Trabalho_2_Deep_Learning

April 30, 2021

1 Projeto 2 - Deep Learning

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2 Bibliotecas

Para a realização dessa atividade foi utilizada as seguintes biblioteca: * Pandas - Biblioteca de software criada para a linguagem Python para manipulação e análise de dados. * Numpy - Biblioteca Python que é usada principalmente para realizar cálculos em Arrays Multidimensionais. * Keras - Biblioteca open-source que dispõe uma interface em Python para redes neurais artificiais. O keras age como uma interface para a biblioteca TensorFlow, do Google. * Matplotlib - Biblioteca para a visualização de dados em Python. Ele apresenta uma API orientada a objetos que permite a criação de gráficos em 2D de uma forma simples e com poucos comandos.

[1]:
```
import pandas as pd
import numpy as np
import os
import keras
import matplotlib.pyplot as plt

from sklearn.metrics import classification_report, confusion_matrix
from keras.layers import Dense,GlobalAveragePooling2D
from keras.applications import MobileNet
from keras.preprocessing import image
from keras.applications.mobilenet import preprocess_input
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Model
from keras.optimizers import Adam
```

3 Importação do modelo e criação das camadas de neurônios

- Para o modelo pré-treinado da literatura, dentre os disponíveis no link (https://keras.io/api/applications/) foi utilizado o MobileNet, que por sua vez utiliza os pesos pré treinados da ImageNet.
- Foi utilizado o 'GlobalAveragePooling2D' para a extração das características na primeira camada.

- Foi utilizado o 'relu' (Rectified Linear Unit) no cálculo de função de ativação das camadas intermediárias.
- Foi utilizado a ativação 'softmax' na última camada, com suas devidas 3 classes para a predição das classes do dataset.

[3]:
```
base_model=MobileNet(weights='imagenet',include_top=False) #importa o modelo de␣
↪mobilenet e descarta a última camada de 1000 neurônios.

x=base_model.output
x=GlobalAveragePooling2D()(x)
x=Dense(1024,activation='relu')(x) #adicionamos camadas densas para que o␣
↪modelo possa aprender funções mais complexas e classificar para melhores␣
↪resultados.
x=Dense(1024,activation='relu')(x) #dense layer 2
x=Dense(512,activation='relu')(x) #dense layer 3
preds=Dense(3,activation='softmax')(x) #final layer com softmax activation
```

```
WARNING:tensorflow:`input_shape` is undefined or non-square, or `rows` is not in
[128, 160, 192, 224]. Weights for input shape (224, 224) will be loaded as the
default.
```

[4]:
```
model=Model(inputs=base_model.input,outputs=preds)
#especificar as entradas
#especifique as saídas
#agora um modelo foi criado com base em nossa arquitetura
```

[5]:
```
for layer in model.layers[:20]:
    layer.trainable=False
for layer in model.layers[20:]:
    layer.trainable=True
```

4 Base de Dados

Para a realização deste projeto foi necessário escolher um dataset do site kaggle para o treinamento do modelo de deep learning. O dataset selecionado pelo grupo foi o "Rock-Paper-Scissors-Images", ou "Jo-Ken-Po", que representa o jogo pedra papel e tesoura.
Esse dataset contém 2189 imagens dos gestos usados para representar uma pedra ou papel ou tesoura no jogo. Essas imagens estão separadas em pastas representando cada uma das três classes e o código a seguir é responsável por fazer a divisão entre treino (80%) e teste (20%) dessas imagens.

[6]:
```
train_data_gen =␣
↪ImageDataGenerator(preprocessing_function=preprocess_input,validation_split=0.
↪8, rescale=1./255, shear_range = 0.2, zoom_range = 0.2) #included in our␣
↪dependencies
#Geração dos dados de treino (80%)
train_generator = train_data_gen.flow_from_directory('dataset',
                                                     target_size=(64, 64),
                                                     batch_size=32,
```

```
                                                    shuffle=True, subset =␣
↪'validation',class_mode='categorical')
#Divisão, teste e treino
test_generator = train_data_gen.flow_from_directory('dataset',
                                                    target_size=(64, 64),
                                                    batch_size=32,
                                                    shuffle=True, subset =␣
↪'training',class_mode='categorical')
```

```
Found 1749 images belonging to 3 classes.
Found 439 images belonging to 3 classes.
```

5 Definição do otimizador, steps e realização do treinamento e teste

- O otimizador utilizado pelo grupo foi o 'Adam', que apresenta um melhor resultado.
- A métrica de avaliação do treinamento foi a acurácia.
- A métrica de erro utilizado foi a 'categorical_crossentropy', já que o dataset utilizado apresenta mais do que duas classes, impossibilitando o uso do 'binary_crossentropy'.
- O treinamento foi realizado em 500 epochs.

[7]:
```
model.
↪compile(optimizer='Adam',loss='categorical_crossentropy',metrics=['accuracy'])
# Adam otimizador
# função de perda será entropia cruzada categórica
# métrica de avaliação será a precisão

step_size_train=train_generator.n//train_generator.batch_size
#Treinando e testando o modelo
history = model.
↪fit_generator(generator=train_generator,steps_per_epoch=step_size_train,
                              epochs=500,validation_data =test_generator,
                              validation_steps=(test_generator.n//
↪test_generator.batch_size))
```

```
C:\ProgramData\Anaconda3\lib\site-
packages\tensorflow\python\keras\engine\training.py:1844: UserWarning:
`Model.fit_generator` is deprecated and will be removed in a future version.
Please use `Model.fit`, which supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '
```

```
Epoch 1/500
54/54 [==============================] - 33s 563ms/step - loss: 0.7984 -
accuracy: 0.7511 - val_loss: 2.8332 - val_accuracy: 0.3245
Epoch 2/500
54/54 [==============================] - 13s 247ms/step - loss: 0.1909 -
accuracy: 0.9346 - val_loss: 1.7724 - val_accuracy: 0.6250
Epoch 3/500
```

```
54/54 [==============================] - 16s 291ms/step - loss: 0.1047 -
accuracy: 0.9632 - val_loss: 2.6271 - val_accuracy: 0.3317
Epoch 4/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0862 -
accuracy: 0.9750 - val_loss: 1.0373 - val_accuracy: 0.6322
Epoch 5/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0971 -
accuracy: 0.9725 - val_loss: 4.5178 - val_accuracy: 0.6274
Epoch 6/500
54/54 [==============================] - 16s 299ms/step - loss: 0.0701 -
accuracy: 0.9764 - val_loss: 9.5787 - val_accuracy: 0.3365
Epoch 7/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0956 -
accuracy: 0.9745 - val_loss: 1.6418 - val_accuracy: 0.6202
Epoch 8/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0732 -
accuracy: 0.9745 - val_loss: 12.1697 - val_accuracy: 0.3317
Epoch 9/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0987 -
accuracy: 0.9696 - val_loss: 4.3325 - val_accuracy: 0.3341
Epoch 10/500
54/54 [==============================] - 18s 332ms/step - loss: 0.0632 -
accuracy: 0.9818 - val_loss: 1.8286 - val_accuracy: 0.6538
Epoch 11/500
54/54 [==============================] - 19s 357ms/step - loