0.
6297 - val_loss: 0.0656 - val_accuracy: 0.6414
Epoch 65/500
469/469 [==============================] - 0s 684us/step - loss: 0.0660 - accuracy: 0.
6341 - val_loss: 0.0650 - val_accuracy: 0.6432
Epoch 66/500
469/469 [==============================] - 0s 689us/step - loss: 0.0655 - accuracy: 0.
6344 - val_loss: 0.0645 - val_accuracy: 0.6462
Epoch 67/500
469/469 [==============================] - 0s 690us/step - loss: 0.0650 - accuracy: 0.
6370 - val_loss: 0.0640 - val_accuracy: 0.6496
Epoch 68/500
469/469 [==============================] - 0s 686us/step - loss: 0.0644 - accuracy: 0.
6416 - val_loss: 0.0634 - val_accuracy: 0.6516
Epoch 69/500
469/469 [==============================] - 0s 671us/step - loss: 0.0638 - accuracy: 0.
6438 - val_loss: 0.0629 - val_accuracy: 0.6548
Epoch 70/500
469/469 [==============================] - 0s 677us/step - loss: 0.0634 - accuracy: 0.
6468 - val_loss: 0.0624 - val_accuracy: 0.6576
Epoch 71/500
469/469 [==============================] - 0s 688us/step - loss: 0.0629 - accuracy: 0.
6483 - val_loss: 0.0618 - val_accuracy: 0.6617
Epoch 72/500
469/469 [==============================] - 0s 690us/step - loss: 0.0622 - accuracy: 0.
6533 - val_loss: 0.0613 - val_accuracy: 0.6646
Epoch 73/500
469/469 [==============================] - 0s 692us/step - loss: 0.0618 - accuracy: 0.
6566 - val_loss: 0.0608 - val_accuracy: 0.6684
Epoch 74/500
469/469 [==============================] - 0s 695us/step - loss: 0.0614 - accuracy: 0.
6556 - val_loss: 0.0603 - val_accuracy: 0.6725
Epoch 75/500
469/469 [==============================] - 0s 682us/step - loss: 0.0607 - accuracy: 0.
6641 - val_loss: 0.0598 - val_accuracy: 0.6762
Epoch 76/500
469/469 [==============================] - 0s 691us/step - loss: 0.0604 - accuracy: 0.
6640 - val_loss: 0.0593 - val_accuracy: 0.6793
Epoch 77/500
469/469 [==============================] - 0s 689us/step - loss: 0.0599 - accuracy: 0.
6676 - val_loss: 0.0588 - val_accuracy: 0.6820
Epoch 78/500
469/469 [==============================] - 0s 678us/step - loss: 0.0592 - accuracy: 0.
6742 - val_loss: 0.0583 - val_accuracy: 0.6858
Epoch 79/500
469/469 [==============================] - 0s 691us/step - loss: 0.0589 - accuracy: 0.
6760 - val_loss: 0.0578 - val_accuracy: 0.6891
Epoch 80/500
469/469 [==============================] - 0s 684us/step - loss: 0.0583 - accuracy: 0.
6797 - val_loss: 0.0573 - val_accuracy: 0.6924
Epoch 81/500
469/469 [==============================] - 0s 680us/step - loss: 0.0580 - accuracy: 0.
6817 - val_loss: 0.0568 - val_accuracy: 0.6961
Epoch 82/500
469/469 [==============================] - 0s 695us/step - loss: 0.0574 - accuracy: 0.
6847 - val_loss: 0.0563 - val_accuracy: 0.6987
Epoch 83/500
469/469 [==============================] - 0s 701us/step - loss: 0.0569 - accuracy: 0.
6897 - val_loss: 0.0559 - val_accuracy: 0.7017
Epoch 84/500
469/469 [==============================] - 0s 688us/step - loss: 0.0567 - accuracy: 0.
6901 - val_loss: 0.0554 - val_accuracy: 0.7046
Epoch 85/500
469/469 [==============================] - 0s 680us/step - loss: 0.0563 - accuracy: 0.
6926 - val_loss: 0.0550 - val_accuracy: 0.7084
Epoch 86/500
469/469 [==============================] - 0s 686us/step - loss: 0.0555 - accuracy: 0.
6985 - val_loss: 0.0545 - val_accuracy: 0.7131
Epoch 87/500
469/469 [==============================] - 0s 684us/step - loss: 0.0552 - accuracy: 0.
7007 - val_loss: 0.0541 - val_accuracy: 0.7160
Epoch 88/500
469/469 [==============================] - 0s 692us/step - loss: 0.0549 - accuracy: 0.
7043 - val_loss: 0.0536 - val_accuracy: 0.7189
Epoch 89/500
469/469 [==============================] - 0s 695us/step - loss: 0.0544 - accuracy: 0.
7074 - val_loss: 0.0532 - val_accuracy: 0.7225
Epoch 90/500
469/469 [==============================] - 0s 688us/step - loss: 0.0534 - accuracy: 0.
7151 - val_loss: 0.0528 - val_accuracy: 0.7253
Epoch 91/500
469/469 [==============================] - 0s 682us/step - loss: 0.0535 - accuracy: 0.
7137 - val_loss: 0.0524 - val_accuracy: 0.7286
Epoch 92/500
469/469 [==============================] - 0s 699us/step - loss: 0.0531 - accuracy: 0.
7164 - val_loss: 0.0519 - val_accuracy: 0.7315
Epoch 93/500
469/469 [==============================] - 0s 688us/step - loss: 0.0527 - accuracy: 0.
7193 - val_loss: 0.0515 - val_accuracy: 0.7336
Epoch 94/500
469/469 [==============================] - 0s 684us/step - loss: 0.0523 - accuracy: 0.
7213 - val_loss: 0.0511 - val_accuracy: 0.7364
Epoch 95/500
469/469 [==============================] - 0s 690us/step - loss: 0.0520 - accuracy: 0.
7236 - val_loss: 0.0507 - val_accuracy: 0.7395
Epoch 96/500
469/469 [==============================] - 0s 688us/step - loss: 0.0516 - accuracy: 0.
7285 - val_loss: 0.0503 - val_accuracy: 0.7429
Epoch 97/500
469/469 [==============================] - 0s 673us/step - loss: 0.0510 - accuracy: 0.
7342 - val_loss: 0.0499 - val_accuracy: 0.7458
Epoch 98/500
469/469 [==============================] - 0s 680us/step - loss: 0.0505 - accuracy: 0.
7343 - val_loss: 0.0496 - val_accuracy: 0.7476
Epoch 99/500
469/469 [==============================] - 0s 685us/step - loss: 0.0503 - accuracy: 0.
7341 - val_loss: 0.0492 - val_accuracy: 0.7503
Epoch 100/500
469/469 [==============================] - 0s 684us/step - loss: 0.0501 - accuracy: 0.
7358 - val_loss: 0.0488 - val_accuracy: 0.7521
Epoch 101/500
469/469 [==============================] - 0s 697us/step - loss: 0.0494 - accuracy: 0.
7398 - val_loss: 0.0484 - val_accuracy: 0.7536
Epoch 102/500
469/469 [==============================] - 0s 690us/step - loss: 0.0492 - accuracy: 0.
7404 - val_loss: 0.0481 - val_accuracy: 0.7551
Epoch 103/500
469/469 [==============================] - 0s 689us/step - loss: 0.0489 - accuracy: 0.
7424 - val_loss: 0.0477 - val_accuracy: 0.7579
Epoch 104/500
469/469 [==============================] - 0s 689us/step - loss: 0.0486 - accuracy: 0.
7459 - val_loss: 0.0474 - val_accuracy: 0.7602
Epoch 105/500
469/469 [==============================] - 0s 699us/step - loss: 0.0483 - accuracy: 0.
7446 - val_loss: 0.0470 - val_accuracy: 0.7622
Epoch 106/500
469/469 [==============================] - 0s 689us/step - loss: 0.0480 - accuracy: 0.
7480 - val_loss: 0.0467 - val_accuracy: 0.7637
Epoch 107/500
469/469 [==============================] - 0s 682us/step - loss: 0.0476 - accuracy: 0.
7481 - val_loss: 0.0463 - val_accuracy: 0.7650
Epoch 108/500
469/469 [==============================] - 0s 697us/step - loss: 0.0473 - accuracy: 0.
7526 - val_loss: 0.0460 - val_accuracy: 0.7671
Epoch 109/500
469/469 [==============================] - 0s 702us/step - loss: 0.0469 - accuracy: 0.
7543 - val_loss: 0.0457 - val_accuracy: 0.7676
Epoch 110/500
469/469 [==============================] - 0s 692us/step - loss: 0.0464 - accuracy: 0.
7571 - val_loss: 0.0453 - val_accuracy: 0.7687
Epoch 111/500
469/469 [==============================] - 0s 695us/step - loss: 0.0463 - accuracy: 0.
7521 - val_loss: 0.0450 - val_accuracy: 0.7697
Epoch 112/500
469/469 [==============================] - 0s 690us/step - loss: 0.0459 - accuracy: 0.
7552 - val_loss: 0.0447 - val_accuracy: 0.7704
Epoch 113/500
469/469 [==============================] - 0s 693us/step - loss: 0.0453 - accuracy: 0.
7597 - val_loss: 0.0444 - val_accuracy: 0.7717
Epoch 114/500
469/469 [==============================] - 0s 701us/step - loss: 0.0453 - accuracy: 0.
7583 - val_loss: 0.0441 - val_accuracy: 0.7727
Epoch 115/500
469/469 [==============================] - 0s 686us/step - loss: 0.0449 - accuracy: 0.
7628 - val_loss: 0.0438 - val_accuracy: 0.7736
Epoch 116/500
469/469 [==============================] - 0s 680us/step - loss: 0.0447 - accuracy: 0.
7627 - val_loss: 0.0435 - val_accuracy: 0.7749
Epoch 117/500
469/469 [==============================] - 0s 685us/step - loss: 0.0442 - accuracy: 0.
7629 - val_loss: 0.0432 - val_accuracy: 0.7766
Epoch 118/500
469/469 [==============================] - 0s 689us/step - loss: 0.0440 - accuracy: 0.
7649 - val_loss: 0.0429 - val_accuracy: 0.7769
Epoch 119/500
469/469 [==============================] - 0s 686us/step - loss: 0.0435 - accuracy: 0.
7684 - val_loss: 0.0426 - val_accuracy: 0.7779
Epoch 120/500
469/469 [==============================] - 0s 691us/step - loss: 0.0434 - accuracy: 0.
7690 - val_loss: 0.0423 - val_accuracy: 0.7790
Epoch 121/500
469/469 [==============================] - 0s 688us/step - loss: 0.0431 - accuracy: 0.
7699 - val_loss: 0.0420 - val_accuracy: 0.7797
Epoch 122/500
469/469 [==============================] - 0s 690us/step - loss: 0.0426 - accuracy: 0.
7710 - val_loss: 0.0417 - val_accuracy: 0.7804
Epoch 123/500
469/469 [==============================] - 0s 693us/step - loss: 0.0426 - accuracy: 0.
7726 - val_loss: 0.0414 - val_accuracy: 0.7819
Epoch 124/500
469/469 [==============================] - 0s 682us/step - loss: 0.0423 - accuracy: 0.
7722 - val_loss: 0.0412 - val_accuracy: 0.7832
Epoch 125/500
469/469 [==============================] - 0s 686us/step - loss: 0.0421 - accuracy: 0.
7742 - val_loss: 0.0409 - val_accuracy: 0.7848
Epoch 126/500
469/469 [==============================] - 0s 685us/step - loss: 0.0419 - accuracy: 0.
7746 - val_loss: 0.0406 - val_accuracy: 0.7861
Epoch 127/500
469/469 [==============================] - 0s 678us/step - loss: 0.0415 - accuracy: 0.
7785 - val_loss: 0.0404 - val_accuracy: 0.7872
Epoch 128/500
469/469 [==============================] - 0s 682us/step - loss: 0.0411 - accuracy: 0.
7807 - val_loss: 0.0401 - val_accuracy: 0.7884
Epoch 129/500
469/469 [==============================] - 0s 693us/step - loss: 0.0409 - accuracy: 0.
7809 - val_loss: 0.0398 - val_accuracy: 0.7904
Epoch 130/500
469/469 [==============================] - 0s 686us/step - loss: 0.0408 - accuracy: 0.
7819 - val_loss: 0.0396 - val_accuracy: 0.7913
Epoch 131/500
469/469 [==============================] - 0s 680us/step - loss: 0.0404 - accuracy: 0.
7845 - val_loss: 0.0393 - val_accuracy: 0.7926
Epoch 132/500
469/469 [==============================] - 0s 676us/step - loss: 0.0402 - accuracy: 0.
7854 - val_loss: 0.0391 - val_accuracy: 0.7944
Epoch 133/500
469/469 [==============================] - 0s 691us/step - loss: 0.0399 - accuracy: 0.
7877 - val_loss: 0.0388 - val_accuracy: 0.7958
Epoch 134/500
469/469 [==============================] - 0s 682us/step - loss: 0.0398 - accuracy: 0.
7882 - val_loss: 0.0386 - val_accuracy: 0.7982
Epoch 135/500
469/469 [==============================] - 0s 684us/step - loss: 0.0392 - accuracy: 0.
7913 - val_loss: 0.0383 - val_accuracy: 0.7995
Epoch 136/500
469/469 [==============================] - 0s 706us/step - loss: 0.0391 - accuracy: 0.
7920 - val_loss: 0.0381 - val_accuracy: 0.8010
Epoch 137/500
469/469 [==============================] - 0s 684us/step - loss: 0.0389 - accuracy: 0.
7943 - val_loss: 0.0379 - val_accuracy: 0.8032
Epoch 138/500
469/469 [==============================] - 0s 691us/step - loss: 0.0387 - accuracy: 0.
7987 - val_loss: 0.0376 - val_accuracy: 0.8060
Epoch 139/500
469/469 [==============================] - 0s 693us/step - loss: 0.0385 - accuracy: 0.
7970 - val_loss: 0.0374 - val_accuracy: 0.8077
Epoch 140/500
469/469 [==============================] - 0s 682us/step - loss: 0.0384 - accuracy: 0.
7982 - val_loss: 0.0372 - val_accuracy: 0.8088
Epoch 141/500
469/469 [==============================] - 0s 690us/step - loss: 0.0378 - accuracy: 0.
8021 - val_loss: 0.0369 - val_accuracy: 0.8113
Epoch 142/500
469/469 [==============================] - 0s 687us/step - loss: 0.0379 - accuracy: 0.
8028 - val_loss: 0.0367 - val_accuracy: 0.8132
Epoch 143/500
469/469 [==============================] - 0s 686us/step - loss: 0.0377 - accuracy: 0.
8017 - val_loss: 0.0365 - val_accuracy: 0.8148
Epoch 144/500
469/469 [==============================] - 0s 703us/step - loss: 0.0375 - accuracy: 0.
8058 - val_loss: 0.0363 - val_accuracy: 0.8170
Epoch 145/500
469/469 [==============================] - 0s 690us/step - loss: 0.0373 - accuracy: 0.
8038 - val_loss: 0.0361 - val_accuracy: 0.8192
Epoch 146/500
469/469 [==============================] - 0s 682us/step - loss: 0.0370 - accuracy: 0.
8098 - val_loss: 0.0358 - val_accuracy: 0.8205
Epoch 147/500
469/469 [==============================] - 0s 688us/step - loss: 0.0367 - accuracy: 0.
8119 - val_loss: 0.0356 - val_accuracy: 0.8222
Epoch 148/500
469/469 [==============================] - 0s 693us/step - loss: 0.0365 - accuracy: 0.
8132 - val_loss: 0.0354 - val_accuracy: 0.8246
Epoch 149/500
469/469 [==============================] - 0s 688us/step - loss: 0.0362 - accuracy: 0.
8165 - val_loss: 0.0352 - val_accuracy: 0.8257
Epoch 150/500
469/469 [==============================] - 0s 686us/step - loss: 0.0363 - accuracy: 0.
8146 - val_loss: 0.0350 - val_accuracy: 0.8262
Epoch 151/500
469/469 [==============================] - 0s 686us/step - loss: 0.0360 - accuracy: 0.
8172 - val_loss: 0.0348 - val_accuracy: 0.8273
Epoch 152/500
469/469 [==============================] - 0s 698us/step - loss: 0.0357 - accuracy: 0.
8203 - val_loss: 0.0346 - val_accuracy: 0.8285
Epoch 153/500
469/469 [==============================] - 0s 690us/step - loss: 0.0357 - accuracy: 0.
8179 - val_loss: 0.0344 - val_accuracy: 0.8301
Epoch 154/500
469/469 [==============================] - 0s 693us/step - loss: 0.0354 - accuracy: 0.
8189 - val_loss: 0.0342 - val_accuracy: 0.8311
Epoch 155/500
469/469 [==============================] - 0s 683us/step - loss: 0.0352 - accuracy: 0.
8212 - val_loss: 0.0340 - val_accuracy: 0.8330
Epoch 156/500
469/469 [==============================] - 0s 688us/step - loss: 0.0350 - accuracy: 0.
8223 - val_loss: 0.0338 - val_accuracy: 0.8349
Epoch 157/500
469/469 [==============================] - 0s 683us/step - loss: 0.0350 - accuracy: 0.
8226 - val_loss: 0.0336 - val_accuracy: 0.8363
Epoch 158/500
469/469 [==============================] - 0s 684us/step - loss: 0.0348 - accuracy: 0.
8252 - val_loss: 0.0334 - val_accuracy: 0.8378
Epoch 159/500
469/469 [==============================] - 0s 685us/step - loss: 0.0345 - accuracy: 0.
8268 - val_loss: 0.0333 - val_accuracy: 0.8389
Epoch 160/500
469/469 [==============================] - 0s 687us/step - loss: 0.0343 - accuracy: 0.
8269 - val_loss: 0.0331 - val_accuracy: 0.8401
Epoch 161/500
469/469 [==============================] - 0s 716us/step - loss: 0.0339 - accuracy: 0.
8307 - val_loss: 0.0329 - val_accuracy: 0.8408
Epoch 162/500
469/469 [==============================] - 0s 816us/step - loss: 0.0338 - accuracy: 0.
8324 - val_loss: 0.0327 - val_accuracy: 0.8417
Epoch 163/500
469/469 [==============================] - 0s 720us/step - loss: 0.0337 - accuracy: 0.
8308 - val_loss: 0.0325 - val_accuracy: 0.8431
Epoch 164/500
469/469 [==============================] - 0s 752us/step - loss: 0.0336 - accuracy: 0.
8334 - val_loss: 0.0324 - val_accuracy: 0.8439
Epoch 165/500
469/469 [==============================] - 0s 729us/step - loss: 0.0332 - accuracy: 0.
8343 - val_loss: 0.0322 - val_accuracy: 0.8450
Epoch 166/500
469/469 [==============================] - 0s 776us/step - loss: 0.0332 - accuracy: 0.
8350 - val_loss: 0.0320 - val_accuracy: 0.8456
Epoch 167/500
469/469 [==============================] - 0s 706us/step - loss: 0.0329 - accuracy: 0.
8368 - val_loss: 0.0318 - val_accuracy: 0.8468
Epoch 168/500
469/469 [==============================] - 0s 739us/step - loss: 0.0328 - accuracy: 0.
8361 - val_loss: 0.0317 - val_accuracy: 0.8476
Epoch 169/500
469/469 [==============================] - 0s 716us/step - loss: 0.0325 - accuracy: 0.
8375 - val_loss: 0.0315 - val_accuracy: 0.8489
Epoch 170/500
469/469 [==============================] - 0s 725us/step - loss: 0.0325 - accuracy: 0.
8383 - val_loss: 0.0313 - val_accuracy: 0.8499
Epoch 171/500
469/469 [==============================] - 0s 705us/step - loss: 0.0323 - accuracy: 0.
8392 - val_loss: 0.0312 - val_accuracy: 0.8503
Epoch 172/500
469/469 [==============================] - 0s 725us/step - loss: 0.0321 - accuracy: 0.
8402 - val_loss: 0.0310 - val_accuracy: 0.8512
Epoch 173/500
469/469 [==============================] - 0s 735us/step - loss: 0.0320 - accuracy: 0.
8400 - val_loss: 0.0309 - val_accuracy: 0.8519
Epoch 174/500
469/469 [==============================] - 0s 718us/step - loss: 0.0318 - accuracy: 0.
8419 - val_loss: 0.0307 - val_accuracy: 0.8522
Epoch 175/500
469/469 [==============================] - 0s 703us/step - loss: 0.0319 - accuracy: 0.
8408 - val_loss: 0.0306 - val_accuracy: 0.8532
Epoch 176/500
469/469 [==============================] - 0s 695us/step - loss: 0.0315 - accuracy: 0.
8435 - val_loss: 0.0304 - val_accuracy: 0.8537
Epoch 177/500
469/469 [==============================] - 0s 697us/step - loss: 0.0313 - accuracy: 0.
8442 - val_loss: 0.0303 - val_accuracy: 0.8541
Epoch 178/500
469/469 [==============================] - 0s 697us/step - loss: 0.0313 - accuracy: 0.
8449 - val_loss: 0.0301 - val_accuracy: 0.8550
Epoch 179/500
469/469 [==============================] - 0s 706us/step - loss: 0.0311 - accuracy: 0.
8455 - val_loss: 0.0300 - val_accuracy: 0.8556
Epoch 180/500
469/469 [==============================] - 0s 693us/step - loss: 0.0310 - accuracy: 0.
8458 - val_loss: 0.0298 - val_accuracy: 0.8561
Epoch 181/500
469/469 [==============================] - 0s 701us/step - loss: 0.0308 - accuracy: 0.
8484 - val_loss: 0.0297 - val_accuracy: 0.8566
Epoch 182/500
469/469 [==============================] - 0s 754us/step - loss: 0.0308 - accuracy: 0.
8467 - val_loss: 0.0295 - val_accuracy: 0.8572
Epoch 183/500
469/469 [==============================] - 0s 716us/step - loss: 0.0305 - accuracy: 0.
8477 - val_loss: 0.0294 - val_accuracy: 0.8581
Epoch 184/500
469/469 [==============================] - 0s 755us/step - loss: 0.0302 - accuracy: 0.
8509 - val_loss: 0.0293 - val_accuracy: 0.8587
Epoch 185/500
469/469 [==============================] - 0s 717us/step - loss: 0.0302 - accuracy: 0.
8492 - val_loss: 0.0291 - val_accuracy: 0.8590
Epoch 186/500
469/469 [==============================] - 0s 733us/step - loss: 0.0301 - accuracy: 0.
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8497 - val_loss: 0.0290 - val_accuracy: 0.8599
Epoch 187/500
469/469 [==============================] - 0s 729us/step - loss: 0.0300 - accuracy: 0.
8509 - val_loss: 0.0289 - val_accuracy: 0.8611
Epoch 188/500
469/469 [==============================] - 0s 690us/step - loss: 0.0300 - accuracy: 0.
8520 - val_loss: 0.0287 - val_accuracy: 0.8620
Epoch 189/500
469/469 [==============================] - 0s 690us/step - loss: 0.0297 - accuracy: 0.
8499 - val_loss: 0.0286 - val_accuracy: 0.8627
Epoch 190/500
469/469 [==============================] - 0s 692us/step - loss: 0.0296 - accuracy: 0.
8516 - val_loss: 0.0285 - val_accuracy: 0.8632
Epoch 191/500
469/469 [==============================] - 0s 739us/step - loss: 0.0295 - accuracy: 0.
8522 - val_loss: 0.0283 - val_accuracy: 0.8638
Epoch 192/500
469/469 [==============================] - 0s 741us/step - loss: 0.0294 - accuracy: 0.
8541 - val_loss: 0.0282 - val_accuracy: 0.8644
Epoch 193/500
469/469 [==============================] - 0s 697us/step - loss: 0.0289 - accuracy: 0.
8545 - val_loss: 0.0281 - val_accuracy: 0.8648
Epoch 194/500
469/469 [==============================] - 0s 695us/step - loss: 0.0291 - accuracy: 0.
8559 - val_loss: 0.0280 - val_accuracy: 0.8653
Epoch 195/500
469/469 [==============================] - 0s 690us/step - loss: 0.0292 - accuracy: 0.
8549 - val_loss: 0.0278 - val_accuracy: 0.8657
Epoch 196/500
469/469 [==============================] - 0s 693us/step - loss: 0.0288 - accuracy: 0.
8565 - val_loss: 0.0277 - val_accuracy: 0.8662
Epoch 197/500
469/469 [==============================] - 0s 690us/step - loss: 0.0289 - accuracy: 0.
8555 - val_loss: 0.0276 - val_accuracy: 0.8664
Epoch 198/500
469/469 [==============================] - 0s 699us/step - loss: 0.0286 - accuracy: 0.
8570 - val_loss: 0.0275 - val_accuracy: 0.8669
Epoch 199/500
469/469 [==============================] - 0s 693us/step - loss: 0.0285 - accuracy: 0.
8566 - val_loss: 0.0274 - val_accuracy: 0.8671
Epoch 200/500
469/469 [==============================] - 0s 712us/step - loss: 0.0283 - accuracy: 0.
8594 - val_loss: 0.0273 - val_accuracy: 0.8672
Epoch 201/500
469/469 [==============================] - 0s 686us/step - loss: 0.0283 - accuracy: 0.
8578 - val_loss: 0.0271 - val_accuracy: 0.8678
Epoch 202/500
469/469 [==============================] - 0s 689us/step - loss: 0.0283 - accuracy: 0.
8584 - val_loss: 0.0270 - val_accuracy: 0.8679
Epoch 203/500
469/469 [==============================] - 0s 697us/step - loss: 0.0280 - accuracy: 0.
8591 - val_loss: 0.0269 - val_accuracy: 0.8684
Epoch 204/500
469/469 [==============================] - 0s 733us/step - loss: 0.0279 - accuracy: 0.
8591 - val_loss: 0.0268 - val_accuracy: 0.8688
Epoch 205/500
469/469 [==============================] - 0s 713us/step - loss: 0.0278 - accuracy: 0.
8613 - val_loss: 0.0267 - val_accuracy: 0.8694
Epoch 206/500
469/469 [==============================] - 0s 712us/step - loss: 0.0279 - accuracy: 0.
8577 - val_loss: 0.0266 - val_accuracy: 0.8696
Epoch 207/500
469/469 [==============================] - 0s 720us/step - loss: 0.0276 - accuracy: 0.
8607 - val_loss: 0.0265 - val_accuracy: 0.8702
Epoch 208/500
469/469 [==============================] - 0s 730us/step - loss: 0.0274 - accuracy: 0.
8626 - val_loss: 0.0264 - val_accuracy: 0.8710
Epoch 209/500
469/469 [==============================] - 0s 695us/step - loss: 0.0274 - accuracy: 0.
8613 - val_loss: 0.0263 - val_accuracy: 0.8714
Epoch 210/500
469/469 [==============================] - 0s 708us/step - loss: 0.0275 - accuracy: 0.
8625 - val_loss: 0.0262 - val_accuracy: 0.8720
Epoch 211/500
469/469 [==============================] - 0s 722us/step - loss: 0.0273 - accuracy: 0.
8616 - val_loss: 0.0261 - val_accuracy: 0.8728
Epoch 212/500
469/469 [==============================] - 0s 698us/step - loss: 0.0269 - accuracy: 0.
8632 - val_loss: 0.0260 - val_accuracy: 0.8730
Epoch 213/500
469/469 [==============================] - 0s 735us/step - loss: 0.0270 - accuracy: 0.
8630 - val_loss: 0.0259 - val_accuracy: 0.8731
Epoch 214/500
469/469 [==============================] - 0s 686us/step - loss: 0.0269 - accuracy: 0.
8643 - val_loss: 0.0258 - val_accuracy: 0.8735
Epoch 215/500
469/469 [==============================] - 0s 695us/step - loss: 0.0270 - accuracy: 0.
8623 - val_loss: 0.0257 - val_accuracy: 0.8734
Epoch 216/500
469/469 [==============================] - 0s 742us/step - loss: 0.0268 - accuracy: 0.
8646 - val_loss: 0.0256 - val_accuracy: 0.8739
Epoch 217/500
469/469 [==============================] - 0s 689us/step - loss: 0.0266 - accuracy: 0.
8648 - val_loss: 0.0255 - val_accuracy: 0.8742
Epoch 218/500
469/469 [==============================] - 0s 693us/step - loss: 0.0268 - accuracy: 0.
8631 - val_loss: 0.0254 - val_accuracy: 0.8744
Epoch 219/500
469/469 [==============================] - 0s 686us/step - loss: 0.0264 - accuracy: 0.
8652 - val_loss: 0.0253 - val_accuracy: 0.8745
Epoch 220/500
469/469 [==============================] - 0s 691us/step - loss: 0.0264 - accuracy: 0.
8647 - val_loss: 0.0252 - val_accuracy: 0.8748
Epoch 221/500
469/469 [==============================] - 0s 699us/step - loss: 0.0261 - accuracy: 0.
8681 - val_loss: 0.0252 - val_accuracy: 0.8750
Epoch 222/500
469/469 [==============================] - 0s 693us/step - loss: 0.0261 - accuracy: 0.
8658 - val_loss: 0.0251 - val_accuracy: 0.8753
Epoch 223/500
469/469 [==============================] - 0s 695us/step - loss: 0.0262 - accuracy: 0.
8664 - val_loss: 0.0250 - val_accuracy: 0.8755
Epoch 224/500
469/469 [==============================] - 0s 703us/step - loss: 0.0261 - accuracy: 0.
8646 - val_loss: 0.0249 - val_accuracy: 0.8758
Epoch 225/500
469/469 [==============================] - 0s 725us/step - loss: 0.0259 - accuracy: 0.
8687 - val_loss: 0.0248 - val_accuracy: 0.8761
Epoch 226/500
469/469 [==============================] - 0s 731us/step - loss: 0.0259 - accuracy: 0.
8655 - val_loss: 0.0247 - val_accuracy: 0.8761
Epoch 227/500
469/469 [==============================] - 0s 725us/step - loss: 0.0259 - accuracy: 0.
8660 - val_loss: 0.0246 - val_accuracy: 0.8764
Epoch 228/500
469/469 [==============================] - 0s 718us/step - loss: 0.0255 - accuracy: 0.
8702 - val_loss: 0.0246 - val_accuracy: 0.8767
Epoch 229/500
469/469 [==============================] - 0s 703us/step - loss: 0.0256 - accuracy: 0.
8690 - val_loss: 0.0245 - val_accuracy: 0.8770
Epoch 230/500
469/469 [==============================] - 0s 698us/step - loss: 0.0254 - accuracy: 0.
8687 - val_loss: 0.0244 - val_accuracy: 0.8774
Epoch 231/500
469/469 [==============================] - 0s 689us/step - loss: 0.0255 - accuracy: 0.
8681 - val_loss: 0.0243 - val_accuracy: 0.8776
Epoch 232/500
469/469 [==============================] - 0s 698us/step - loss: 0.0256 - accuracy: 0.
8661 - val_loss: 0.0242 - val_accuracy: 0.8779
Epoch 233/500
469/469 [==============================] - 0s 693us/step - loss: 0.0253 - accuracy: 0.
8682 - val_loss: 0.0242 - val_accuracy: 0.8780
Epoch 234/500
469/469 [==============================] - 0s 690us/step - loss: 0.0250 - accuracy: 0.
8704 - val_loss: 0.0241 - val_accuracy: 0.8782
Epoch 235/500
469/469 [==============================] - 0s 729us/step - loss: 0.0250 - accuracy: 0.
8701 - val_loss: 0.0240 - val_accuracy: 0.8783
Epoch 236/500
469/469 [==============================] - 0s 686us/step - loss: 0.0248 - accuracy: 0.
8711 - val_loss: 0.0239 - val_accuracy: 0.8787
Epoch 237/500
469/469 [==============================] - 0s 682us/step - loss: 0.0248 - accuracy: 0.
8711 - val_loss: 0.0239 - val_accuracy: 0.8787
Epoch 238/500
469/469 [==============================] - 0s 700us/step - loss: 0.0247 - accuracy: 0.
8717 - val_loss: 0.0238 - val_accuracy: 0.8793
Epoch 239/500
469/469 [==============================] - 0s 690us/step - loss: 0.0248 - accuracy: 0.
8695 - val_loss: 0.0237 - val_accuracy: 0.8795
Epoch 240/500
469/469 [==============================] - 0s 687us/step - loss: 0.0248 - accuracy: 0.
8712 - val_loss: 0.0237 - val_accuracy: 0.8798
Epoch 241/500
469/469 [==============================] - 0s 691us/step - loss: 0.0246 - accuracy: 0.
8717 - val_loss: 0.0236 - val_accuracy: 0.8804
Epoch 242/500
469/469 [==============================] - 0s 686us/step - loss: 0.0245 - accuracy: 0.
8711 - val_loss: 0.0235 - val_accuracy: 0.8805
Epoch 243/500
469/469 [==============================] - 0s 681us/step - loss: 0.0245 - accuracy: 0.
8715 - val_loss: 0.0234 - val_accuracy: 0.8806
Epoch 244/500
469/469 [==============================] - 0s 688us/step - loss: 0.0245 - accuracy: 0.
8711 - val_loss: 0.0234 - val_accuracy: 0.8806
Epoch 245/500
469/469 [==============================] - 0s 685us/step - loss: 0.0243 - accuracy: 0.
8724 - val_loss: 0.0233 - val_accuracy: 0.8811
Epoch 246/500
469/469 [==============================] - 0s 684us/step - loss: 0.0244 - accuracy: 0.
8710 - val_loss: 0.0232 - val_accuracy: 0.8813
Epoch 247/500
469/469 [==============================] - 0s 686us/step - loss: 0.0240 - accuracy: 0.
8733 - val_loss: 0.0232 - val_accuracy: 0.8815
Epoch 248/500
469/469 [==============================] - 0s 686us/step - loss: 0.0243 - accuracy: 0.
8700 - val_loss: 0.0231 - val_accuracy: 0.8820
Epoch 249/500
469/469 [==============================] - 0s 695us/step - loss: 0.0241 - accuracy: 0.
8728 - val_loss: 0.0230 - val_accuracy: 0.8821
Epoch 250/500
469/469 [==============================] - 0s 678us/step - loss: 0.0241 - accuracy: 0.
8712 - val_loss: 0.0230 - val_accuracy: 0.8822
Epoch 251/500
469/469 [==============================] - 0s 688us/step - loss: 0.0239 - accuracy: 0.
8737 - val_loss: 0.0229 - val_accuracy: 0.8822
Epoch 252/500
469/469 [==============================] - 0s 688us/step - loss: 0.0238 - accuracy: 0.
8740 - val_loss: 0.0229 - val_accuracy: 0.8825
Epoch 253/500
469/469 [==============================] - 0s 688us/step - loss: 0.0240 - accuracy: 0.
8717 - val_loss: 0.0228 - val_accuracy: 0.8828
Epoch 254/500
469/469 [==============================] - 0s 686us/step - loss: 0.0240 - accuracy: 0.
8710 - val_loss: 0.0227 - val_accuracy: 0.8831
Epoch 255/500
469/469 [==============================] - 0s 697us/step - loss: 0.0236 - accuracy: 0.
8754 - val_loss: 0.0227 - val_accuracy: 0.8834
Epoch 256/500
469/469 [==============================] - 0s 696us/step - loss: 0.0238 - accuracy: 0.
8716 - val_loss: 0.0226 - val_accuracy: 0.8838
Epoch 257/500
469/469 [==============================] - 0s 699us/step - loss: 0.0235 - accuracy: 0.
8738 - val_loss: 0.0225 - val_accuracy: 0.8843
Epoch 258/500
469/469 [==============================] - 0s 690us/step - loss: 0.0234 - accuracy: 0.
8758 - val_loss: 0.0225 - val_accuracy: 0.8844
Epoch 259/500
469/469 [==============================] - 0s 708us/step - loss: 0.0235 - accuracy: 0.
8740 - val_loss: 0.0224 - val_accuracy: 0.8845
Epoch 260/500
469/469 [==============================] - 0s 706us/step - loss: 0.0234 - accuracy: 0.
8747 - val_loss: 0.0224 - val_accuracy: 0.8846
Epoch 261/500
469/469 [==============================] - 0s 718us/step - loss: 0.0233 - accuracy: 0.
8763 - val_loss: 0.0223 - val_accuracy: 0.8848
Epoch 262/500
469/469 [==============================] - 0s 712us/step - loss: 0.0231 - accuracy: 0.
8780 - val_loss: 0.0223 - val_accuracy: 0.8848
Epoch 263/500
469/469 [==============================] - 0s 765us/step - loss: 0.0233 - accuracy: 0.
8748 - val_loss: 0.0222 - val_accuracy: 0.8852
Epoch 264/500
469/469 [==============================] - 0s 739us/step - loss: 0.0231 - accuracy: 0.
8759 - val_loss: 0.0221 - val_accuracy: 0.8854
Epoch 265/500
469/469 [==============================] - 0s 729us/step - loss: 0.0233 - accuracy: 0.
8741 - val_loss: 0.0221 - val_accuracy: 0.8858
Epoch 266/500
469/469 [==============================] - 0s 737us/step - loss: 0.0229 - accuracy: 0.
8771 - val_loss: 0.0220 - val_accuracy: 0.8859
Epoch 267/500
469/469 [==============================] - 0s 729us/step - loss: 0.0230 - accuracy: 0.
8754 - val_loss: 0.0220 - val_accuracy: 0.8859
Epoch 268/500
469/469 [==============================] - 0s 712us/step - loss: 0.0230 - accuracy: 0.
8755 - val_loss: 0.0219 - val_accuracy: 0.8859
Epoch 269/500
469/469 [==============================] - 0s 705us/step - loss: 0.0229 - accuracy: 0.
8758 - val_loss: 0.0219 - val_accuracy: 0.8860
Epoch 270/500
469/469 [==============================] - 0s 727us/step - loss: 0.0230 - accuracy: 0.
8743 - val_loss: 0.0218 - val_accuracy: 0.8860
Epoch 271/500
469/469 [==============================] - 0s 729us/step - loss: 0.0228 - accuracy: 0.
8766 - val_loss: 0.0218 - val_accuracy: 0.8861
Epoch 272/500
469/469 [==============================] - 0s 697us/step - loss: 0.0228 - accuracy: 0.
8759 - val_loss: 0.0217 - val_accuracy: 0.8861
Epoch 273/500
469/469 [==============================] - 0s 697us/step - loss: 0.0229 - accuracy: 0.
8756 - val_loss: 0.0217 - val_accuracy: 0.8863
Epoch 274/500
469/469 [==============================] - 0s 685us/step - loss: 0.0224 - accuracy: 0.
8799 - val_loss: 0.0216 - val_accuracy: 0.8866
Epoch 275/500
469/469 [==============================] - 0s 690us/step - loss: 0.0224 - accuracy: 0.
8788 - val_loss: 0.0216 - val_accuracy: 0.8868
Epoch 276/500
469/469 [==============================] - 0s 693us/step - loss: 0.0224 - accuracy: 0.
8782 - val_loss: 0.0215 - val_accuracy: 0.8870
Epoch 277/500
469/469 [==============================] - 0s 676us/step - loss: 0.0226 - accuracy: 0.
8761 - val_loss: 0.0215 - val_accuracy: 0.8869
Epoch 278/500
469/469 [==============================] - 0s 682us/step - loss: 0.0223 - accuracy: 0.
8794 - val_loss: 0.0214 - val_accuracy: 0.8871
Epoch 279/500
469/469 [==============================] - 0s 705us/step - loss: 0.0222 - accuracy: 0.
8804 - val_loss: 0.0214 - val_accuracy: 0.8871
Epoch 280/500
469/469 [==============================] - 0s 690us/step - loss: 0.0223 - accuracy: 0.
8785 - val_loss: 0.0213 - val_accuracy: 0.8871
Epoch 281/500
469/469 [==============================] - 0s 729us/step - loss: 0.0222 - accuracy: 0.
8775 - val_loss: 0.0213 - val_accuracy: 0.8874
Epoch 282/500
469/469 [==============================] - 0s 720us/step - loss: 0.0221 - accuracy: 0.
8793 - val_loss: 0.0212 - val_accuracy: 0.8874
Epoch 283/500
469/469 [==============================] - 0s 712us/step - loss: 0.0223 - accuracy: 0.
8791 - val_loss: 0.0212 - val_accuracy: 0.8875
Epoch 284/500
469/469 [==============================] - 0s 718us/step - loss: 0.0220 - accuracy: 0.
8800 - val_loss: 0.0211 - val_accuracy: 0.8876
Epoch 285/500
469/469 [==============================] - 0s 706us/step - loss: 0.0221 - accuracy: 0.
8786 - val_loss: 0.0211 - val_accuracy: 0.8879
Epoch 286/500
469/469 [==============================] - 0s 701us/step - loss: 0.0219 - accuracy: 0.
8811 - val_loss: 0.0210 - val_accuracy: 0.8882
Epoch 287/500
469/469 [==============================] - 0s 735us/step - loss: 0.0220 - accuracy: 0.
8798 - val_loss: 0.0210 - val_accuracy: 0.8888
Epoch 288/500
469/469 [==============================] - 0s 731us/step - loss: 0.0219 - accuracy: 0.
8808 - val_loss: 0.0210 - val_accuracy: 0.8888
Epoch 289/500
469/469 [==============================] - 0s 720us/step - loss: 0.0218 - accuracy: 0.
8806 - val_loss: 0.0209 - val_accuracy: 0.8890
Epoch 290/500
469/469 [==============================] - 0s 716us/step - loss: 0.0219 - accuracy: 0.
8784 - val_loss: 0.0209 - val_accuracy: 0.8890
Epoch 291/500
469/469 [==============================] - 0s 735us/step - loss: 0.0220 - accuracy: 0.
8780 - val_loss: 0.0208 - val_accuracy: 0.8891
Epoch 292/500
469/469 [==============================] - 0s 720us/step - loss: 0.0218 - accuracy: 0.
8799 - val_loss: 0.0208 - val_accuracy: 0.8890
Epoch 293/500
469/469 [==============================] - 0s 732us/step - loss: 0.0217 - accuracy: 0.
8804 - val_loss: 0.0207 - val_accuracy: 0.8890
Epoch 294/500
469/469 [==============================] - 0s 735us/step - loss: 0.0218 - accuracy: 0.
8786 - val_loss: 0.0207 - val_accuracy: 0.8890
Epoch 295/500
469/469 [==============================] - 0s 720us/step - loss: 0.0218 - accuracy: 0.
8793 - val_loss: 0.0207 - val_accuracy: 0.8891
Epoch 296/500
469/469 [==============================] - 0s 727us/step - loss: 0.0215 - accuracy: 0.
8805 - val_loss: 0.0206 - val_accuracy: 0.8892
Epoch 297/500
469/469 [==============================] - 0s 730us/step - loss: 0.0216 - accuracy: 0.
8800 - val_loss: 0.0206 - val_accuracy: 0.8894
Epoch 298/500
469/469 [==============================] - 0s 724us/step - loss: 0.0213 - accuracy: 0.
8822 - val_loss: 0.0205 - val_accuracy: 0.8894
Epoch 299/500
469/469 [==============================] - 0s 725us/step - loss: 0.0216 - accuracy: 0.
8799 - val_loss: 0.0205 - val_accuracy: 0.8896
Epoch 300/500
469/469 [==============================] - ETA: 0s - loss: 0.0215 - accuracy: 0.88 - 0
s 719us/step - loss: 0.0215 - accuracy: 0.8808 - val_loss: 0.0204 - val_accuracy: 0.88
99
Epoch 301/500
469/469 [==============================] - 0s 720us/step - loss: 0.0213 - accuracy: 0.
8825 - val_loss: 0.0204 - val_accuracy: 0.8898
Epoch 302/500
469/469 [==============================] - 0s 736us/step - loss: 0.0212 - accuracy: 0.
8826 - val_loss: 0.0204 - val_accuracy: 0.8898
Epoch 303/500
469/469 [==============================] - 0s 733us/step - loss: 0.0212 - accuracy: 0.
8809 - val_loss: 0.0203 - val_accuracy: 0.8900
Epoch 304/500
469/469 [==============================] - 0s 720us/step - loss: 0.0214 - accuracy: 0.
8804 - val_loss: 0.0203 - val_accuracy: 0.8901
Epoch 305/500
469/469 [==============================] - 0s 737us/step - loss: 0.0212 - accuracy: 0.
8824 - val_loss: 0.0203 - val_accuracy: 0.8903
Epoch 306/500
469/469 [==============================] - 0s 724us/step - loss: 0.0214 - accuracy: 0.
8798 - val_loss: 0.0202 - val_accuracy: 0.8906
Epoch 307/500
469/469 [==============================] - 0s 719us/step - loss: 0.0212 - accuracy: 0.
8819 - val_loss: 0.0202 - val_accuracy: 0.8907
Epoch 308/500
469/469 [==============================] - 0s 725us/step - loss: 0.0210 - accuracy: 0.
8842 - val_loss: 0.0201 - val_accuracy: 0.8910
Epoch 309/500
469/469 [==============================] - 0s 724us/step - loss: 0.0211 - accuracy: 0.
8828 - val_loss: 0.0201 - val_accuracy: 0.8911
Epoch 310/500
469/469 [==============================] - 0s 722us/step - loss: 0.0210 - accuracy: 0.
8834 - val_loss: 0.0201 - val_accuracy: 0.8910
Epoch 311/500
469/469 [==============================] - 0s 728us/step - loss: 0.0211 - accuracy: 0.
8825 - val_loss: 0.0200 - val_accuracy: 0.8911
Epoch 312/500
469/469 [==============================] - 0s 722us/step - loss: 0.0208 - accuracy: 0.
8836 - val_loss: 0.0200 - val_accuracy: 0.8914
Epoch 313/500
469/469 [==============================] - 0s 722us/step - loss: 0.0209 - accuracy: 0.
8825 - val_loss: 0.0200 - val_accuracy: 0.8915
Epoch 314/500
469/469 [==============================] - 0s 731us/step - loss: 0.0210 - accuracy: 0.
8831 - val_loss: 0.0199 - val_accuracy: 0.8917
Epoch 315/500
469/469 [==============================] - 0s 721us/step - loss: 0.0208 - accuracy: 0.
8842 - val_loss: 0.0199 - val_accuracy: 0.8918
Epoch 316/500
469/469 [==============================] - 0s 721us/step - loss: 0.0209 - accuracy: 0.
8821 - val_loss: 0.0199 - val_accuracy: 0.8918
Epoch 317/500
469/469 [==============================] - 0s 732us/step - loss: 0.0209 - accuracy: 0.
8827 - val_loss: 0.0198 - val_accuracy: 0.8920
Epoch 318/500
469/469 [==============================] - 0s 724us/step - loss: 0.0205 - accuracy: 0.
8847 - val_loss: 0.0198 - val_accuracy: 0.8920
Epoch 319/500
469/469 [==============================] - 0s 714us/step - loss: 0.0207 - accuracy: 0.
8835 - val_loss: 0.0197 - val_accuracy: 0.8921
Epoch 320/500
469/469 [==============================] - 0s 734us/step - loss: 0.0208 - accuracy: 0.
8828 - val_loss: 0.0197 - val_accuracy: 0.8922
Epoch 321/500
469/469 [==============================] - 0s 695us/step - loss: 0.0205 - accuracy: 0.
8848 - val_loss: 0.0197 - val_accuracy: 0.8923
Epoch 322/500
469/469 [==============================] - 0s 722us/step - loss: 0.0206 - accuracy: 0.
8844 - val_loss: 0.0196 - val_accuracy: 0.8925
Epoch 323/500
469/469 [==============================] - 0s 752us/step - loss: 0.0206 - accuracy: 0.
8846 - val_loss: 0.0196 - val_accuracy: 0.8930
Epoch 324/500
469/469 [==============================] - 0s 722us/step - loss: 0.0207 - accuracy: 0.
8834 - val_loss: 0.0196 - val_accuracy: 0.8930
Epoch 325/500
469/469 [==============================] - 0s 718us/step - loss: 0.0207 - accuracy: 0.
8817 - val_loss: 0.0195 - val_accuracy: 0.8932
Epoch 326/500
469/469 [==============================] - 0s 695us/step - loss: 0.0205 - accuracy: 0.
8835 - val_loss: 0.0195 - val_accuracy: 0.8932
Epoch 327/500
469/469 [==============================] - 0s 725us/step - loss: 0.0203 - accuracy: 0.
8855 - val_loss: 0.0195 - val_accuracy: 0.8932
Epoch 328/500
469/469 [==============================] - 0s 722us/step - loss: 0.0206 - accuracy: 0.
8835 - val_loss: 0.0195 - val_accuracy: 0.8933
Epoch 329/500
469/469 [==============================] - 0s 718us/step - loss: 0.0205 - accuracy: 0.
8845 - val_loss: 0.0194 - val_accuracy: 0.8933
Epoch 330/500
469/469 [==============================] - 0s 705us/step - loss: 0.0202 - accuracy: 0.
8853 - val_loss: 0.0194 - val_accuracy: 0.8935
Epoch 331/500
469/469 [==============================] - 0s 716us/step - loss: 0.0205 - accuracy: 0.
8832 - val_loss: 0.0194 - val_accuracy: 0.8937
Epoch 332/500
469/469 [==============================] - 0s 732us/step - loss: 0.0202 - accuracy: 0.
8872 - val_loss: 0.0193 - val_accuracy: 0.8938
Epoch 333/500
469/469 [==============================] - 0s 737us/step - loss: 0.0203 - accuracy: 0.
8839 - val_loss: 0.0193 - val_accuracy: 0.8939
Epoch 334/500
469/469 [==============================] - 0s 722us/step - loss: 0.0202 - accuracy: 0.
8861 - val_loss: 0.0193 - val_accuracy: 0.8938
Epoch 335/500
469/469 [==============================] - 0s 727us/step - loss: 0.0203 - accuracy: 0.
8838 - val_loss: 0.0192 - val_accuracy: 0.8940
Epoch 336/500
469/469 [==============================] - 0s 723us/step - loss: 0.0203 - accuracy: 0.
8839 - val_loss: 0.0192 - val_accuracy: 0.8946
Epoch 337/500
469/469 [==============================] - 0s 721us/step - loss: 0.0201 - accuracy: 0.
8860 - val_loss: 0.0192 - val_accuracy: 0.8949
Epoch 338/500
469/469 [==============================] - 0s 725us/step - loss: 0.0200 - accuracy: 0.
8862 - val_loss: 0.0191 - val_accuracy: 0.8948
Epoch 339/500
469/469 [==============================] - 0s 737us/step - loss: 0.0202 - accuracy: 0.
8854 - val_loss: 0.0191 - val_accuracy: 0.8949
Epoch 340/500
469/469 [==============================] - 0s 731us/step - loss: 0.0201 - accuracy: 0.
8852 - val_loss: 0.0191 - val_accuracy: 0.8950
Epoch 341/500
469/469 [==============================] - 0s 729us/step - loss: 0.0198 - accuracy: 0.
8874 - val_loss: 0.0191 - val_accuracy: 0.8950
Epoch 342/500
469/469 [==============================] - 0s 721us/step - loss: 0.0199 - accuracy: 0.
8874 - val_loss: 0.0190 - val_accuracy: 0.8952
Epoch 343/500
469/469 [==============================] - 0s 727us/step - loss: 0.0200 - accuracy: 0.
8864 - val_loss: 0.0190 - val_accuracy: 0.8953
Epoch 344/500
469/469 [==============================] - 0s 729us/step - loss: 0.0201 - accuracy: 0.
8855 - val_loss: 0.0190 - val_accuracy: 0.8951
Epoch 345/500
469/469 [==============================] - 0s 731us/step - loss: 0.0200 - accuracy: 0.
8864 - val_loss: 0.0189 - val_accuracy: 0.8951
Epoch 346/500
469/469 [==============================] - 0s 727us/step - loss: 0.0199 - accuracy: 0.
8860 - val_loss: 0.0189 - val_accuracy: 0.8951
Epoch 347/500
469/469 [==============================] - 0s 718us/step - loss: 0.0198 - accuracy: 0.
8863 - val_loss: 0.0189 - val_accuracy: 0.8954
Epoch 348/500
469/469 [==============================] - 0s 722us/step - loss: 0.0199 - accuracy: 0.
8859 - val_loss: 0.0189 - val_accuracy: 0.8955
Epoch 349/500
469/469 [==============================] - 0s 727us/step - loss: 0.0197 - accuracy: 0.
8887 - val_loss: 0.0188 - val_accuracy: 0.8956
Epoch 350/500
469/469 [==============================] - 0s 716us/step - loss: 0.0200 - accuracy: 0.
8852 - val_loss: 0.0188 - val_accuracy: 0.8956
Epoch 351/500
469/469 [==============================] - 0s 720us/step - loss: 0.0197 - accuracy: 0.
8880 - val_loss: 0.0188 - val_accuracy: 0.8958
Epoch 352/500
469/469 [==============================] - 0s 712us/step - loss: 0.0196 - accuracy: 0.
8886 - val_loss: 0.0187 - val_accuracy: 0.8959
Epoch 353/500
469/469 [==============================] - 0s 727us/step - loss: 0.0198 - accuracy: 0.
8869 - val_loss: 0.0187 - val_accuracy: 0.8959
Epoch 354/500
469/469 [==============================] - 0s 725us/step - loss: 0.0196 - accuracy: 0.
8874 - val_loss: 0.0187 - val_accuracy: 0.8959
Epoch 355/500
469/469 [==============================] - 0s 720us/step - loss: 0.0196 - accuracy: 0.
8895 - val_loss: 0.0187 - val_accuracy: 0.8961
Epoch 356/500
469/469 [==============================] - 0s 720us/step - loss: 0.0195 - accuracy: 0.
8885 - val_loss: 0.0186 - val_accuracy: 0.8961
Epoch 357/500
469/469 [==============================] - 0s 739us/step - loss: 0.0196 - accuracy: 0.
8880 - val_loss: 0.0186 - val_accuracy: 0.8961
Epoch 358/500
469/469 [==============================] - 0s 707us/step - loss: 0.0196 - accuracy: 0.
8877 - val_loss: 0.0186 - val_accuracy: 0.8962
Epoch 359/500
469/469 [==============================] - 0s 782us/step - loss: 0.0198 - accuracy: 0.
8859 - val_loss: 0.0186 - val_accuracy: 0.8962
Epoch 360/500
469/469 [==============================] - 0s 712us/step - loss: 0.0198 - accuracy: 0.
8865 - val_loss: 0.0185 - val_accuracy: 0.8962
Epoch 361/500
469/469 [==============================] - 0s 745us/step - loss: 0.0194 - accuracy: 0.
8888 - val_loss: 0.0185 - val_accuracy: 0.8962
Epoch 362/500
469/469 [==============================] - 0s 731us/step - loss: 0.0191 - accuracy: 0.
8925 - val_loss: 0.0185 - val_accuracy: 0.8962
Epoch 363/500
469/469 [==============================] - 0s 727us/step - loss: 0.0194 - accuracy: 0.
8873 - val_loss: 0.0185 - val_accuracy: 0.8962
Epoch 364/500
469/469 [==============================] - 0s 722us/step - loss: 0.0190 - accuracy: 0.
8913 - val_loss: 0.0184 - val_accuracy: 0.8962
Epoch 365/500
469/469 [==============================] - 0s 735us/step - loss: 0.0193 - accuracy: 0.
8884 - val_loss: 0.0184 - val_accuracy: 0.8963
Epoch 366/500
469/469 [==============================] - 0s 708us/step - loss: 0.0194 - accuracy: 0.
8895 - val_loss: 0.0184 - val_accuracy: 0.8964
Epoch 367/500
469/469 [==============================] - 0s 705us/step - loss: 0.0193 - accuracy: 0.
8898 - val_loss: 0.0184 - val_accuracy: 0.8964
Epoch 368/500
469/469 [==============================] - 0s 739us/step - loss: 0.0192 - accuracy: 0.
8908 - val_loss: 0.0183 - val_accuracy: 0.8963
Epoch 369/500
469/469 [==============================] - 0s 725us/step - loss: 0.0192 - accuracy: 0.
8892 - val_loss: 0.0183 - val_accuracy: 0.8963
Epoch 370/500
469/469 [==============================] - 0s 718us/step - loss: 0.0193 - accuracy: 0.
8884 - val_loss: 0.0183 - val_accuracy: 0.8962
Epoch 371/500
469/469 [==============================] - 0s 733us/step - loss: 0.0191 - accuracy: 0.
8911 - val_loss: 0.0183 - val_accuracy: 0.8963
Epoch 372/500
469/469 [==============================] - 0s 694us/step - loss: 0.0194 - accuracy: 0.
8877 - val_loss: 0.0182 - val_accuracy: 0.8965
Epoch 373/500
469/469 [==============================] - 0s 699us/step - loss: 0.0189 - accuracy: 0.
8915 - val_loss: 0.0182 - val_accuracy: 0.8966
Epoch 374/500
469/469 [==============================] - 0s 726us/step - loss: 0.0192 - accuracy: 0.
8882 - val_loss: 0.0182 - val_accuracy: 0.8968
Epoch 375/500
469/469 [==============================] - 0s 728us/step - loss: 0.0192 - accuracy: 0.
8889 - val_loss: 0.0182 - val_accuracy: 0.8967
Epoch 376/500
469/469 [==============================] - 0s 726us/step - loss: 0.0189 - accuracy: 0.
8928 - val_loss: 0.0182 - val_accuracy: 0.8967
Epoch 377/500
469/469 [==============================] - 0s 721us/step - loss: 0.0190 - accuracy: 0.
8898 - val_loss: 0.0181 - val_accuracy: 0.8968
Epoch 378/500
469/469 [==============================] - 0s 720us/step - loss: 0.0191 - accuracy: 0.
8894 - val_loss: 0.0181 - val_accuracy: 0.8969
Epoch 379/500
469/469 [==============================] - 0s 733us/step - loss: 0.0188 - accuracy: 0.
8922 - val_loss: 0.0181 - val_accuracy: 0.8970
Epoch 380/500
469/469 [==============================] - 0s 735us/step - loss: 0.0189 - accuracy: 0.
8907 - val_loss: 0.0181 - val_accuracy: 0.8970
Epoch 381/500
469/469 [==============================] - 0s 710us/step - loss: 0.0192 - accuracy: 0.
8892 - val_loss: 0.0180 - val_accuracy: 0.8970
Epoch 382/500
469/469 [==============================] - 0s 750us/step - loss: 0.0187 - accuracy: 0.
8935 - val_loss: 0.0180 - val_accuracy: 0.8972
Epoch 383/500
469/469 [==============================] - 0s 688us/step - loss: 0.0187 - accuracy: 0.
8912 - val_loss: 0.0180 - val_accuracy: 0.8971
Epoch 384/500
469/469 [==============================] - 0s 733us/step - loss: 0.0187 - accuracy: 0.
8923 - val_loss: 0.0180 - val_accuracy: 0.8971
Epoch 385/500
469/469 [==============================] - 0s 731us/step - loss: 0.0190 - accuracy: 0.
8894 - val_loss: 0.0180 - val_accuracy: 0.8972
Epoch 386/500
469/469 [==============================] - 0s 729us/step - loss: 0.0187 - accuracy: 0.
8916 - val_loss: 0.0179 - val_accuracy: 0.8973
Epoch 387/500
469/469 [==============================] - 0s 720us/step - loss: 0.0187 - accuracy: 0.
8918 - val_loss: 0.0179 - val_accuracy: 0.8974
Epoch 388/500
469/469 [==============================] - 0s 733us/step - loss: 0.0191 - accuracy: 0.
8897 - val_loss: 0.0179 - val_accuracy: 0.8974
Epoch 389/500
469/469 [==============================] - 0s 698us/step - loss: 0.0186 - accuracy: 0.
8936 - val_loss: 0.0179 - val_accuracy: 0.8974
Epoch 390/500
469/469 [==============================] - 0s 741us/step - loss: 0.0187 - accuracy: 0.
8926 - val_loss: 0.0178 - val_accuracy: 0.8977
Epoch 391/500
469/469 [==============================] - 0s 731us/step - loss: 0.0188 - accuracy: 0.
8901 - val_loss: 0.0178 - val_accuracy: 0.8979
Epoch 392/500
469/469 [==============================] - 0s 714us/step - loss: 0.0188 - accuracy: 0.
8896 - val_loss: 0.0178 - val_accuracy: 0.8980
Epoch 393/500
469/469 [==============================] - 0s 701us/step - loss: 0.0186 - accuracy: 0.
8910 - val_loss: 0.0178 - val_accuracy: 0.8980
Epoch 394/500
469/469 [==============================] - 0s 733us/step - loss: 0.0186 - accuracy: 0.
8913 - val_loss: 0.0178 - val_accuracy: 0.8980
Epoch 395/500
469/469 [==============================] - 0s 722us/step - loss: 0.0186 - accuracy: 0.
8917 - val_loss: 0.0177 - val_accuracy: 0.8981
Epoch 396/500
469/469 [==============================] - 0s 701us/step - loss: 0.0185 - accuracy: 0.
8924 - val_loss: 0.0177 - val_accuracy: 0.8983
Epoch 397/500
469/469 [==============================] - 0s 703us/step - loss: 0.0185 - accuracy: 0.
8942 - val_loss: 0.0177 - val_accuracy: 0.8983
Epoch 398/500
469/469 [==============================] - 0s 737us/step - loss: 0.0186 - accuracy: 0.
8919 - val_loss: 0.0177 - val_accuracy: 0.8984
Epoch 399/500
469/469 [==============================] - 0s 720us/step - loss: 0.0183 - accuracy: 0.
8934 - val_loss: 0.0177 - val_accuracy: 0.8985
Epoch 400/500
469/469 [==============================] - 0s 722us/step - loss: 0.0185 - accuracy: 0.
8928 - val_loss: 0.0176 - val_accuracy: 0.8985
Epoch 401/500
469/469 [==============================] - 0s 695us/step - loss: 0.0185 - accuracy: 0.
8919 - val_loss: 0.0176 - val_accuracy: 0.8985
Epoch 402/500
469/469 [==============================] - 0s 687us/step - loss: 0.0184 - accuracy: 0.
8920 - val_loss: 0.0176 - val_accuracy: 0.8986
Epoch 403/500
469/469 [==============================] - 0s 735us/step - loss: 0.0183 - accuracy: 0.
8936 - val_loss: 0.0176 - val_accuracy: 0.8986
Epoch 404/500
469/469 [==============================] - 0s 727us/step - loss: 0.0185 - accuracy: 0.
8922 - val_loss: 0.0176 - val_accuracy: 0.8988
Epoch 405/500
469/469 [==============================] - 0s 722us/step - loss: 0.0186 - accuracy: 0.
8913 - val_loss: 0.0175 - val_accuracy: 0.8988
Epoch 406/500
469/469 [==============================] - 0s 710us/step - loss: 0.0185 - accuracy: 0.
8911 - val_loss: 0.0175 - val_accuracy: 0.8989
Epoch 407/500
469/469 [==============================] - 0s 725us/step - loss: 0.0184 - accuracy: 0.
8925 - val_loss: 0.0175 - val_accuracy: 0.8990
Epoch 408/500
469/469 [==============================] - 0s 708us/step - loss: 0.0184 - accuracy: 0.
8927 - val_loss: 0.0175 - val_accuracy: 0.8990
Epoch 409/500
469/469 [==============================] - 0s 727us/step - loss: 0.0183 - accuracy: 0.
8917 - val_loss: 0.0175 - val_accuracy: 0.8991
Epoch 410/500
469/469 [==============================] - 0s 721us/step - loss: 0.0182 - accuracy: 0.
8928 - val_loss: 0.0174 - val_accuracy: 0.8992
Epoch 411/500
469/469 [==============================] - 0s 721us/step - loss: 0.0182 - accuracy: 0.
8932 - val_loss: 0.0174 - val_accuracy: 0.8992
Epoch 412/500
469/469 [==============================] - 0s 729us/step - loss: 0.0185 - accuracy: 0.
8914 - val_loss: 0.0174 - val_accuracy: 0.8994
Epoch 413/500
469/469 [==============================] - 0s 692us/step - loss: 0.0183 - accuracy: 0.
8924 - val_loss: 0.0174 - val_accuracy: 0.8994
Epoch 414/500
469/469 [==============================] - 0s 686us/step - loss: 0.0180 - accuracy: 0.
8959 - val_loss: 0.0174 - val_accuracy: 0.8994
Epoch 415/500
469/469 [==============================] - 0s 691us/step - loss: 0.0182 - accuracy: 0.
8935 - val_loss: 0.0174 - val_accuracy: 0.8993
Epoch 416/500
469/469 [==============================] - 0s 708us/step - loss: 0.0182 - accuracy: 0.
8935 - val_loss: 0.0173 - val_accuracy: 0.8994
Epoch 417/500
469/469 [==============================] - 0s 703us/step - loss: 0.0183 - accuracy: 0.
8921 - val_loss: 0.0173 - val_accuracy: 0.8995
Epoch 418/500
469/469 [==============================] - 0s 688us/step - loss: 0.0181 - accuracy: 0.
8936 - val_loss: 0.0173 - val_accuracy: 0.8996
Epoch 419/500
469/469 [==============================] - 0s 684us/step - loss: 0.0184 - accuracy: 0.
8907 - val_loss: 0.0173 - val_accuracy: 0.8997
Epoch 420/500
469/469 [==============================] - 0s 697us/step - loss: 0.0181 - accuracy: 0.
8927 - val_loss: 0.0173 - val_accuracy: 0.8997
Epoch 421/500
469/469 [==============================] - 0s 693us/step - loss: 0.0183 - accuracy: 0.
8917 - val_loss: 0.0172 - val_accuracy: 0.8997
Epoch 422/500
469/469 [==============================] - 0s 680us/step - loss: 0.0181 - accuracy: 0.
8929 - val_loss: 0.0172 - val_accuracy: 0.8997
Epoch 423/500
469/469 [==============================] - 0s 718us/step - loss: 0.0183 - accuracy: 0.
8918 - val_loss: 0.0172 - val_accuracy: 0.8998
Epoch 424/500
469/469 [==============================] - 0s 688us/step - loss: 0.0180 - accuracy: 0.
8949 - val_loss: 0.0172 - val_accuracy: 0.9000
Epoch 425/500
469/469 [==============================] - 0s 702us/step - loss: 0.0181 - accuracy: 0.
8924 - val_loss: 0.0172 - val_accuracy: 0.9001
Epoch 426/500
469/469 [==============================] - 0s 693us/step - loss: 0.0180 - accuracy: 0.
8942 - val_loss: 0.0172 - val_accuracy: 0.9001
Epoch 427/500
469/469 [==============================] - 0s 688us/step - loss: 0.0180 - accuracy: 0.
8936 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 428/500
469/469 [==============================] - 0s 690us/step - loss: 0.0180 - accuracy: 0.
8936 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 429/500
469/469 [==============================] - 0s 691us/step - loss: 0.0182 - accuracy: 0.
8918 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 430/500
469/469 [==============================] - 0s 688us/step - loss: 0.0178 - accuracy: 0.
8965 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 431/500
469/469 [==============================] - 0s 684us/step - loss: 0.0180 - accuracy: 0.
8945 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 432/500
469/469 [==============================] - 0s 733us/step - loss: 0.0180 - accuracy: 0.
8929 - val_loss: 0.0171 - val_accuracy: 0.9002
Epoch 433/500
469/469 [==============================] - 0s 731us/step - loss: 0.0180 - accuracy: 0.
8953 - val_loss: 0.0170 - val_accuracy: 0.9003
Epoch 434/500
469/469 [==============================] - 0s 720us/step - loss: 0.0181 - accuracy: 0.
8928 - val_loss: 0.0170 - val_accuracy: 0.9003
Epoch 435/500
469/469 [==============================] - 0s 694us/step - loss: 0.0179 - accuracy: 0.
8946 - val_loss: 0.0170 - val_accuracy: 0.9003
Epoch 436/500
469/469 [==============================] - 0s 684us/step - loss: 0.0178 - accuracy: 0.
8957 - val_loss: 0.0170 - val_accuracy: 0.9004
Epoch 437/500
469/469 [==============================] - 0s 694us/step - loss: 0.0177 - accuracy: 0.
8964 - val_loss: 0.0170 - val_accuracy: 0.9004
Epoch 438/500
469/469 [==============================] - 0s 689us/step - loss: 0.0179 - accuracy: 0.
8945 - val_loss: 0.0170 - val_accuracy: 0.9004
Epoch 439/500
469/469 [==============================] - 0s 685us/step - loss: 0.0177 - accuracy: 0.
8963 - val_loss: 0.0169 - val_accuracy: 0.9004
Epoch 440/500
469/469 [==============================] - 0s 682us/step - loss: 0.0179 - accuracy: 0.
8948 - val_loss: 0.0169 - val_accuracy: 0.9006
Epoch 441/500
469/469 [==============================] - 0s 689us/step - loss: 0.0178 - accuracy: 0.
8957 - val_loss: 0.0169 - val_accuracy: 0.9006
Epoch 442/500
469/469 [==============================] - 0s 686us/step - loss: 0.0180 - accuracy: 0.
8941 - val_loss: 0.0169 - val_accuracy: 0.9006
Epoch 443/500
469/469 [==============================] - 0s 698us/step - loss: 0.0177 - accuracy: 0.
8973 - val_loss: 0.0169 - val_accuracy: 0.9006
Epoch 444/500
469/469 [==============================] - 0s 688us/step - loss: 0.0178 - accuracy: 0.
8961 - val_loss: 0.0169 - val_accuracy: 0.9006
Epoch 445/500
469/469 [==============================] - 0s 680us/step - loss: 0.0178 - accuracy: 0.
8941 - val_loss: 0.0168 - val_accuracy: 0.9007
Epoch 446/500
469/469 [==============================] - 0s 693us/step - loss: 0.0177 - accuracy: 0.
8957 - val_loss: 0.0168 - val_accuracy: 0.9008
Epoch 447/500
469/469 [==============================] - 0s 695us/step - loss: 0.0176 - accuracy: 0.
8960 - val_loss: 0.0168 - val_accuracy: 0.9008
Epoch 448/500
469/469 [==============================] - 0s 688us/step - loss: 0.0178 - accuracy: 0.
8950 - val_loss: 0.0168 - val_accuracy: 0.9009
Epoch 449/500
469/469 [==============================] - 0s 685us/step - loss: 0.0177 - accuracy: 0.
8951 - val_loss: 0.0168 - val_accuracy: 0.9009
Epoch 450/500
469/469 [==============================] - 0s 676us/step - loss: 0.0176 - accuracy: 0.
8959 - val_loss: 0.0168 - val_accuracy: 0.9011
Epoch 451/500
469/469 [==============================] - 0s 691us/step - loss: 0.0178 - accuracy: 0.
8943 - val_loss: 0.0168 - val_accuracy: 0.9011
Epoch 452/500
469/469 [==============================] - 0s 690us/step - loss: 0.0175 - accuracy: 0.
8958 - val_loss: 0.0167 - val_accuracy: 0.9012
Epoch 453/500
469/469 [==============================] - 0s 690us/step - loss: 0.0176 - accuracy: 0.
8959 - val_loss: 0.0167 - val_accuracy: 0.9015
Epoch 454/500
469/469 [==============================] - 0s 688us/step - loss: 0.0177 - accuracy: 0.
8956 - val_loss: 0.0167 - val_accuracy: 0.9016
Epoch 455/500
469/469 [==============================] - 0s 695us/step - loss: 0.0174 - accuracy: 0.
8977 - val_loss: 0.0167 - val_accuracy: 0.9016
Epoch 456/500
469/469 [==============================] - 0s 686us/step - loss: 0.0178 - accuracy: 0.
8943 - val_loss: 0.0167 - val_accuracy: 0.9016
Epoch 457/500
469/469 [==============================] - 0s 676us/step - loss: 0.0175 - accuracy: 0.
8962 - val_loss: 0.0167 - val_accuracy: 0.9016
Epoch 458/500
469/469 [==============================] - 0s 688us/step - loss: 0.0175 - accuracy: 0.
8965 - val_loss: 0.0167 - val_accuracy: 0.9016
Epoch 459/500
469/469 [==============================] - 0s 690us/step - loss: 0.0174 - accuracy: 0.
8965 - val_loss: 0.0166 - val_accuracy: 0.9017
Epoch 460/500
469/469 [==============================] - 0s 688us/step - loss: 0.0172 - accuracy: 0.
8981 - val_loss: 0.0166 - val_accuracy: 0.9018
Epoch 461/500
469/469 [==============================] - 0s 698us/step - loss: 0.0176 - accuracy: 0.
8958 - val_loss: 0.0166 - val_accuracy: 0.9018
Epoch 462/500
469/469 [==============================] - 0s 686us/step - loss: 0.0175 - accuracy: 0.
8961 - val_loss: 0.0166 - val_accuracy: 0.9018
Epoch 463/500
469/469 [==============================] - 0s 683us/step - loss: 0.0172 - accuracy: 0.
8979 - val_loss: 0.0166 - val_accuracy: 0.9018
Epoch 464/500
469/469 [==============================] - 0s 684us/step - loss: 0.0175 - accuracy: 0.
8965 - val_loss: 0.0166 - val_accuracy: 0.9018
Epoch 465/500
469/469 [==============================] - 0s 678us/step - loss: 0.0173 - accuracy: 0.
8981 - val_loss: 0.0165 - val_accuracy: 0.9019
Epoch 466/500
469/469 [==============================] - 0s 697us/step - loss: 0.0174 - accuracy: 0.
8969 - val_loss: 0.0165 - val_accuracy: 0.9019
Epoch 467/500
469/469 [==============================] - 0s 688us/step - loss: 0.0173 - accuracy: 0.
8975 - val_loss: 0.0165 - val_accuracy: 0.9019
Epoch 468/500
469/469 [==============================] - 0s 689us/step - loss: 0.0174 - accuracy: 0.
8965 - val_loss: 0.0165 - val_accuracy: 0.9018
Epoch 469/500
469/469 [==============================] - 0s 686us/step - loss: 0.0172 - accuracy: 0.
8971 - val_loss: 0.0165 - val_accuracy: 0.9021
Epoch 470/500
469/469 [==============================] - 0s 695us/step - loss: 0.0172 - accuracy: 0.
8987 - val_loss: 0.0165 - val_accuracy: 0.9022
Epoch 471/500
469/469 [==============================] - 0s 701us/step - loss: 0.0175 - accuracy: 0.
8964 - val_loss: 0.0165 - val_accuracy: 0.9021
Epoch 472/500
469/469 [==============================] - 0s 693us/step - loss: 0.0174 - accuracy: 0.
8965 - val_loss: 0.0165 - val_accuracy: 0.9023
Epoch 473/500
469/469 [==============================] - 0s 694us/step - loss: 0.0172 - accuracy: 0.
8975 - val_loss: 0.0164 - val_accuracy: 0.9023
Epoch 474/500
469/469 [==============================] - 0s 688us/step - loss: 0.0172 - accuracy: 0.
8975 - val_loss: 0.0164 - val_accuracy: 0.9022
Epoch 475/500
469/469 [==============================] - 0s 684us/step - loss: 0.0172 - accuracy: 0.
8976 - val_loss: 0.0164 - val_accuracy: 0.9023
Epoch 476/500
469/469 [==============================] - 0s 688us/step - loss: 0.0172 - accuracy: 0.
8981 - val_loss: 0.0164 - val_accuracy: 0.9023
Epoch 477/500
469/469 [==============================] - 0s 678us/step - loss: 0.0171 - accuracy: 0.
8995 - val_loss: 0.0164 - val_accuracy: 0.9026
Epoch 478/500
469/469 [==============================] - 0s 685us/step - loss: 0.0173 - accuracy: 0.
8961 - val_loss: 0.0164 - val_accuracy: 0.9027
Epoch 479/500
469/469 [==============================] - 0s 684us/step - loss: 0.0169 - accuracy: 0.
8995 - val_loss: 0.0164 - val_accuracy: 0.9029
Epoch 480/500
469/469 [==============================] - 0s 680us/step - loss: 0.0172 - accuracy: 0.
8976 - val_loss: 0.0163 - val_accuracy: 0.9029
Epoch 481/500
469/469 [==============================] - 0s 686us/step - loss: 0.0171 - accuracy: 0.
8990 - val_loss: 0.0163 - val_accuracy: 0.9029
Epoch 482/500
469/469 [==============================] - 0s 691us/step - loss: 0.0173 - accuracy: 0.
8969 - val_loss: 0.0163 - val_accuracy: 0.9031
Epoch 483/500
469/469 [==============================] - 0s 688us/step - loss: 0.0171 - accuracy: 0.
8985 - val_loss: 0.0163 - val_accuracy: 0.9032
Epoch 484/500
469/469 [==============================] - 0s 685us/step - loss: 0.0170 - accuracy: 0.
8987 - val_loss: 0.0163 - val_accuracy: 0.9031
Epoch 485/500
469/469 [==============================] - 0s 678us/step - loss: 0.0171 - accuracy: 0.
8976 - val_loss: 0.0163 - val_accuracy: 0.9032
Epoch 486/500
469/469 [==============================] - 0s 680us/step - loss: 0.0173 - accuracy: 0.
8963 - val_loss: 0.0163 - val_accuracy: 0.9032
Epoch 487/500
469/469 [==============================] - 0s 684us/step - loss: 0.0171 - accuracy: 0.
8977 - val_loss: 0.0162 - val_accuracy: 0.9032
Epoch 488/500
469/469 [==============================] - 0s 686us/step - loss: 0.0171 - accuracy: 0.
8973 - val_loss: 0.0162 - val_accuracy: 0.9033
Epoch 489/500
469/469 [==============================] - 0s 694us/step - loss: 0.0173 - accuracy: 0.
8966 - val_loss: 0.0162 - val_accuracy: 0.9033
Epoch 490/500
469/469 [==============================] - 0s 696us/step - loss: 0.0171 - accuracy: 0.
8982 - val_loss: 0.0162 - val_accuracy: 0.9033
Epoch 491/500
469/469 [==============================] - 0s 695us/step - loss: 0.0170 - accuracy: 0.
9001 - val_loss: 0.0162 - val_accuracy: 0.9033
Epoch 492/500
469/469 [==============================] - 0s 688us/step - loss: 0.0170 - accuracy: 0.
8992 - val_loss: 0.0162 - val_accuracy: 0.9034
Epoch 493/500
469/469 [==============================] - 0s 695us/step - loss: 0.0170 - accuracy: 0.
8983 - val_loss: 0.0162 - val_accuracy: 0.9036
Epoch 494/500
469/469 [==============================] - 0s 690us/step - loss: 0.0169 - accuracy: 0.
8993 - val_loss: 0.0162 - val_accuracy: 0.9036
Epoch 495/500
469/469 [==============================] - 0s 690us/step - loss: 0.0170 - accuracy: 0.
8988 - val_loss: 0.0161 - val_accuracy: 0.9036
Epoch 496/500
469/469 [==============================] - 0s 682us/step - loss: 0.0171 - accuracy: 0.
8972 - val_loss: 0.0161 - val_accuracy: 0.9036
Epoch 497/500
469/469 [==============================] - 0s 690us/step - loss: 0.0170 - accuracy: 0.
8985 - val_loss: 0.0161 - val_accuracy: 0.9039
Epoch 498/500
469/469 [==============================] - 0s 686us/step - loss: 0.0170 - accuracy: 0.
8991 - val_loss: 0.0161 - val_accuracy: 0.9039
Epoch 499/500
469/469 [==============================] - 0s 690us/step - loss: 0.0170 - accuracy: 0.
8984 - val_loss: 0.0161 - val_accuracy: 0.9039
Epoch 500/500
469/469 [==============================] - 0s 693us/step - loss: 0.0166 - accuracy: 0.
9005 - val_loss: 0.0161 - val_accuracy: 0.9040
```

In [101…

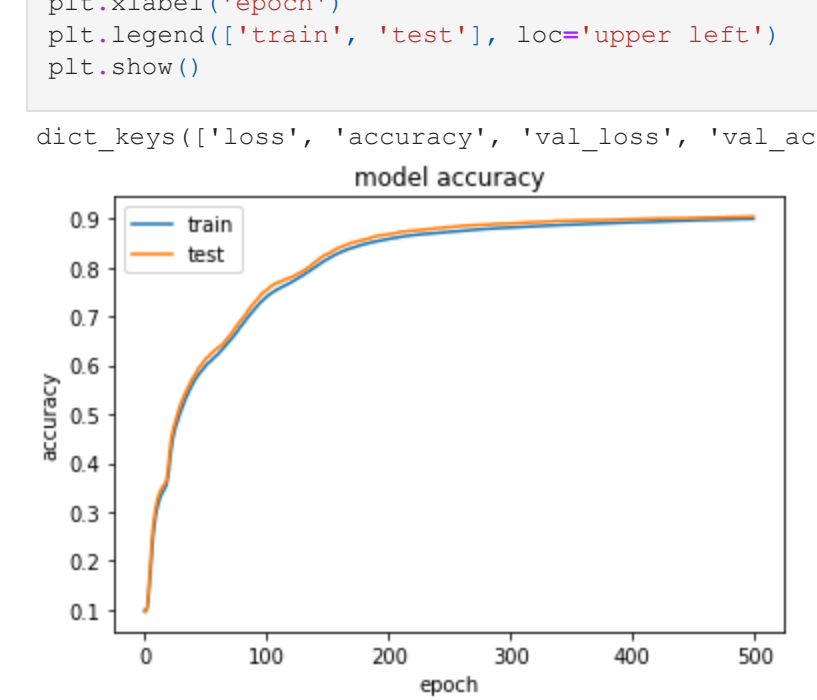
```python
# list all data in history
print(history.history.keys())

# summarize history for accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()

# summarize history for loss
```

```python
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```



QUESTION 3: Does the model show any indication of overfitting? Why (not)?

QUESTION 4: How do the accuracy and loss compare to the previous model?What can you infer from this comparison?

When we look at the graphs generated above the model converges because the loss lines form a horzontal line after the epoch is greater than 300. There is no overfitting in the model because if you look at nth validation set it is not different from the behavior of the model with the training dataa set. I can clearly infer the model does handle generalization very well and above graphs validates that.

Evaluate the model

In [102…

```python
model.evaluate(X_validation, y_validation)
```

```
313/313 [==============================] - 0s 396us/step - loss: 0.0161 - accuracy: 0.
9040
```

Out[102… [0.016085464507341385, 0.9039999842643738]

TODO 3

Write code to display the confusion matrix for your classifier and comment on the insights such confusion matrix provides.

See this for an example.

In [103…

```python
import warnings
warnings.filterwarnings("ignore")
def conMatrix():
    plt.figure(figsize=(20,10))
    sns.heatmap(confusion_matrix(y_valid, model.predict_classes(X_validation)) ,
                cmap=sns.color_palette("pastel", as_cmap=True),
               annot=True, fmt="d")
    plt.title("Conf Matrix")
    plt.show()
conMatrix()
```

In [104…

```python
mod =  model.predict_classes(X_validation)
report = classification_report(y_valid, mod)
print(report)
```

```
              precision    recall  f1-score   support

           0       0.92      0.98      0.95       980
           1       0.95      0.97      0.96      1135
           2       0.91      0.87      0.89      1032
           3       0.90      0.89      0.90      1010
           4       0.89      0.93      0.91       982
           5       0.88      0.81      0.84       892
           6       0.91      0.93      0.92       958
           7       0.92      0.90      0.91      1028
           8       0.86      0.87      0.87       974
           9       0.89      0.88      0.89      1009

    accuracy                           0.90     10000
   macro avg       0.90      0.90      0.90     10000
weighted avg       0.90      0.90      0.90     10000
```

Question 3

The confusion matrix can give us performance metrics of the model some metrics are like accuracy score and over all error. If we look at index 0 on first column you can see the model is doing well. You can see forom 980 samples that have 0 label 956 were done callsification right. If you look at index 5 you can see support for 892 and 738 classified correctly which is weaker. Index 5 has more issues on correct classfication

(OPTIONAL) TODO 4

Write code to display 10 cases where the classifier makes mistakes. Make sure to display both the true value as well as the predicted value.

See this for an example.

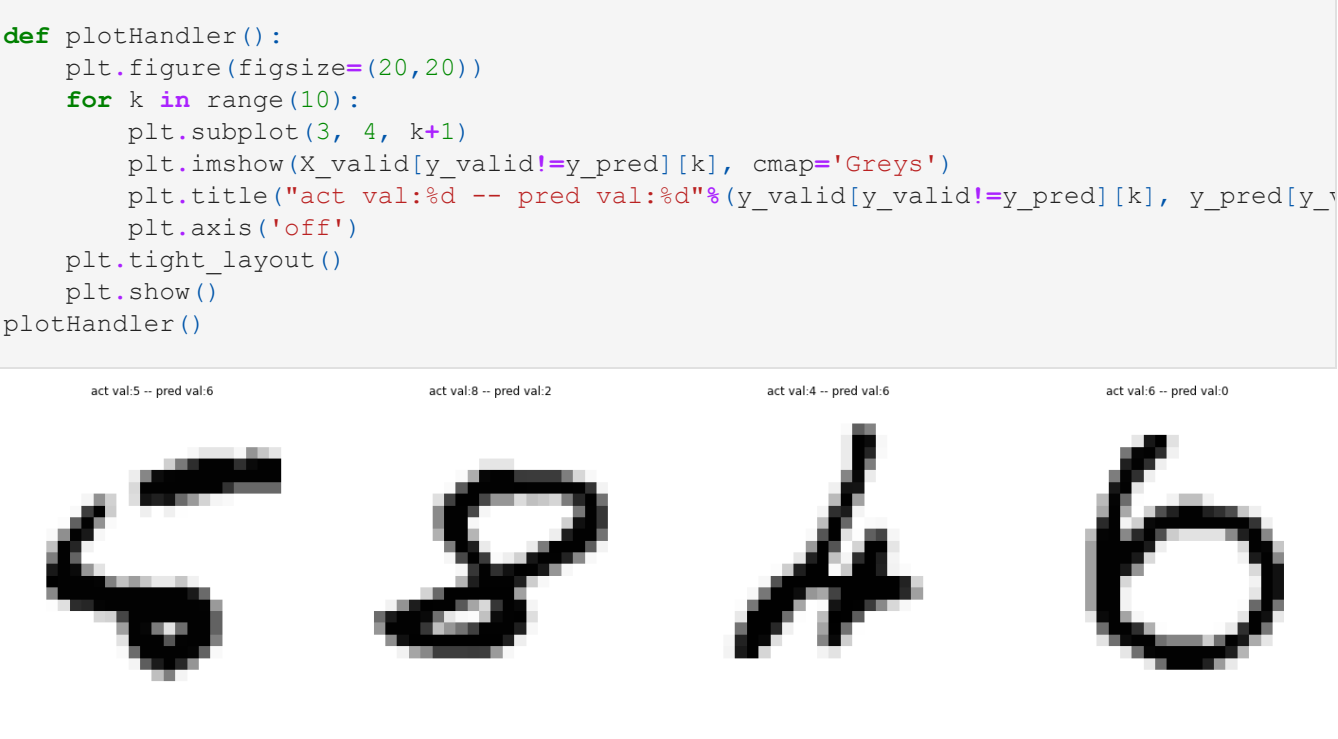
In [105…

```python
y_pred = model.predict_classes(X_validation)
print(y_pred)
```

```
[7 2 1 ... 4 8 6]
```

In [106…

```python
def plotHandler():
    plt.figure(figsize=(20,20))
    for k in range(10):
        plt.subplot(3, 4, k+1)
        plt.imshow(X_valid[y_valid!=y_pred][k], cmap='Greys')
        plt.title("act val:%d -- pred val:%d"%(y_valid[y_valid!=y_pred][k], y_pred[y_v
        plt.axis('off')
    plt.tight_layout()
    plt.show()
plotHandler()
```



Different optimizer Adam (OPTIONAL Questions)

In [107…

```python
batch_size=128
epochs=1000

model.compile(
    loss='mean_squared_error',
    optimizer="adam",
    metrics=['accuracy']
)

history = model.fit(
  X_training, # training data
  y_training, # training targets
  epochs=epochs,# number of passes of the entire training datase
  batch_size=batch_size, # number of samples processed before the model is updated
  verbose=1,
  validation_data=(X_validation, y_validation)
)
```

```
Epoch 1/1000
469/469 [==============================] - 1s 2ms/step - loss: 0.0151 - accuracy: 0.90
79 - val_loss: 0.0113 - val_accuracy: 0.9303
Epoch 2/1000
469/469 [==============================] - 0s 767us/step - loss: 0.0109 - accuracy: 0.
9333 - val_loss: 0.0097 - val_accuracy: 0.9386
Epoch 3/1000
469/469 [==============================] - 0s 780us/step - loss: 0.0094 - accuracy: 0.
9414 - val_loss: 0.0085 - val_accuracy: 0.9478
Epoch 4/1000
469/469 [==============================] - 0s 774us/step - loss: 0.0084 - accuracy: 0.
9483 - val_loss: 0.0079 - val_accuracy: 0.9512
Epoch 5/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0074 - accuracy: 0.
9553 - val_loss: 0.0072 - val_accuracy: 0.9550
Epoch 6/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0067 - accuracy: 0.
9594 - val_loss: 0.0067 - val_accuracy: 0.9564
Epoch 7/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0062 - accuracy: 0.
9627 - val_loss: 0.0064 - val_accuracy: 0.9592
Epoch 8/1000
469/469 [==============================] - 0s 857us/step - loss: 0.0056 - accuracy: 0.
9665 - val_loss: 0.0061 - val_accuracy: 0.9614
Epoch 9/1000
469/469 [==============================] - 0s 833us/step - loss: 0.0054 - accuracy: 0.
9681 - val_loss: 0.0059 - val_accuracy: 0.9615
Epoch 10/1000
469/469 [==============================] - 0s 786us/step - loss: 0.0048 - accuracy: 0.
9717 - val_loss: 0.0056 - val_accuracy: 0.9648
Epoch 11/1000
469/469 [==============================] - 0s 823us/step - loss: 0.0045 - accuracy: 0.
9736 - val_loss: 0.0055 - val_accuracy: 0.9643
Epoch 12/1000
469/469 [==============================] - 0s 774us/step - loss: 0.0042 - accuracy: 0.
9770 - val_loss: 0.0053 - val_accuracy: 0.9665
Epoch 13/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0039 - accuracy: 0.
9784 - val_loss: 0.0051 - val_accuracy: 0.9660
Epoch 14/1000
469/469 [==============================] - 0s 778us/step - loss: 0.0038 - accuracy: 0.
9790 - val_loss: 0.0050 - val_accuracy: 0.9669
Epoch 15/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0036 - accuracy: 0.
9803 - val_loss: 0.0049 - val_accuracy: 0.9685
Epoch 16/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0033 - accuracy: 0.
9830 - val_loss: 0.0048 - val_accuracy: 0.9687
Epoch 17/1000
469/469 [==============================] - 0s 780us/step - loss: 0.0032 - accuracy: 0.
9831 - val_loss: 0.0046 - val_accuracy: 0.9695
Epoch 18/1000
469/469 [==============================] - 0s 774us/step - loss: 0.0030 - accuracy: 0.
9843 - val_loss: 0.0046 - val_accuracy: 0.9699
Epoch 19/1000
469/469 [==============================] - 0s 780us/step - loss: 0.0028 - accuracy: 0.
9857 - val_loss: 0.0045 - val_accuracy: 0.9699
Epoch 20/1000
469/469 [==============================] - 0s 767us/step - loss: 0.0027 - accuracy: 0.
9860 - val_loss: 0.0045 - val_accuracy: 0.9703
Epoch 21/1000
469/469 [==============================] - 0s 776us/step - loss: 0.0027 - accuracy: 0.
9865 - val_loss: 0.0044 - val_accuracy: 0.9709
Epoch 22/1000
469/469 [==============================] - 0s 774us/step - loss: 0.0025 - accuracy: 0.
9876 - val_loss: 0.0044 - val_accuracy: 0.9702
Epoch 23/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0022 - accuracy: 0.
9888 - val_loss: 0.0043 - val_accuracy: 0.9710
Epoch 24/1000
469/469 [==============================] - 0s 788us/step - loss: 0.0023 - accuracy: 0.
9889 - val_loss: 0.0042 - val_accuracy: 0.9719
Epoch 25/1000
469/469 [==============================] - 0s 782us/step - loss: 0.0021 - accuracy: 0.
9895 - val_loss: 0.0042 - val_accuracy: 0.9712
Epoch 26/1000
469/469 [==============================] - 0s 776us/step - loss: 0.0020 - accuracy: 0.
9904 - val_loss: 0.0042 - val_accuracy: 0.9721
Epoch 27/1000
469/469 [==============================] - 0s 782us/step - loss: 0.0020 - accuracy: 0.
9904 - val_loss: 0.0043 - val_accuracy: 0.9722
Epoch 28/1000
469/469 [==============================] - 0s 776us/step - loss: 0.0018 - accuracy: 0.
9917 - val_loss: 0.0041 - val_accuracy: 0.9733
Epoch 29/1000
469/469 [==============================] - 0s 769us/step - loss: 0.0019 - accuracy: 0.
9908 - val_loss: 0.0041 - val_accuracy: 0.9732
Epoch 30/1000
469/469 [==============================] - 0s 784us/step - loss: 0.0017 - accuracy: 0.
9919 - val_loss: 0.0040 - val_accuracy: 0.9733
Epoch 31/1000
469/469 [==============================] - 0s 810us/step - loss: 0.0016 - accuracy: 0.
9922 - val_loss: 0.0042 - val_accuracy: 0.9720
Epoch 32/1000
469/469 [==============================] - 0s 774us/step - loss: 0.0015 - accuracy: 0.
9933 - val_loss: 0.0040 - val_accuracy: 0.9739
Epoch 33/1000
469/469 [==============================] - 0s 782us/step - loss: 0.0015 - accuracy: 0.
9926 - val_loss: 0.0040 - val_accuracy: 0.9747
Epoch 34/1000
469/469 [==============================] - 0s 782us/step - loss: 0.0015 - accuracy: 0.
9927 - val_loss: 0.0041 - val_accuracy: 0.9733
Epoch 35/1000
469/469 [==============================] - 0s 776us/step - loss: 0.0014 - accuracy: 0.
9937 - val_loss: 0.0040 - val_accuracy: 0.9732
Epoch 36/1000
469/469 [==============================] - 0s 778us/step - loss: 0.0013 - accuracy: 0.
9942 - val_loss: 0.0040 - val_accuracy: 0.9737
Epoch 37/1000
469/469 [==============================] - 0s 786us/step - loss: 0.0012 - accuracy: 0.
9946 - val_loss: 0.0041 - val_accuracy: 0.9734
Epoch 38/1000
469/469 [==============================] - 0s 776us/step - loss: 0.0013 - accuracy: 0.
9943 - val_loss: 0.0039 - val_accuracy: 0.9742
Epoch 39/1000
469/469 [==============================] - 0s 778us/step - loss: 0.0011 - accuracy: 0.
9954 - val_loss: 0.0039 - val_accuracy: 0.9747
Epoch 40/1000
469/469 [==============================] - 0s 782us/step - loss: 0.0010 - accuracy: 0.
9953 - val_loss: 0.0040 - val_accuracy: 0.9744
Epoch 41/1000
469/469 [==============================] - 0s 780us/step - loss: 0.0011 - accuracy: 0.
9950 - val_loss: 0.0039 - val_accuracy: 0.9738
Epoch 42/1000
469/469 [==============================] - 0s 786us/step - loss: 9.9034e-04 - accurac
y: 0.9956 - val_loss: 0.0039 - val_accuracy: 0.9754
Epoch 43/1000
469/469 [==============================] - 0s 771us/step - loss: 0.0010 - accuracy: 0.
9953 - val_loss: 0.0039 - val_accuracy: 0.9744
Epoch 44/1000
469/469 [==============================] - 0s 784us/step - loss: 9.2919e-04 - accurac
y: 0.9959 - val_loss: 0.0039 - val_accuracy: 0.9754
Epoch 45/1000
469/469 [==============================] - 0s 786us/step - loss: 8.8987e-04 - accurac
y: 0.9962 - val_loss: 0.0040 - val_accuracy: 0.9742
Epoch 46/1000
469/469 [==============================] - 0s 775us/step - loss: 7.8896e-04 - accurac
y: 0.9965 - val_loss: 0.0039 - val_accuracy: 0.9733
Epoch 47/1000
469/469 [==============================] - 0s 791us/step - loss: 7.9624e-04 - accurac
y: 0.9965 - val_loss: 0.0040 - val_accuracy: 0.9739
Epoch 48/1000
469/469 [==============================] - 0s 774us/step - loss: 8.0867e-04 - accurac
y: 0.9962 - val_loss: 0.0039 - val_accuracy: 0.9744
Epoch 49/1000
469/469 [==============================] - 0s 780us/step - loss: 7.8318e-04 - accurac
y: 0.9964 - val_loss: 0.0039 - val_accuracy: 0.9754
Epoch 50/1000
469/469 [==============================] - 0s 774us/step - loss: 7.1224e-04 - accurac
y: 0.9968 - val_loss: 0.0040 - val_accuracy: 0.9741
Epoch 51/1000
469/469 [==============================] - 0s 771us/step - loss: 7.1810e-04 - accurac
y: 0.9966 - val_loss: 0.0039 - val_accuracy: 0.9741
Epoch 52/1000
469/469 [==============================] - 0s 780us/step - loss: 7.0067e-04 - accurac
y: 0.9967 - val_loss: 0.0039 - val_accuracy: 0.9745
Epoch 53/1000
469/469 [==============================] - 0s 774us/step - loss: 6.0818e-04 - accurac
y: 0.9971 - val_loss: 0.0039 - val_accuracy: 0.9740
Epoch 54/1000
469/469 [==============================] - 0s 776us/step - loss: 6.1936e-04 - accurac
y: 0.9969 - val_loss: 0.0040 - val_accuracy: 0.9736
Epoch 55/1000
469/469 [==============================] - 0s 791us/step - loss: 5.8386e-04 - accurac
y: 0.9972 - val_loss: 0.0040 - val_accuracy: 0.9736
Epoch 56/1000
469/469 [==============================] - 0s 778us/step - loss: 6.1068e-04 - accurac
y: 0.9971 - val_loss: 0.0040 - val_accuracy: 0.9738
Epoch 57/1000
469/469 [==============================] - 0s 780us/step - loss: 5.9033e-04 - accurac
y: 0.9971 - val_loss: 0.0039 - val_accuracy: 0.9750
Epoch 58/1000
469/469 [==============================] - 0s 784us/step - loss: 5.1268e-04 - accurac
y: 0.9975 - val_loss: 0.0040 - val_accuracy: 0.9735
Epoch 59/1000
469/469 [==============================] - 0s 774us/step - loss: 4.6468e-04 - accurac
y: 0.9977 - val_loss: 0.0039 - val_accuracy: 0.9753
Epoch 60/1000
469/469 [==============================] - 0s 782us/step - loss: 5.0132e-04 - accurac
y: 0.9975 - val_loss: 0.0039 - val_accuracy: 0.9742
Epoch 61/1000
469/469 [==============================] - 0s 780us/step - loss: 5.0743e-04 - accurac
y: 0.9974 - val_loss: 0.0039 - val_accuracy: 0.9749
Epoch 62/1000
469/469 [==============================] - 0s 771us/step - loss: 4.7425e-04 - accurac
y: 0.9976 - val_loss: 0.0039 - val_accuracy: 0.9741
Epoch 63/1000
469/469 [==============================] - 0s 784us/step - loss: 4.2310e-04 - accurac
y: 0.9978 - val_loss: 0.0039 - val_accuracy: 0.9744
Epoch 64/1000
469/469 [==============================] - 0s 774us/step - loss: 4.8103e-04 - accurac
y: 0.9976 - val_loss: 0.0040 - val_accuracy: 0.9743
Epoch 65/1000
469/469 [==============================] - 0s 771us/step - loss: 4.3983e-04 - accurac
y: 0.9977 - val_loss: 0.0040 - val_accuracy: 0.9737
Epoch 66/1000
469/469 [==============================] - 0s 780us/step - loss: 4.3095e-04 - accurac
y: 0.9977 - val_loss: 0.0039 - val_accuracy: 0.9746
Epoch 67/1000
469/469 [==============================] - 0s 776us/step - loss: 3.8146e-04 - accurac
y: 0.9981 - val_loss: 0.0040 - val_accuracy: 0.9740
Epoch 68/1000
469/469 [==============================] - 0s 780us/step - loss: 3.7742e-04 - accurac
y: 0.9980 - val_loss: 0.0039 - val_accuracy: 0.9746
Epoch 69/1000
469/469 [==============================] - 0s 778us/step - loss: 4.1203e-04 - accurac
y: 0.9978 - val_loss: 0.0040 - val_accuracy: 0.9738
Epoch 70/1000
469/469 [==============================] - 0s 781us/step - loss: 3.7296e-04 - accurac
y: 0.9980 - val_loss: 0.0040 - val_accuracy: 0.9739
Epoch 71/1000
469/469 [==============================] - 0s 780us/step - loss: 3.4064e-04 - accurac
y: 0.9982 - val_loss: 0.0040 - val_accuracy: 0.9741
Epoch 72/1000
469/469 [==============================] - 0s 771us/step - loss: 3.4040e-04 - accurac
y: 0.9983 - val_loss: 0.0040 - val_accuracy: 0.9736
Epoch 73/1000
469/469 [==============================] - 0s 778us/step - loss: 4.0128e-04 - accurac
y: 0.9980 - val_loss: 0.0040 - val_accuracy: 0.9740
Epoch 74/1000
469/469 [==============================] - 0s 778us/step - loss: 3.0979e-04 - accurac
y: 0.9984 - val_loss: 0.0040 - val_accuracy: 0.9742
Epoch 75/1000
469/469 [==============================] - 0s 786us/step - loss: 3.1322e-04 - accurac
y: 0.9983 - val_loss: 0.0041 - val_accuracy: 0.9736
Epoch 76/1000
469/469 [==============================] - 0s 788us/step - loss: 2.9563e-04 - accurac
y: 0.9984 - val_loss: 0.0040 - val_accuracy: 0.9735
Epoch 77/1000
469/469 [==============================] - 0s 784us/step - loss: 3.1157e-04 - accurac
y: 0.9982 - val_loss: 0.0041 - val_accuracy: 0.9737
Epoch 78/1000
469/469 [==============================] - 0s 781us/step - loss: 3.2363e-04 - accurac
y: 0.9983 - val_loss: 0.0042 - val_accuracy: 0.9731
Epoch 79/1000
469/469 [==============================] - 0s 778us/step - loss: 3.0595e-04 - accurac
y: 0.9984 - val_loss: 0.0041 - val_accuracy: 0.9735
Epoch 80/1000
469/469 [==============================] - 0s 776us/step - loss: 2.6085e-04 - accurac
y: 0.9986 - val_loss: 0.0040 - val_accuracy: 0.9740
Epoch 81/1000
469/469 [==============================] - 0s 778us/step - loss: 3.0001e-04 - accurac
y: 0.9983 - val_loss: 0.0042 - val_accuracy: 0.9727
Epoch 82/1000
469/469 [==============================] - 0s 791us/step - loss: 2.8228e-04 - accurac
y: 0.9984 - val_loss: 0.0042 - val_accuracy: 0.9729
Epoch 83/1000
469/469 [==============================] - 0s 769us/step - loss: 2.8482e-04 - accurac
y: 0.9985 - val_loss: 0.0041 - val_accuracy: 0.9734
Epoch 84/1000
469/469 [==============================] - 0s 774us/step - loss: 3.1908e-04 - accurac
y: 0.9982 - val_loss: 0.0041 - val_accuracy: 0.9727
Epoch 85/1000
469/469 [==============================] - 0s 776us/step - loss: 2.6626e-04 - accurac
y: 0.9986 - val_loss: 0.0040 - val_accuracy: 0.9737
Epoch 86/1000
469/469 [==============================] - 0s 779us/step - loss: 2.5504e-04 - accurac
y: 0.9986 - val_loss: 0.0041 - val_accuracy: 0.9739
Epoch 87/1000
469/469 [==============================] - 0s 776us/step - loss: 2.7332e-04 - accurac
y: 0.9985 - val_loss: 0.0040 - val_accuracy: 0.9745
Epoch 88/1000
469/469 [==============================] - 0s 780us/step - loss: 2.4666e-04 - accurac
y: 0.9986 - val_loss: 0.0040 - val_accuracy: 0.9738
Epoch 89/1000
469/469 [==============================] - 0s 774us/step - loss: 2.3777e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 90/1000
469/469 [==============================] - 0s 782us/step - loss: 2.8704e-04 - accurac
y: 0.9984 - val_loss: 0.0041 - val_accuracy: 0.9732
Epoch 91/1000
469/469 [==============================] - 0s 778us/step - loss: 2.5268e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 92/1000
469/469 [==============================] - 0s 774us/step - loss: 2.3961e-04 - accurac
y: 0.9987 - val_loss: 0.0041 - val_accuracy: 0.9737
Epoch 93/1000
469/469 [==============================] - 0s 778us/step - loss: 2.4391e-04 - accurac
y: 0.9986 - val_loss: 0.0041 - val_accuracy: 0.9736
Epoch 94/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0578e-04 - accurac
y: 0.9988 - val_loss: 0.0041 - val_accuracy: 0.9735
Epoch 95/1000
469/469 [==============================] - 0s 771us/step - loss: 2.9901e-04 - accurac
y: 0.9983 - val_loss: 0.0041 - val_accuracy: 0.9731
Epoch 96/1000
469/469 [==============================] - 0s 780us/step - loss: 2.5493e-04 - accurac
y: 0.9985 - val_loss: 0.0041 - val_accuracy: 0.9733
Epoch 97/1000
469/469 [==============================] - 0s 776us/step - loss: 1.9213e-04 - accurac
y: 0.9988 - val_loss: 0.0041 - val_accuracy: 0.9736
Epoch 98/1000
469/469 [==============================] - 0s 784us/step - loss: 3.1782e-04 - accurac
y: 0.9981 - val_loss: 0.0041 - val_accuracy: 0.9741
Epoch 99/1000
469/469 [==============================] - 0s 769us/step - loss: 2.7705e-04 - accurac
y: 0.9985 - val_loss: 0.0041 - val_accuracy: 0.9736
Epoch 100/1000
469/469 [==============================] - 0s 778us/step - loss: 2.2915e-04 - accurac
y: 0.9987 - val_loss: 0.0041 - val_accuracy: 0.9742
Epoch 101/1000
469/469 [==============================] - 0s 776us/step - loss: 2.0754e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9731
Epoch 102/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0538e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 103/1000
469/469 [==============================] - 0s 780us/step - loss: 1.9901e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9737
Epoch 104/1000
469/469 [==============================] - 0s 786us/step - loss: 2.0548e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9731
Epoch 105/1000
469/469 [==============================] - 0s 786us/step - loss: 2.3350e-04 - accurac
y: 0.9986 - val_loss: 0.0041 - val_accuracy: 0.9732
Epoch 106/1000
469/469 [==============================] - 0s 780us/step - loss: 2.1855e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 107/1000
469/469 [==============================] - 0s 799us/step - loss: 2.4117e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9729
Epoch 108/1000
469/469 [==============================] - 0s 776us/step - loss: 2.3929e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9729
Epoch 109/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0662e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 110/1000
469/469 [==============================] - 0s 778us/step - loss: 2.1568e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9724
Epoch 111/1000
469/469 [==============================] - 0s 765us/step - loss: 1.9954e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9728
Epoch 112/1000
469/469 [==============================] - 0s 782us/step - loss: 2.2433e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 113/1000
469/469 [==============================] - 0s 791us/step - loss: 1.8309e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 114/1000
469/469 [==============================] - 0s 776us/step - loss: 2.1007e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 115/1000
469/469 [==============================] - 0s 774us/step - loss: 2.2015e-04 - accurac
y: 0.9987 - val_loss: 0.0046 - val_accuracy: 0.9712
Epoch 116/1000
469/469 [==============================] - 0s 771us/step - loss: 2.2809e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9738
Epoch 117/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6268e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 118/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8093e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 119/1000
469/469 [==============================] - 0s 776us/step - loss: 2.0388e-04 - accurac
y: 0.9988 - val_loss: 0.0041 - val_accuracy: 0.9740
Epoch 120/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0238e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9727
Epoch 121/1000
469/469 [==============================] - 0s 791us/step - loss: 2.1684e-04 - accurac
y: 0.9987 - val_loss: 0.0041 - val_accuracy: 0.9739
Epoch 122/1000
469/469 [==============================] - 0s 784us/step - loss: 1.9609e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 123/1000
469/469 [==============================] - 0s 782us/step - loss: 1.9002e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9742
Epoch 124/1000
469/469 [==============================] - 0s 784us/step - loss: 2.0166e-04 - accurac
y: 0.9988 - val_loss: 0.0041 - val_accuracy: 0.9742
Epoch 125/1000
469/469 [==============================] - 0s 782us/step - loss: 1.7320e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 126/1000
469/469 [==============================] - 0s 795us/step - loss: 2.1324e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9729
Epoch 127/1000
469/469 [==============================] - 0s 782us/step - loss: 2.2928e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9729
Epoch 128/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7847e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 129/1000
469/469 [==============================] - 0s 786us/step - loss: 2.1412e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9728
Epoch 130/1000
469/469 [==============================] - 0s 797us/step - loss: 2.1255e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9744
Epoch 131/1000
469/469 [==============================] - 0s 783us/step - loss: 2.3203e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 132/1000
469/469 [==============================] - 0s 774us/step - loss: 2.0321e-04 - accurac
y: 0.9988 - val_loss: 0.0041 - val_accuracy: 0.9734
Epoch 133/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8541e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 134/1000
469/469 [==============================] - 0s 786us/step - loss: 2.0839e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 135/1000
469/469 [==============================] - 0s 765us/step - loss: 2.4674e-04 - accurac
y: 0.9985 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 136/1000
469/469 [==============================] - 0s 780us/step - loss: 1.9067e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 137/1000
469/469 [==============================] - 0s 793us/step - loss: 1.6734e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9743
Epoch 138/1000
469/469 [==============================] - 0s 769us/step - loss: 1.8946e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 139/1000
469/469 [==============================] - 0s 788us/step - loss: 1.8867e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 140/1000
469/469 [==============================] - 0s 780us/step - loss: 2.2305e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 141/1000
469/469 [==============================] - 0s 782us/step - loss: 1.9490e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 142/1000
469/469 [==============================] - 0s 786us/step - loss: 1.8146e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 143/1000
469/469 [==============================] - 0s 776us/step - loss: 2.6758e-04 - accurac
y: 0.9983 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 144/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0822e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 145/1000
469/469 [==============================] - 0s 791us/step - loss: 1.7149e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 146/1000
469/469 [==============================] - 0s 799us/step - loss: 1.9886e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9720
Epoch 147/1000
469/469 [==============================] - 0s 784us/step - loss: 2.0033e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 148/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8362e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 149/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0877e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 150/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7442e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9729
Epoch 151/1000
469/469 [==============================] - 0s 782us/step - loss: 2.1637e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 152/1000
469/469 [==============================] - 0s 783us/step - loss: 2.0389e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 153/1000
469/469 [==============================] - 0s 782us/step - loss: 2.4339e-04 - accurac
y: 0.9985 - val_loss: 0.0041 - val_accuracy: 0.9741
Epoch 154/1000
469/469 [==============================] - 0s 799us/step - loss: 1.8742e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 155/1000
469/469 [==============================] - 0s 784us/step - loss: 1.9016e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 156/1000
469/469 [==============================] - 0s 776us/step - loss: 1.6593e-04 - accurac
y: 0.9990 - val_loss: 0.0041 - val_accuracy: 0.9744
Epoch 157/1000
469/469 [==============================] - 0s 778us/step - loss: 1.7085e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 158/1000
469/469 [==============================] - 0s 786us/step - loss: 2.4665e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9747
Epoch 159/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8477e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 160/1000
469/469 [==============================] - 0s 781us/step - loss: 1.8061e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 161/1000
469/469 [==============================] - 0s 774us/step - loss: 1.7311e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9742
Epoch 162/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5737e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 163/1000
469/469 [==============================] - 0s 786us/step - loss: 1.7650e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9741
Epoch 164/1000
469/469 [==============================] - 0s 780us/step - loss: 1.7238e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 165/1000
469/469 [==============================] - 0s 776us/step - loss: 1.6505e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 166/1000
469/469 [==============================] - 0s 778us/step - loss: 2.1163e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 167/1000
469/469 [==============================] - 0s 784us/step - loss: 2.4639e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 168/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8030e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 169/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6734e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9728
Epoch 170/1000
469/469 [==============================] - 0s 788us/step - loss: 1.8235e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9722
Epoch 171/1000
469/469 [==============================] - 0s 778us/step - loss: 1.7371e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 172/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8485e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 173/1000
469/469 [==============================] - 0s 782us/step - loss: 2.3118e-04 - accurac
y: 0.9986 - val_loss: 0.0043 - val_accuracy: 0.9729
Epoch 174/1000
469/469 [==============================] - 0s 786us/step - loss: 1.7302e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 175/1000
469/469 [==============================] - 0s 781us/step - loss: 1.9197e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 176/1000
469/469 [==============================] - 0s 771us/step - loss: 1.6368e-04 - accurac
y: 0.9990 - val_loss: 0.0045 - val_accuracy: 0.9720
Epoch 177/1000
469/469 [==============================] - 0s 778us/step - loss: 2.6842e-04 - accurac
y: 0.9986 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 178/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6713e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 179/1000
469/469 [==============================] - 0s 771us/step - loss: 1.8269e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 180/1000
469/469 [==============================] - 0s 774us/step - loss: 2.0226e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 181/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5720e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 182/1000
469/469 [==============================] - 0s 793us/step - loss: 1.5016e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9743
Epoch 183/1000
469/469 [==============================] - 0s 780us/step - loss: 1.7790e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 184/1000
469/469 [==============================] - 0s 787us/step - loss: 1.8270e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 185/1000
469/469 [==============================] - 0s 765us/step - loss: 2.0176e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9726
Epoch 186/1000
469/469 [==============================] - 0s 788us/step - loss: 2.0630e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 187/1000
469/469 [==============================] - 0s 774us/step - loss: 2.0334e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 188/1000
469/469 [==============================] - 0s 771us/step - loss: 1.8267e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 189/1000
469/469 [==============================] - 0s 788us/step - loss: 2.0421e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 190/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8135e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9729
Epoch 191/1000
469/469 [==============================] - 0s 778us/step - loss: 1.9570e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 192/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4770e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 193/1000
469/469 [==============================] - 0s 776us/step - loss: 1.9967e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 194/1000
469/469 [==============================] - 0s 778us/step - loss: 1.7612e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9723
Epoch 195/1000
469/469 [==============================] - 0s 783us/step - loss: 1.9312e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 196/1000
469/469 [==============================] - 0s 774us/step - loss: 1.8117e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 197/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5128e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 198/1000
469/469 [==============================] - 0s 782us/step - loss: 1.8266e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 199/1000
469/469 [==============================] - 0s 791us/step - loss: 2.1645e-04 - accurac
y: 0.9986 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 200/1000
469/469 [==============================] - 0s 782us/step - loss: 1.8861e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9725
Epoch 201/1000
469/469 [==============================] - 0s 782us/step - loss: 2.0023e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 202/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8601e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 203/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8644e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 204/1000
469/469 [==============================] - 0s 776us/step - loss: 1.9366e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 205/1000
469/469 [==============================] - 0s 771us/step - loss: 1.5580e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 206/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7558e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 207/1000
469/469 [==============================] - 0s 786us/step - loss: 2.1214e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 208/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6169e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 209/1000
469/469 [==============================] - 0s 778us/step - loss: 1.7679e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9725
Epoch 210/1000
469/469 [==============================] - 0s 779us/step - loss: 1.7388e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 211/1000
469/469 [==============================] - 0s 784us/step - loss: 1.8453e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 212/1000
469/469 [==============================] - 0s 786us/step - loss: 1.8586e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 213/1000
469/469 [==============================] - 0s 778us/step - loss: 1.9733e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 214/1000
469/469 [==============================] - 0s 784us/step - loss: 1.6835e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 215/1000
469/469 [==============================] - 0s 791us/step - loss: 1.6915e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 216/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6541e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 217/1000
469/469 [==============================] - 0s 790us/step - loss: 1.9598e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 218/1000
469/469 [==============================] - 0s 776us/step - loss: 2.1418e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 219/1000
469/469 [==============================] - 0s 786us/step - loss: 2.1627e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 220/1000
469/469 [==============================] - 0s 774us/step - loss: 1.6053e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 221/1000
469/469 [==============================] - 0s 780us/step - loss: 2.1136e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9720
Epoch 222/1000
469/469 [==============================] - 0s 784us/step - loss: 1.8200e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 223/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8882e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9725
Epoch 224/1000
469/469 [==============================] - 0s 778us/step - loss: 2.0432e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9724
Epoch 225/1000
469/469 [==============================] - 0s 784us/step - loss: 1.8154e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 226/1000
469/469 [==============================] - 0s 771us/step - loss: 2.0085e-04 - accurac
y: 0.9988 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 227/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8548e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 228/1000
469/469 [==============================] - 0s 788us/step - loss: 1.5849e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 229/1000
469/469 [==============================] - 0s 771us/step - loss: 1.6999e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9721
Epoch 230/1000
469/469 [==============================] - 0s 782us/step - loss: 2.0829e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 231/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6361e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 232/1000
469/469 [==============================] - 0s 784us/step - loss: 1.8210e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 233/1000
469/469 [==============================] - 0s 775us/step - loss: 1.6463e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 234/1000
469/469 [==============================] - 0s 771us/step - loss: 1.7281e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 235/1000
469/469 [==============================] - 0s 771us/step - loss: 1.5416e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 236/1000
469/469 [==============================] - 0s 776us/step - loss: 1.6247e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 237/1000
469/469 [==============================] - 0s 788us/step - loss: 2.0037e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 238/1000
469/469 [==============================] - 0s 791us/step - loss: 2.2600e-04 - accurac
y: 0.9986 - val_loss: 0.0043 - val_accuracy: 0.9722
```

```
Epoch 239/1000
469/469 [==============================] - 0s 784us/step - loss: 1.8644e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 240/1000
469/469 [==============================] - 0s 771us/step - loss: 1.6889e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 241/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4971e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 242/1000
469/469 [==============================] - 0s 786us/step - loss: 1.6125e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 243/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7557e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 244/1000
469/469 [==============================] - 0s 779us/step - loss: 2.1331e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9745
Epoch 245/1000
469/469 [==============================] - 0s 774us/step - loss: 1.7288e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9742
Epoch 246/1000
469/469 [==============================] - 0s 774us/step - loss: 1.5765e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 247/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6365e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 248/1000
469/469 [==============================] - 0s 784us/step - loss: 2.0228e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 249/1000
469/469 [==============================] - 0s 771us/step - loss: 1.6852e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 250/1000
469/469 [==============================] - 0s 778us/step - loss: 1.5603e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9727
Epoch 251/1000
469/469 [==============================] - 0s 780us/step - loss: 1.3319e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 252/1000
469/469 [==============================] - 0s 774us/step - loss: 1.5671e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 253/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4189e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 254/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8015e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9732
Epoch 255/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8328e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 256/1000
469/469 [==============================] - 0s 782us/step - loss: 1.7612e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9721
Epoch 257/1000
469/469 [==============================] - 0s 774us/step - loss: 1.8870e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 258/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4960e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 259/1000
469/469 [==============================] - 0s 769us/step - loss: 1.3778e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 260/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4080e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 261/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6133e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 262/1000
469/469 [==============================] - 0s 788us/step - loss: 1.6775e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9745
Epoch 263/1000
469/469 [==============================] - 0s 780us/step - loss: 1.7434e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 264/1000
469/469 [==============================] - 0s 782us/step - loss: 1.8252e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 265/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8314e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 266/1000
469/469 [==============================] - 0s 788us/step - loss: 1.6588e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 267/1000
469/469 [==============================] - 0s 772us/step - loss: 1.5306e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 268/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8707e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 269/1000
469/469 [==============================] - 0s 793us/step - loss: 1.6167e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 270/1000
469/469 [==============================] - 0s 786us/step - loss: 1.9241e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9741
Epoch 271/1000
469/469 [==============================] - 0s 784us/step - loss: 2.0587e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9724
Epoch 272/1000
469/469 [==============================] - 0s 788us/step - loss: 2.1155e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 273/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4721e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 274/1000
469/469 [==============================] - 0s 788us/step - loss: 1.6637e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 275/1000
469/469 [==============================] - 0s 778us/step - loss: 1.2638e-04 - accurac
y: 0.9992 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 276/1000
469/469 [==============================] - 0s 784us/step - loss: 2.2403e-04 - accurac
y: 0.9986 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 277/1000
469/469 [==============================] - 0s 788us/step - loss: 1.6802e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9720
Epoch 278/1000
469/469 [==============================] - 0s 772us/step - loss: 2.2150e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 279/1000
469/469 [==============================] - 0s 808us/step - loss: 1.7294e-04 - accurac
y: 0.9989 - val_loss: 0.0041 - val_accuracy: 0.9742
Epoch 280/1000
469/469 [==============================] - 0s 801us/step - loss: 1.7772e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 281/1000
469/469 [==============================] - 0s 780us/step - loss: 2.3629e-04 - accurac
y: 0.9985 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 282/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6911e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 283/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4710e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 284/1000
469/469 [==============================] - 0s 776us/step - loss: 2.0512e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 285/1000
469/469 [==============================] - 0s 786us/step - loss: 1.5131e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 286/1000
469/469 [==============================] - 0s 780us/step - loss: 1.3119e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 287/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5316e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 288/1000
469/469 [==============================] - 0s 776us/step - loss: 1.9271e-04 - accurac
y: 0.9988 - val_loss: 0.0046 - val_accuracy: 0.9718
Epoch 289/1000
469/469 [==============================] - 0s 780us/step - loss: 1.7127e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 290/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4269e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9725
Epoch 291/1000
469/469 [==============================] - 0s 774us/step - loss: 1.5459e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 292/1000
469/469 [==============================] - 0s 771us/step - loss: 1.8324e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9724
Epoch 293/1000
469/469 [==============================] - 0s 791us/step - loss: 1.6739e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 294/1000
469/469 [==============================] - 0s 791us/step - loss: 1.7796e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 295/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7172e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9729
Epoch 296/1000
469/469 [==============================] - 0s 788us/step - loss: 1.4135e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 297/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6339e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 298/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4154e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9738
Epoch 299/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4855e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9742
Epoch 300/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6724e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9745
Epoch 301/1000
469/469 [==============================] - 0s 784us/step - loss: 2.1209e-04 - accurac
y: 0.9987 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 302/1000
469/469 [==============================] - 0s 780us/step - loss: 2.2177e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 303/1000
469/469 [==============================] - 0s 793us/step - loss: 1.8385e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9744
Epoch 304/1000
469/469 [==============================] - 0s 776us/step - loss: 1.6572e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 305/1000
469/469 [==============================] - 0s 780us/step - loss: 2.1309e-04 - accurac
y: 0.9987 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 306/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5221e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9744
Epoch 307/1000
469/469 [==============================] - 0s 784us/step - loss: 1.6368e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 308/1000
469/469 [==============================] - 0s 776us/step - loss: 1.2692e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9723
Epoch 309/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6842e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 310/1000
469/469 [==============================] - 0s 801us/step - loss: 1.7390e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 311/1000
469/469 [==============================] - 0s 786us/step - loss: 1.5007e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 312/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5840e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 313/1000
469/469 [==============================] - 0s 774us/step - loss: 1.4132e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 314/1000
469/469 [==============================] - 0s 784us/step - loss: 1.3238e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 315/1000
469/469 [==============================] - 0s 786us/step - loss: 1.5458e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 316/1000
469/469 [==============================] - 0s 783us/step - loss: 1.4550e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 317/1000
469/469 [==============================] - 0s 786us/step - loss: 2.1441e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9744
Epoch 318/1000
469/469 [==============================] - 0s 795us/step - loss: 1.6510e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9741
Epoch 319/1000
469/469 [==============================] - 0s 831us/step - loss: 1.5724e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9743
Epoch 320/1000
469/469 [==============================] - 0s 791us/step - loss: 1.4552e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 321/1000
469/469 [==============================] - 0s 793us/step - loss: 1.5771e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9745
Epoch 322/1000
469/469 [==============================] - 0s 785us/step - loss: 1.7015e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9744
Epoch 323/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5212e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9742
Epoch 324/1000
469/469 [==============================] - 0s 812us/step - loss: 1.9113e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 325/1000
469/469 [==============================] - 0s 769us/step - loss: 1.5633e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 326/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6573e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 327/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8836e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9743
Epoch 328/1000
469/469 [==============================] - 0s 776us/step - loss: 1.5261e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 329/1000
469/469 [==============================] - 0s 780us/step - loss: 1.9195e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9742
Epoch 330/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5185e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9747
Epoch 331/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7288e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 332/1000
469/469 [==============================] - 0s 776us/step - loss: 1.8287e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9743
Epoch 333/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5795e-04 - accurac
y: 0.9990 - val_loss: 0.0045 - val_accuracy: 0.9726
Epoch 334/1000
469/469 [==============================] - 0s 780us/step - loss: 2.0964e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 335/1000
469/469 [==============================] - 0s 781us/step - loss: 1.8035e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 336/1000
469/469 [==============================] - 0s 780us/step - loss: 1.7304e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 337/1000
469/469 [==============================] - 0s 782us/step - loss: 1.7599e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9727
Epoch 338/1000
469/469 [==============================] - 0s 792us/step - loss: 1.7757e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 339/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6191e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 340/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6244e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 341/1000
469/469 [==============================] - 0s 791us/step - loss: 2.0556e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 342/1000
469/469 [==============================] - 0s 774us/step - loss: 1.6274e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 343/1000
469/469 [==============================] - 0s 788us/step - loss: 1.5814e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 344/1000
469/469 [==============================] - 0s 788us/step - loss: 1.7679e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 345/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4433e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9729
Epoch 346/1000
469/469 [==============================] - 0s 788us/step - loss: 1.5667e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 347/1000
469/469 [==============================] - 0s 774us/step - loss: 1.3138e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 348/1000
469/469 [==============================] - 0s 778us/step - loss: 1.8748e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 349/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6752e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 350/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4382e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 351/1000
469/469 [==============================] - 0s 788us/step - loss: 1.5719e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 352/1000
469/469 [==============================] - 0s 776us/step - loss: 1.6204e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 353/1000
469/469 [==============================] - 0s 781us/step - loss: 1.3523e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 354/1000
469/469 [==============================] - 0s 784us/step - loss: 1.9182e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 355/1000
469/469 [==============================] - 0s 776us/step - loss: 1.7021e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 356/1000
469/469 [==============================] - 0s 795us/step - loss: 1.4499e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9728
Epoch 357/1000
469/469 [==============================] - 0s 774us/step - loss: 1.6109e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9730
Epoch 358/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6315e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 359/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5028e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 360/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5438e-04 - accurac
y: 0.9990 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 361/1000
469/469 [==============================] - 0s 791us/step - loss: 2.3150e-04 - accurac
y: 0.9986 - val_loss: 0.0044 - val_accuracy: 0.9721
Epoch 362/1000
469/469 [==============================] - 0s 771us/step - loss: 1.6165e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 363/1000
469/469 [==============================] - 0s 788us/step - loss: 1.5299e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9729
Epoch 364/1000
469/469 [==============================] - 0s 797us/step - loss: 1.3120e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 365/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4173e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9728
Epoch 366/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5914e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 367/1000
469/469 [==============================] - 0s 784us/step - loss: 1.6783e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9726
Epoch 368/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4898e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 369/1000
469/469 [==============================] - 0s 769us/step - loss: 1.7767e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 370/1000
469/469 [==============================] - 0s 795us/step - loss: 1.6205e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 371/1000
469/469 [==============================] - 0s 786us/step - loss: 1.2024e-04 - accurac
y: 0.9993 - val_loss: 0.0043 - val_accuracy: 0.9730
Epoch 372/1000
469/469 [==============================] - 0s 785us/step - loss: 1.4717e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9731
Epoch 373/1000
469/469 [==============================] - 0s 782us/step - loss: 1.6185e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9740
Epoch 374/1000
469/469 [==============================] - 0s 776us/step - loss: 1.3320e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 375/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4657e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 376/1000
469/469 [==============================] - 0s 812us/step - loss: 1.4663e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9723
Epoch 377/1000
469/469 [==============================] - 0s 778us/step - loss: 2.0098e-04 - accurac
y: 0.9987 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 378/1000
469/469 [==============================] - 0s 788us/step - loss: 1.2154e-04 - accurac
y: 0.9992 - val_loss: 0.0042 - val_accuracy: 0.9737
Epoch 379/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8087e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9731
Epoch 380/1000
469/469 [==============================] - 0s 788us/step - loss: 1.7325e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9733
Epoch 381/1000
469/469 [==============================] - 0s 786us/step - loss: 1.8059e-04 - accurac
y: 0.9988 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 382/1000
469/469 [==============================] - 0s 778us/step - loss: 1.6946e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9734
Epoch 383/1000
469/469 [==============================] - 0s 776us/step - loss: 1.1562e-04 - accurac
y: 0.9993 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 384/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4909e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9736
Epoch 385/1000
469/469 [==============================] - 0s 776us/step - loss: 1.3964e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 386/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6682e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 387/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4788e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9745
Epoch 388/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4553e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 389/1000
469/469 [==============================] - 0s 793us/step - loss: 1.6906e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 390/1000
469/469 [==============================] - 0s 788us/step - loss: 1.3740e-04 - accurac
y: 0.9991 - val_loss: 0.0042 - val_accuracy: 0.9735
Epoch 391/1000
469/469 [==============================] - 0s 782us/step - loss: 1.7093e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9742
Epoch 392/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2763e-04 - accurac
y: 0.9992 - val_loss: 0.0042 - val_accuracy: 0.9748
Epoch 393/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2000e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9744
Epoch 394/1000
469/469 [==============================] - 0s 792us/step - loss: 1.5932e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9742
Epoch 395/1000
469/469 [==============================] - 0s 776us/step - loss: 1.1092e-04 - accurac
y: 0.9993 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 396/1000
469/469 [==============================] - 0s 784us/step - loss: 1.5103e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 397/1000
469/469 [==============================] - 0s 779us/step - loss: 1.3575e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9746
Epoch 398/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6627e-04 - accurac
y: 0.9989 - val_loss: 0.0042 - val_accuracy: 0.9739
Epoch 399/1000
469/469 [==============================] - 0s 791us/step - loss: 1.5411e-04 - accurac
y: 0.9990 - val_loss: 0.0042 - val_accuracy: 0.9743
Epoch 400/1000
469/469 [==============================] - 0s 782us/step - loss: 1.3949e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9710
Epoch 401/1000
469/469 [==============================] - 0s 780us/step - loss: 1.9889e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 402/1000
469/469 [==============================] - 0s 780us/step - loss: 1.3179e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 403/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4359e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 404/1000
469/469 [==============================] - 0s 842us/step - loss: 1.5587e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 405/1000
469/469 [==============================] - 0s 844us/step - loss: 2.1212e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 406/1000
469/469 [==============================] - 0s 893us/step - loss: 1.5643e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9727
Epoch 407/1000
469/469 [==============================] - 0s 788us/step - loss: 1.0576e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9723
Epoch 408/1000
469/469 [==============================] - 0s 814us/step - loss: 1.7335e-04 - accurac
y: 0.9989 - val_loss: 0.0047 - val_accuracy: 0.9717
Epoch 409/1000
469/469 [==============================] - 0s 897us/step - loss: 2.1534e-04 - accurac
y: 0.9987 - val_loss: 0.0045 - val_accuracy: 0.9731
Epoch 410/1000
469/469 [==============================] - 0s 810us/step - loss: 1.7774e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 411/1000
469/469 [==============================] - 0s 788us/step - loss: 1.6934e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 412/1000
469/469 [==============================] - 0s 835us/step - loss: 1.7094e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 413/1000
469/469 [==============================] - 0s 801us/step - loss: 1.6132e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 414/1000
469/469 [==============================] - 0s 816us/step - loss: 1.6001e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9739
Epoch 415/1000
469/469 [==============================] - 0s 833us/step - loss: 1.5769e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 416/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4416e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 417/1000
469/469 [==============================] - 0s 833us/step - loss: 2.0889e-04 - accurac
y: 0.9987 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 418/1000
469/469 [==============================] - 0s 806us/step - loss: 1.6907e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 419/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5797e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 420/1000
469/469 [==============================] - 0s 801us/step - loss: 1.6020e-04 - accurac
y: 0.9989 - val_loss: 0.0045 - val_accuracy: 0.9717
Epoch 421/1000
469/469 [==============================] - 0s 844us/step - loss: 1.5827e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9737
Epoch 422/1000
469/469 [==============================] - 0s 844us/step - loss: 1.5860e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 423/1000
469/469 [==============================] - 0s 838us/step - loss: 1.6912e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 424/1000
469/469 [==============================] - 0s 791us/step - loss: 1.3949e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 425/1000
469/469 [==============================] - 0s 797us/step - loss: 1.3193e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 426/1000
469/469 [==============================] - 0s 791us/step - loss: 1.2525e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9725
Epoch 427/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4757e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 428/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2528e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9713
Epoch 429/1000
469/469 [==============================] - 0s 835us/step - loss: 1.7509e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 430/1000
469/469 [==============================] - 0s 838us/step - loss: 1.6532e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 431/1000
469/469 [==============================] - 0s 791us/step - loss: 1.6255e-04 - accurac
y: 0.9989 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 432/1000
469/469 [==============================] - 0s 816us/step - loss: 1.6394e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 433/1000
469/469 [==============================] - 0s 784us/step - loss: 1.3470e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 434/1000
469/469 [==============================] - 0s 791us/step - loss: 1.6316e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 435/1000
469/469 [==============================] - 0s 793us/step - loss: 1.4612e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 436/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2351e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 437/1000
469/469 [==============================] - 0s 782us/step - loss: 1.3843e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 438/1000
469/469 [==============================] - 0s 780us/step - loss: 1.8611e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 439/1000
469/469 [==============================] - 0s 788us/step - loss: 1.4858e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 440/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4360e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 441/1000
469/469 [==============================] - 0s 786us/step - loss: 1.5763e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 442/1000
469/469 [==============================] - 0s 848us/step - loss: 1.4851e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 443/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5777e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 444/1000
469/469 [==============================] - 0s 833us/step - loss: 8.5930e-05 - accurac
y: 0.9994 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 445/1000
469/469 [==============================] - 0s 786us/step - loss: 1.2481e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 446/1000
469/469 [==============================] - 0s 791us/step - loss: 1.6255e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 447/1000
469/469 [==============================] - 0s 863us/step - loss: 1.6885e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 448/1000
469/469 [==============================] - 0s 797us/step - loss: 1.4174e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 449/1000
469/469 [==============================] - 0s 780us/step - loss: 1.1238e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 450/1000
469/469 [==============================] - 0s 797us/step - loss: 1.1500e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9726
Epoch 451/1000
469/469 [==============================] - 0s 786us/step - loss: 1.7111e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9741
Epoch 452/1000
469/469 [==============================] - 0s 776us/step - loss: 1.4608e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9719
Epoch 453/1000
469/469 [==============================] - 0s 799us/step - loss: 1.4728e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 454/1000
469/469 [==============================] - 0s 801us/step - loss: 1.5462e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9725
Epoch 455/1000
469/469 [==============================] - 0s 782us/step - loss: 1.3613e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 456/1000
469/469 [==============================] - 0s 806us/step - loss: 1.6637e-04 - accurac
y: 0.9989 - val_loss: 0.0045 - val_accuracy: 0.9725
Epoch 457/1000
469/469 [==============================] - 0s 778us/step - loss: 1.3226e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 458/1000
469/469 [==============================] - 0s 814us/step - loss: 1.5082e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9718
Epoch 459/1000
469/469 [==============================] - 0s 812us/step - loss: 1.7532e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9718
Epoch 460/1000
469/469 [==============================] - 0s 831us/step - loss: 1.1808e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9727
Epoch 461/1000
469/469 [==============================] - 0s 823us/step - loss: 1.3982e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9729
Epoch 462/1000
469/469 [==============================] - 0s 812us/step - loss: 1.0434e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 463/1000
469/469 [==============================] - 0s 793us/step - loss: 1.1707e-04 - accurac
y: 0.9993 - val_loss: 0.0045 - val_accuracy: 0.9714
Epoch 464/1000
469/469 [==============================] - 0s 820us/step - loss: 1.5783e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 465/1000
469/469 [==============================] - 0s 814us/step - loss: 1.3698e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9726
Epoch 466/1000
469/469 [==============================] - 0s 833us/step - loss: 1.6269e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 467/1000
469/469 [==============================] - 0s 820us/step - loss: 1.2223e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 468/1000
469/469 [==============================] - 0s 820us/step - loss: 1.3631e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 469/1000
469/469 [==============================] - 0s 852us/step - loss: 1.1868e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 470/1000
469/469 [==============================] - 0s 825us/step - loss: 1.6157e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 471/1000
469/469 [==============================] - 0s 838us/step - loss: 1.4468e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 472/1000
469/469 [==============================] - 0s 823us/step - loss: 1.5387e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 473/1000
469/469 [==============================] - 0s 831us/step - loss: 1.4847e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9724
Epoch 474/1000
469/469 [==============================] - 0s 791us/step - loss: 1.3229e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 475/1000
469/469 [==============================] - 0s 791us/step - loss: 1.2295e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9728
Epoch 476/1000
469/469 [==============================] - 0s 830us/step - loss: 1.2915e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9726
Epoch 477/1000
469/469 [==============================] - 0s 777us/step - loss: 1.3408e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 478/1000
469/469 [==============================] - 0s 852us/step - loss: 1.4961e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 479/1000
469/469 [==============================] - 0s 825us/step - loss: 1.6211e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 480/1000
469/469 [==============================] - 0s 863us/step - loss: 1.3199e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9722
Epoch 481/1000
469/469 [==============================] - 0s 791us/step - loss: 1.5810e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9737
Epoch 482/1000
469/469 [==============================] - 0s 833us/step - loss: 1.4438e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 483/1000
469/469 [==============================] - 0s 818us/step - loss: 1.4513e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 484/1000
469/469 [==============================] - 0s 796us/step - loss: 1.3288e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9713
Epoch 485/1000
469/469 [==============================] - 0s 778us/step - loss: 1.5214e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9744
Epoch 486/1000
469/469 [==============================] - 0s 778us/step - loss: 1.3821e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9745
Epoch 487/1000
469/469 [==============================] - 0s 836us/step - loss: 1.3447e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 488/1000
469/469 [==============================] - 0s 828us/step - loss: 1.5562e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 489/1000
469/469 [==============================] - 0s 814us/step - loss: 1.7955e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9732
Epoch 490/1000
469/469 [==============================] - 0s 820us/step - loss: 1.5604e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9733
Epoch 491/1000
469/469 [==============================] - 0s 825us/step - loss: 1.5037e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 492/1000
469/469 [==============================] - 0s 844us/step - loss: 1.4512e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 493/1000
469/469 [==============================] - 0s 852us/step - loss: 1.6210e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9736
Epoch 494/1000
469/469 [==============================] - 0s 793us/step - loss: 1.7861e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 495/1000
469/469 [==============================] - 0s 844us/step - loss: 1.4987e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9742
Epoch 496/1000
469/469 [==============================] - 0s 833us/step - loss: 1.4914e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 497/1000
469/469 [==============================] - 0s 838us/step - loss: 1.1109e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 498/1000
469/469 [==============================] - 0s 820us/step - loss: 1.6446e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 499/1000
469/469 [==============================] - 0s 797us/step - loss: 1.5082e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 500/1000
469/469 [==============================] - 0s 793us/step - loss: 1.5009e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9739
Epoch 501/1000
469/469 [==============================] - 0s 819us/step - loss: 1.2117e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9726
Epoch 502/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4419e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 503/1000
469/469 [==============================] - 0s 782us/step - loss: 1.1558e-04 - accurac
y: 0.9992 - val_loss: 0.0045 - val_accuracy: 0.9727
Epoch 504/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4858e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 505/1000
469/469 [==============================] - 0s 774us/step - loss: 1.3674e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9739
Epoch 506/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4226e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 507/1000
469/469 [==============================] - 0s 774us/step - loss: 1.3215e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 508/1000
469/469 [==============================] - 0s 776us/step - loss: 1.4670e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9733
Epoch 509/1000
469/469 [==============================] - 0s 835us/step - loss: 1.3628e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 510/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4706e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 511/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4768e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 512/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4242e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 513/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4092e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9739
Epoch 514/1000
469/469 [==============================] - 0s 812us/step - loss: 1.3483e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9715
Epoch 515/1000
469/469 [==============================] - 0s 786us/step - loss: 1.6915e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 516/1000
469/469 [==============================] - 0s 818us/step - loss: 1.3750e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9730
Epoch 517/1000
469/469 [==============================] - 0s 808us/step - loss: 1.8868e-04 - accurac
y: 0.9987 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 518/1000
469/469 [==============================] - 0s 808us/step - loss: 1.4533e-04 - accurac
y: 0.9990 - val_loss: 0.0045 - val_accuracy: 0.9721
Epoch 519/1000
469/469 [==============================] - 0s 827us/step - loss: 1.5352e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9741
Epoch 520/1000
469/469 [==============================] - 0s 782us/step - loss: 1.2815e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 521/1000
469/469 [==============================] - 0s 820us/step - loss: 1.2847e-04 - accurac
y: 0.9992 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 522/1000
469/469 [==============================] - 0s 876us/step - loss: 1.4776e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 523/1000
469/469 [==============================] - 0s 803us/step - loss: 1.6396e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 524/1000
469/469 [==============================] - 0s 818us/step - loss: 1.7460e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9738
Epoch 525/1000
469/469 [==============================] - 0s 791us/step - loss: 1.3842e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 526/1000
469/469 [==============================] - 0s 774us/step - loss: 1.3570e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 527/1000
469/469 [==============================] - 0s 780us/step - loss: 1.2877e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 528/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5738e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9735
Epoch 529/1000
469/469 [==============================] - 0s 781us/step - loss: 1.5881e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 530/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5074e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9739
Epoch 531/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5084e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 532/1000
469/469 [==============================] - 0s 795us/step - loss: 1.5253e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 533/1000
469/469 [==============================] - 0s 803us/step - loss: 1.5492e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9740
Epoch 534/1000
469/469 [==============================] - 0s 799us/step - loss: 1.3758e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 535/1000
469/469 [==============================] - 0s 814us/step - loss: 1.1456e-04 - accurac
y: 0.9993 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 536/1000
469/469 [==============================] - 0s 799us/step - loss: 1.3942e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 537/1000
469/469 [==============================] - 0s 782us/step - loss: 1.5056e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 538/1000
469/469 [==============================] - 0s 799us/step - loss: 1.7511e-04 - accurac
y: 0.9988 - val_loss: 0.0044 - val_accuracy: 0.9734
Epoch 539/1000
469/469 [==============================] - 0s 799us/step - loss: 1.4251e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9728
Epoch 540/1000
469/469 [==============================] - 0s 786us/step - loss: 1.2506e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9740
Epoch 541/1000
469/469 [==============================] - 0s 784us/step - loss: 1.3039e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 542/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4597e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9729
Epoch 543/1000
469/469 [==============================] - 0s 797us/step - loss: 1.3466e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 544/1000
469/469 [==============================] - 0s 797us/step - loss: 1.1390e-04 - accurac
y: 0.9993 - val_loss: 0.0043 - val_accuracy: 0.9742
Epoch 545/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5613e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 546/1000
469/469 [==============================] - 0s 776us/step - loss: 1.1725e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9739
Epoch 547/1000
469/469 [==============================] - 0s 784us/step - loss: 1.3147e-04 - accurac
y: 0.9991 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 548/1000
469/469 [==============================] - 0s 793us/step - loss: 1.4279e-04 - accurac
y: 0.9991 - val_loss: 0.0043 - val_accuracy: 0.9737
Epoch 549/1000
469/469 [==============================] - 0s 795us/step - loss: 1.5387e-04 - accurac
y: 0.9990 - val_loss: 0.0043 - val_accuracy: 0.9734
Epoch 550/1000
469/469 [==============================] - 0s 797us/step - loss: 1.6149e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9736
Epoch 551/1000
469/469 [==============================] - 0s 789us/step - loss: 1.5699e-04 - accurac
y: 0.9990 - val_loss: 0.0044 - val_accuracy: 0.9731
Epoch 552/1000
469/469 [==============================] - 0s 786us/step - loss: 1.6988e-04 - accurac
y: 0.9989 - val_loss: 0.0044 - val_accuracy: 0.9732
Epoch 553/1000
469/469 [==============================] - 0s 782us/step - loss: 1.2907e-04 - accurac
y: 0.9991 - val_loss: 0.0045 - val_accuracy: 0.9728
Epoch 554/1000
469/469 [==============================] - 0s 791us/step - loss: 1.1663e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9737
Epoch 555/1000
469/469 [==============================] - 0s 782us/step - loss: 1.7979e-04 - accurac
y: 0.9988 - val_loss: 0.0043 - val_accuracy: 0.9742
Epoch 556/1000
469/469 [==============================] - 0s 780us/step - loss: 1.2278e-04 - accurac
y: 0.9992 - val_loss: 0.0044 - val_accuracy: 0.9735
Epoch 557/1000
469/469 [==============================] - 0s 784us/step - loss: 1.7518e-04 - accurac
y: 0.9989 - val_loss: 0.0045 - val_accuracy: 0.9732
Epoch 558/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4059e-04 - accurac
y: 0.9990 - val_loss: 0.0045 - val_accuracy: 0.9722
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Epoch 879/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4222e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9727
Epoch 880/1000
469/469 [==============================] - 0s 799us/step - loss: 1.7918e-04 - accurac
y: 0.9988 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 881/1000
469/469 [==============================] - 0s 797us/step - loss: 1.2263e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 882/1000
469/469 [==============================] - 0s 820us/step - loss: 1.4544e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9719
Epoch 883/1000
469/469 [==============================] - 0s 786us/step - loss: 1.4255e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9714
Epoch 884/1000
469/469 [==============================] - 0s 821us/step - loss: 1.1371e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9719
Epoch 885/1000
469/469 [==============================] - 0s 782us/step - loss: 1.3770e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9718
Epoch 886/1000
469/469 [==============================] - 0s 823us/step - loss: 1.4281e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9720
Epoch 887/1000
469/469 [==============================] - 0s 791us/step - loss: 1.2505e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9722
Epoch 888/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4395e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9722
Epoch 889/1000
469/469 [==============================] - 0s 778us/step - loss: 1.1495e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9712
Epoch 890/1000
469/469 [==============================] - 0s 785us/step - loss: 1.2695e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 891/1000
469/469 [==============================] - 0s 776us/step - loss: 1.3454e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9723
Epoch 892/1000
469/469 [==============================] - 0s 793us/step - loss: 1.3892e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 893/1000
469/469 [==============================] - 0s 797us/step - loss: 1.4314e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 894/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5111e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9726
Epoch 895/1000
469/469 [==============================] - 0s 780us/step - loss: 1.4887e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9711
Epoch 896/1000
469/469 [==============================] - 0s 793us/step - loss: 1.3005e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 897/1000
469/469 [==============================] - 0s 797us/step - loss: 1.4789e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9710
Epoch 898/1000
469/469 [==============================] - 0s 788us/step - loss: 1.4704e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 899/1000
469/469 [==============================] - 0s 784us/step - loss: 1.3246e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9720
Epoch 900/1000
469/469 [==============================] - 0s 791us/step - loss: 1.0330e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9711
Epoch 901/1000
469/469 [==============================] - 0s 797us/step - loss: 1.4208e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9730
Epoch 902/1000
469/469 [==============================] - 0s 788us/step - loss: 1.0241e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9708
Epoch 903/1000
469/469 [==============================] - 0s 816us/step - loss: 1.0247e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 904/1000
469/469 [==============================] - 0s 829us/step - loss: 1.1372e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 905/1000
469/469 [==============================] - 0s 818us/step - loss: 1.3632e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 906/1000
469/469 [==============================] - 0s 825us/step - loss: 1.4248e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9712
Epoch 907/1000
469/469 [==============================] - 0s 833us/step - loss: 1.0280e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9715
Epoch 908/1000
469/469 [==============================] - 0s 810us/step - loss: 1.4303e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9723
Epoch 909/1000
469/469 [==============================] - 0s 831us/step - loss: 1.1399e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 910/1000
469/469 [==============================] - 0s 829us/step - loss: 1.2973e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 911/1000
469/469 [==============================] - 0s 803us/step - loss: 1.3822e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9723
Epoch 912/1000
469/469 [==============================] - 0s 833us/step - loss: 1.4321e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9724
Epoch 913/1000
469/469 [==============================] - 0s 829us/step - loss: 1.2446e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9722
Epoch 914/1000
469/469 [==============================] - 0s 846us/step - loss: 1.5739e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9724
Epoch 915/1000
469/469 [==============================] - 0s 835us/step - loss: 1.4664e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9723
Epoch 916/1000
469/469 [==============================] - 0s 808us/step - loss: 1.7013e-04 - accurac
y: 0.9988 - val_loss: 0.0046 - val_accuracy: 0.9724
Epoch 917/1000
469/469 [==============================] - 0s 843us/step - loss: 1.3690e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9724
Epoch 918/1000
469/469 [==============================] - 0s 788us/step - loss: 1.1313e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 919/1000
469/469 [==============================] - 0s 861us/step - loss: 1.2496e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9719
Epoch 920/1000
469/469 [==============================] - 0s 782us/step - loss: 1.2059e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 921/1000
469/469 [==============================] - 0s 808us/step - loss: 1.4130e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9717
Epoch 922/1000
469/469 [==============================] - 0s 852us/step - loss: 1.4329e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9725
Epoch 923/1000
469/469 [==============================] - 0s 852us/step - loss: 1.0059e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 924/1000
469/469 [==============================] - 0s 829us/step - loss: 1.3091e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 925/1000
469/469 [==============================] - 0s 869us/step - loss: 1.1226e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9725
Epoch 926/1000
469/469 [==============================] - 0s 827us/step - loss: 1.5008e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 927/1000
469/469 [==============================] - 0s 816us/step - loss: 1.3196e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 928/1000
469/469 [==============================] - 0s 825us/step - loss: 1.2267e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 929/1000
469/469 [==============================] - 0s 802us/step - loss: 1.1949e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 930/1000
469/469 [==============================] - 0s 812us/step - loss: 1.0412e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 931/1000
469/469 [==============================] - 0s 812us/step - loss: 1.2060e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9718
Epoch 932/1000
469/469 [==============================] - 0s 803us/step - loss: 1.2202e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9723
Epoch 933/1000
469/469 [==============================] - 0s 810us/step - loss: 1.0382e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 934/1000
469/469 [==============================] - 0s 776us/step - loss: 1.4047e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 935/1000
469/469 [==============================] - 0s 784us/step - loss: 1.4737e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9726
Epoch 936/1000
469/469 [==============================] - 0s 784us/step - loss: 1.0108e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9723
Epoch 937/1000
469/469 [==============================] - 0s 795us/step - loss: 1.4273e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9710
Epoch 938/1000
469/469 [==============================] - 0s 791us/step - loss: 1.1556e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 939/1000
469/469 [==============================] - 0s 777us/step - loss: 1.2939e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9711
Epoch 940/1000
469/469 [==============================] - 0s 788us/step - loss: 1.1472e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9716
Epoch 941/1000
469/469 [==============================] - 0s 776us/step - loss: 1.2320e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 942/1000
469/469 [==============================] - 0s 788us/step - loss: 9.3282e-05 - accurac
y: 0.9994 - val_loss: 0.0046 - val_accuracy: 0.9716
Epoch 943/1000
469/469 [==============================] - 0s 782us/step - loss: 1.1511e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 944/1000
469/469 [==============================] - 0s 800us/step - loss: 1.0551e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9719
Epoch 945/1000
469/469 [==============================] - 0s 790us/step - loss: 1.1782e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9718
Epoch 946/1000
469/469 [==============================] - 0s 780us/step - loss: 1.5166e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 947/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2094e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9723
Epoch 948/1000
469/469 [==============================] - 0s 779us/step - loss: 1.4022e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9715
Epoch 949/1000
469/469 [==============================] - 0s 784us/step - loss: 1.2027e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 950/1000
469/469 [==============================] - 0s 778us/step - loss: 1.4456e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 951/1000
469/469 [==============================] - 0s 799us/step - loss: 1.1769e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 952/1000
469/469 [==============================] - 0s 786us/step - loss: 1.2535e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9719
Epoch 953/1000
469/469 [==============================] - 0s 786us/step - loss: 1.1163e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 954/1000
469/469 [==============================] - 0s 784us/step - loss: 1.1446e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9714
Epoch 955/1000
469/469 [==============================] - 0s 784us/step - loss: 1.0723e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9718
Epoch 956/1000
469/469 [==============================] - 0s 780us/step - loss: 1.6261e-04 - accurac
y: 0.9989 - val_loss: 0.0046 - val_accuracy: 0.9714
Epoch 957/1000
469/469 [==============================] - 0s 788us/step - loss: 1.3095e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9715
Epoch 958/1000
469/469 [==============================] - 0s 835us/step - loss: 1.5034e-04 - accurac
y: 0.9990 - val_loss: 0.0046 - val_accuracy: 0.9717
Epoch 959/1000
469/469 [==============================] - 0s 784us/step - loss: 1.1336e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9724
Epoch 960/1000
469/469 [==============================] - 0s 782us/step - loss: 1.0497e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9714
Epoch 961/1000
469/469 [==============================] - 0s 780us/step - loss: 1.3622e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9720
Epoch 962/1000
469/469 [==============================] - 0s 825us/step - loss: 1.2869e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9721
Epoch 963/1000
469/469 [==============================] - 0s 840us/step - loss: 1.0744e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9717
Epoch 964/1000
469/469 [==============================] - 0s 840us/step - loss: 1.7165e-04 - accurac
y: 0.9988 - val_loss: 0.0047 - val_accuracy: 0.9715
Epoch 965/1000
469/469 [==============================] - 0s 848us/step - loss: 1.2143e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9719
Epoch 966/1000
469/469 [==============================] - 0s 827us/step - loss: 1.4291e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9718
Epoch 967/1000
469/469 [==============================] - 0s 823us/step - loss: 1.3351e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 968/1000
469/469 [==============================] - 0s 844us/step - loss: 1.1752e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9722
Epoch 969/1000
469/469 [==============================] - 0s 812us/step - loss: 1.1168e-04 - accurac
y: 0.9993 - val_loss: 0.0046 - val_accuracy: 0.9725
Epoch 970/1000
469/469 [==============================] - 0s 878us/step - loss: 1.1281e-04 - accurac
y: 0.9992 - val_loss: 0.0046 - val_accuracy: 0.9725
Epoch 971/1000
469/469 [==============================] - 0s 842us/step - loss: 1.2417e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9718
Epoch 972/1000
469/469 [==============================] - 0s 835us/step - loss: 1.4899e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9712
Epoch 973/1000
469/469 [==============================] - 0s 825us/step - loss: 1.1930e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9717
Epoch 974/1000
469/469 [==============================] - 0s 797us/step - loss: 1.4825e-04 - accurac
y: 0.9990 - val_loss: 0.0050 - val_accuracy: 0.9701
Epoch 975/1000
469/469 [==============================] - 0s 795us/step - loss: 1.4284e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 976/1000
469/469 [==============================] - 0s 818us/step - loss: 1.2758e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9721
Epoch 977/1000
469/469 [==============================] - 0s 810us/step - loss: 1.1078e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9720
Epoch 978/1000
469/469 [==============================] - 0s 808us/step - loss: 9.4212e-05 - accurac
y: 0.9994 - val_loss: 0.0047 - val_accuracy: 0.9723
Epoch 979/1000
469/469 [==============================] - 0s 816us/step - loss: 1.0002e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9723
Epoch 980/1000
469/469 [==============================] - 0s 827us/step - loss: 1.1747e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9724
Epoch 981/1000
469/469 [==============================] - 0s 812us/step - loss: 1.0514e-04 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9721
Epoch 982/1000
469/469 [==============================] - 0s 801us/step - loss: 1.3736e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9723
Epoch 983/1000
469/469 [==============================] - 0s 778us/step - loss: 1.1581e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9721
Epoch 984/1000
469/469 [==============================] - 0s 783us/step - loss: 1.1925e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9724
Epoch 985/1000
469/469 [==============================] - 0s 842us/step - loss: 1.1211e-04 - accurac
y: 0.9992 - val_loss: 0.0048 - val_accuracy: 0.9717
Epoch 986/1000
469/469 [==============================] - 0s 825us/step - loss: 9.6126e-05 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9722
Epoch 987/1000
469/469 [==============================] - 0s 795us/step - loss: 1.4053e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9715
Epoch 988/1000
469/469 [==============================] - 0s 782us/step - loss: 1.1048e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9714
Epoch 989/1000
469/469 [==============================] - 0s 820us/step - loss: 1.1862e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9715
Epoch 990/1000
469/469 [==============================] - 0s 782us/step - loss: 1.4899e-04 - accurac
y: 0.9990 - val_loss: 0.0048 - val_accuracy: 0.9716
Epoch 991/1000
469/469 [==============================] - 0s 842us/step - loss: 1.4061e-04 - accurac
y: 0.9990 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 992/1000
469/469 [==============================] - 0s 822us/step - loss: 1.4905e-04 - accurac
y: 0.9990 - val_loss: 0.0048 - val_accuracy: 0.9712
Epoch 993/1000
469/469 [==============================] - 0s 778us/step - loss: 9.2221e-05 - accurac
y: 0.9993 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 994/1000
469/469 [==============================] - 0s 823us/step - loss: 9.4652e-05 - accurac
y: 0.9994 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 995/1000
469/469 [==============================] - 0s 786us/step - loss: 1.2786e-04 - accurac
y: 0.9991 - val_loss: 0.0048 - val_accuracy: 0.9711
Epoch 996/1000
469/469 [==============================] - 0s 811us/step - loss: 1.4137e-04 - accurac
y: 0.9990 - val_loss: 0.0048 - val_accuracy: 0.9712
Epoch 997/1000
469/469 [==============================] - 0s 786us/step - loss: 1.1855e-04 - accurac
y: 0.9992 - val_loss: 0.0047 - val_accuracy: 0.9721
Epoch 998/1000
469/469 [==============================] - 0s 823us/step - loss: 1.3870e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9716
Epoch 999/1000
469/469 [==============================] - 0s 780us/step - loss: 1.2937e-04 - accurac
y: 0.9991 - val_loss: 0.0046 - val_accuracy: 0.9722
Epoch 1000/1000
469/469 [==============================] - 0s 829us/step - loss: 1.2767e-04 - accurac
y: 0.9991 - val_loss: 0.0047 - val_accuracy: 0.9717
```
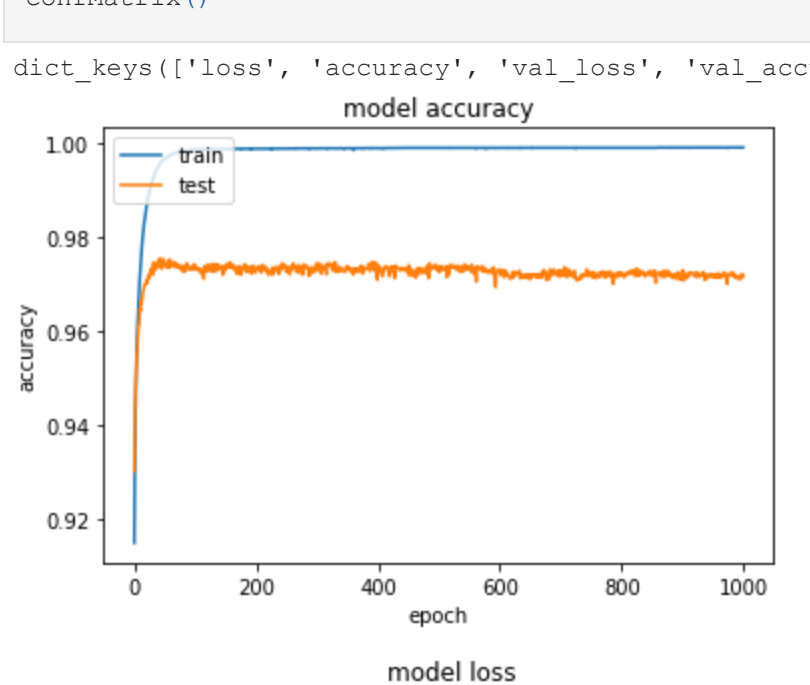
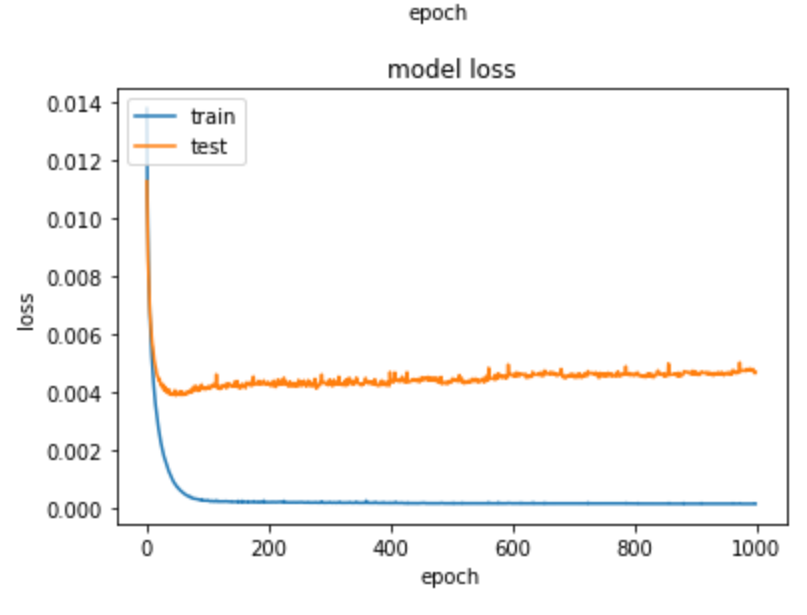
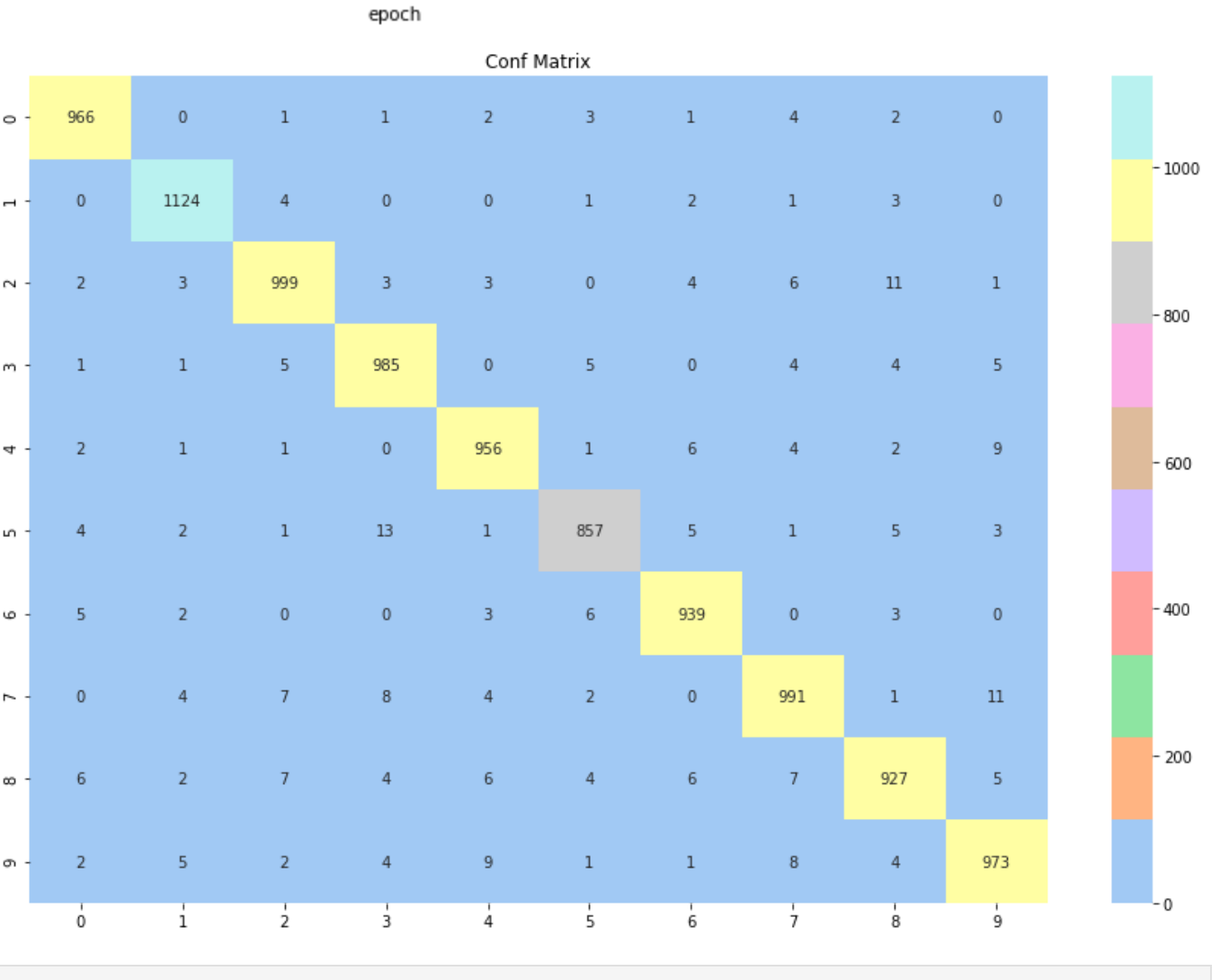

In [110…

```python
def plot():
    # show all all data in history
    print(history.history.keys())

     # display summary of history for accuracy
    plt.plot(history.history['accuracy'])
    plt.plot(history.history['val_accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()

    # breakdown summary history for loss
    plt.plot(history.history['loss'])
    plt.plot(history.history['val_loss'])
    plt.title('model loss')
    plt.ylabel('loss')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()

def confMatrix():
    plt.figure(figsize=(15,10))
    sns.heatmap(confusion_matrix(y_valid, model.predict_classes(X_validation)) ,
                cmap=sns.color_palette("pastel", as_cmap=True),
               annot=True, fmt="d")
    plt.title("Conf Matrix")
    plt.show()
plot()
confMatrix()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```







In [111…

```python
print(classification_report(y_valid, model.predict_classes(X_validation)))
```

```
              precision    recall  f1-score   support

           0       0.98      0.99      0.98       980
           1       0.98      0.99      0.99      1135
           2       0.97      0.97      0.97      1032
           3       0.97      0.98      0.97      1010
           4       0.97      0.97      0.97       982
           5       0.97      0.96      0.97       892
           6       0.97      0.98      0.98       958
           7       0.97      0.96      0.96      1028
           8       0.96      0.95      0.96       974
           9       0.97      0.96      0.97      1009

    accuracy                           0.97     10000
   macro avg       0.97      0.97      0.97     10000
weighted avg       0.97      0.97      0.97     10000
```

In [112…

```python
model.evaluate(X_validation, y_validation)
```

```
313/313 [==============================] - 0s 406us/step - loss: 0.0047 - accuracy: 0.
9717
```

Out[112…

```
[0.004666103515774012, 0.9717000126838684]
```

Optimizers are functions/algorithms used to manipulate the features of your neural network like learningr rates and weights to bring down the losses. Some goals for optimizers to assist with quicker results.Above you can see optimizer does help perform better.You can see that the loss lines for fit and test deteriorate heavy towward 480-500. As we increase iterations we will eventually get better scores.

PART 2 - Convolutional neural network (CNN) architecture

In [113…

```python
model_cnn = keras.Sequential(
    [
        keras.layers.InputLayer(input_shape),
        layers.Conv2D(32, kernel_size=(3, 3), activation="relu"),
        layers.MaxPooling2D(pool_size=(2, 2)),
        layers.Conv2D(64, kernel_size=(3, 3), activation="relu"),
        layers.MaxPooling2D(pool_size=(2, 2)),
        layers.Flatten(),
        layers.Dropout(0.5),
        layers.Dense(num_classes, activation="softmax"),
    ]
)

model_cnn.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
module_wrapper (ModuleWrappe (None, 26, 26, 32)        320
_________________________________________________________________
module_wrapper_1 (ModuleWrap (None, 13, 13, 32)        0
_________________________________________________________________
module_wrapper_2 (ModuleWrap (None, 11, 11, 64)        18496
_________________________________________________________________
module_wrapper_3 (ModuleWrap (None, 5, 5, 64)          0
_________________________________________________________________
module_wrapper_4 (ModuleWrap (None, 1600)              0
_________________________________________________________________
module_wrapper_5 (ModuleWrap (None, 1600)              0
_________________________________________________________________
module_wrapper_6 (ModuleWrap (None, 10)                16010
=================================================================
Total params: 34,826
Trainable params: 34,826
Non-trainable params: 0
_________________________________________________________________
```

Configure model

In [114…

```python
model_cnn.compile(
    loss="categorical_crossentropy",
    optimizer="adam",
    metrics=["accuracy"]
)
```

Prepare the data

The CNN does not expect the images to be flattened.

In [116…

```python
# upload
(X_train, y_train), (X_valid, y_valid) = mnist.load_data()

# convert vectors to binary  matrices
y_training = keras.utils.np_utils.to_categorical(y_train, num_classes)
y_validation = keras.utils.np_utils.to_categorical(y_valid, num_classes)

# update images to [0, 1] range
X_train_cnn = X_train.astype("float32") / 255
X_valid_cnn = X_valid.astype("float32") / 255

# update  dimension of train/test inputs
X_train_cnn = np.expand_dims(X_train_cnn, -1)
X_valid_cnn = np.expand_dims(X_valid_cnn, -1)

# Make sure images have shape (28, 28, 1)
print("x_train shape:", X_train_cnn.shape)
print(X_train_cnn.shape[0], "train samples")
print(X_valid_cnn.shape[0], "test samples")
```

```
x_train shape: (60000, 28, 28, 1)
60000 train samples
10000 test samples
```

Train!

In [117…

```python
batch_size=128
epochs=15

history = model_cnn.fit(
  X_train_cnn, # training data
  y_training, # training targets
  epochs=epochs,
  batch_size=batch_size,
  verbose=1,
  validation_data=(X_valid_cnn, y_validation)
)
```

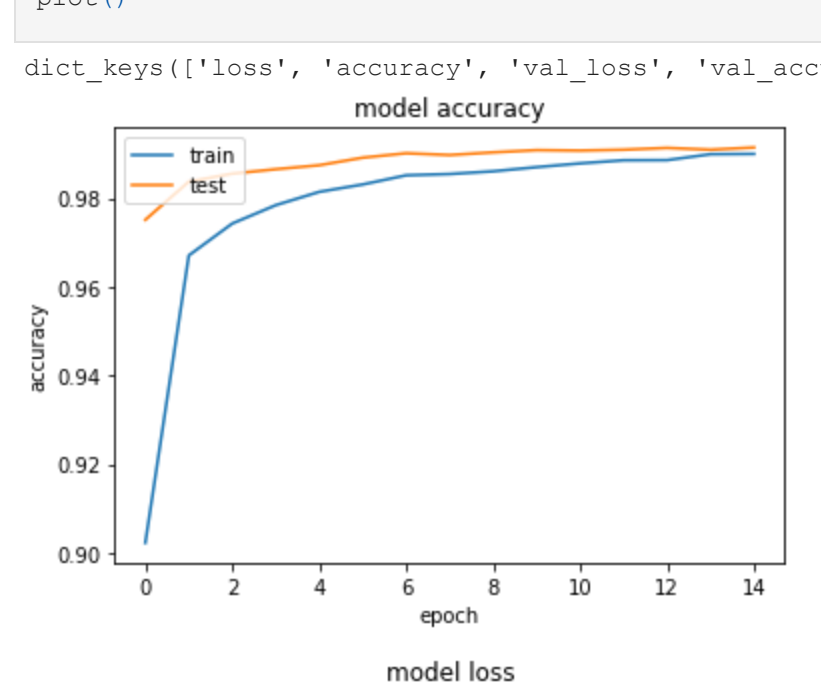
```
Epoch 1/15
469/469 [==============================] - 12s 24ms/step - loss: 0.7016 - accuracy: 0.
7941 - val_loss: 0.0831 - val_accuracy: 0.9751
Epoch 2/15
469/469 [==============================] - 11s 24ms/step - loss: 0.1168 - accuracy: 0.
9638 - val_loss: 0.0548 - val_accuracy: 0.9837
Epoch 3/15
469/469 [==============================] - 12s 25ms/step - loss: 0.0841 - accuracy: 0.
9738 - val_loss: 0.0447 - val_accuracy: 0.9855
Epoch 4/15
469/469 [==============================] - 11s 24ms/step - loss: 0.0695 - accuracy: 0.
9787 - val_loss: 0.0416 - val_accuracy: 0.9865
Epoch 5/15
469/469 [==============================] - 11s 24ms/step - loss: 0.0599 - accuracy: 0.
9817 - val_loss: 0.0369 - val_accuracy: 0.9874
Epoch 6/15
469/469 [==============================] - 12s 25ms/step - loss: 0.0564 - accuracy: 0.
9827 - val_loss: 0.0317 - val_accuracy: 0.9891
Epoch 7/15
469/469 [==============================] - 12s 26ms/step - loss: 0.0475 - accuracy: 0.
9856 - val_loss: 0.0308 - val_accuracy: 0.9901
Epoch 8/15
469/469 [==============================] - 12s 25ms/step - loss: 0.0456 - accuracy: 0.
9855 - val_loss: 0.0307 - val_accuracy: 0.9897
Epoch 9/15
469/469 [==============================] - 12s 25ms/step - loss: 0.0424 - accuracy: 0.
9863 - val_loss: 0.0292 - val_accuracy: 0.9903
Epoch 10/15
469/469 [==============================] - 11s 24ms/step - loss: 0.0414 - accuracy: 0.
9867 - val_loss: 0.0290 - val_accuracy: 0.9908
Epoch 11/15
469/469 [==============================] - 11s 23ms/step - loss: 0.0368 - accuracy: 0.
9884 - val_loss: 0.0288 - val_accuracy: 0.9907
Epoch 12/15
469/469 [==============================] - 11s 23ms/step - loss: 0.0347 - accuracy: 0.
9886 - val_loss: 0.0260 - val_accuracy: 0.9909
Epoch 13/15
469/469 [==============================] - 11s 23ms/step - loss: 0.0349 - accuracy: 0.
9886 - val_loss: 0.0262 - val_accuracy: 0.9913
Epoch 14/15
469/469 [==============================] - 11s 23ms/step - loss: 0.0327 - accuracy: 0.
9896 - val_loss: 0.0277 - val_accuracy: 0.9909
Epoch 15/15
469/469 [==============================] - 11s 23ms/step - loss: 0.0321 - accuracy: 0.
9898 - val_loss: 0.0254 - val_accuracy: 0.9914
```

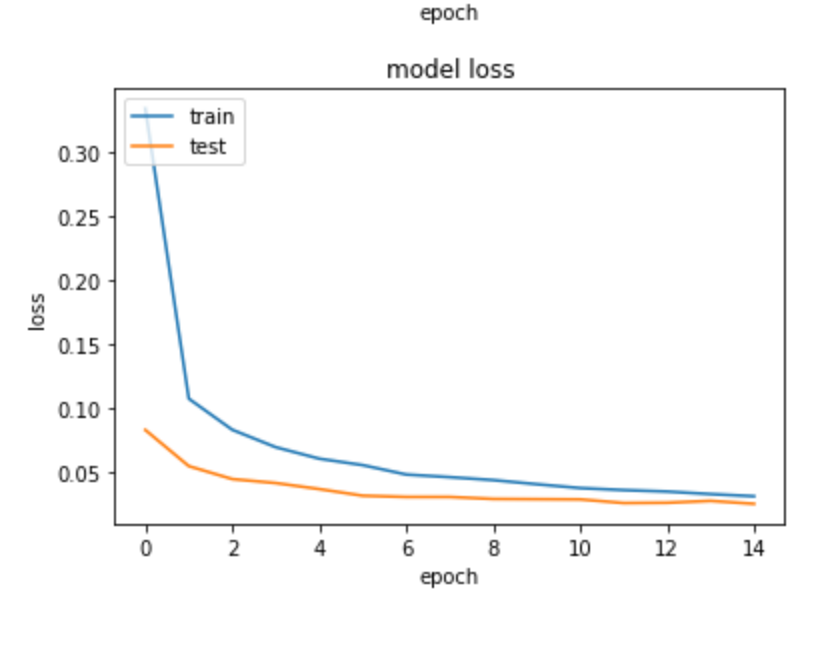
Plot learning curves

In [118…

```python
def plot():
    # show all all data in history
    print(history.history.keys())

    # display summary of history for accuracy
    plt.plot(history.history['accuracy'])
    plt.plot(history.history['val_accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()

    # breakdown summary history for loss
    plt.plot(history.history['loss'])
    plt.plot(history.history['val_loss'])
    plt.title('model loss')
    plt.ylabel('loss')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()
plot()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```





Evaluate the model

In [119…

```python
model_cnn.evaluate(X_valid_cnn, y_validation)
```

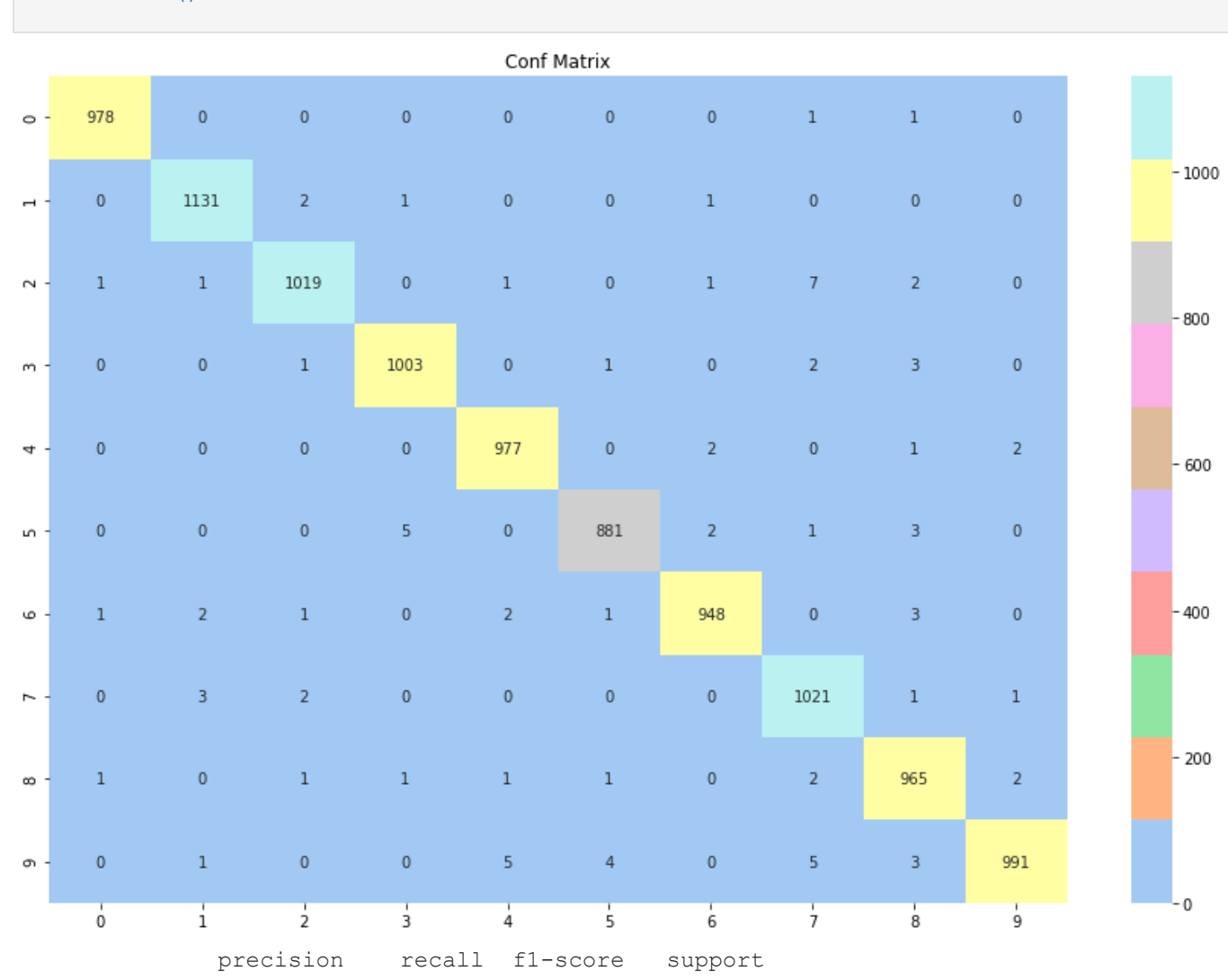
```
313/313 [==============================] - 1s 2ms/step - loss: 0.0254 - accuracy: 0.99
14
```

Out[119…

```
[0.02536826767027378, 0.9914000034332275]
```

In [124…

```python
def confMatrix():
    plt.figure(figsize=(15,10))
    sns.heatmap(confusion_matrix(y_valid, model_cnn.predict_classes(X_valid_cnn)) ,
               cmap=sns.color_palette("pastel", as_cmap=True),
              annot=True, fmt="d")
    plt.title("Conf Matrix")
    plt.show()
confMatrix()
```




```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00       980
           1       0.99      1.00      1.00      1135
           2       0.99      0.99      0.99      1032
           3       0.99      0.99      0.99      1010
           4       0.99      0.99      0.99       982
           5       0.99      0.99      0.99       892
           6       0.99      0.99      0.99       958
           7       0.98      0.99      0.99      1028
           8       0.98      0.99      0.99       974
           9       0.99      0.98      0.99      1009

    accuracy                           0.99     10000
   macro avg       0.99      0.99      0.99     10000
weighted avg       0.99      0.99      0.99     10000
```

In [130…

```python
print(model_cnn.predict_classes(X_valid_cnn))
print(y_valid)

print(classification_report(y_valid, model_cnn.predict_classes(X_valid_cnn)))
```

```
[7 2 1 ... 4 5 6]
[7 2 1 ... 4 5 6]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00       980
           1       0.99      1.00      1.00      1135
           2       0.99      0.99      0.99      1032
           3       0.99      0.99      0.99      1010
           4       0.99      0.99      0.99       982
           5       0.99      0.99      0.99       892
           6       0.99      0.99      0.99       958
           7       0.98      0.99      0.99      1028
           8       0.98      0.99      0.99       974
           9       0.99      0.98      0.99      1009

    accuracy                           0.99     10000
   macro avg       0.99      0.99      0.99     10000
weighted avg       0.99      0.99      0.99     10000
```

QUESTION 4: How do the accuracy and loss compare to the previous model?What can you infer from this comparison?

You look at the curves and the results from conf matrix above we notice better results from 90% to 99%.Loss value shows how poorly or well a model behaves after each iteration of optimization.The accuracy data is used to determine the models performance in an unobfuscated way. You can aslo validate with above we reduced iterations which means it helped us reduce the time by 50% which was alot helpful it was taxing on my cpu and took more time to run other models.You can validate with example above with deeper models we get more better performance resutls and also quicker results. This has some things as I was getting better results. I also continued to monitor any over fitting that might happening. So overfitting can be a possible issue with this.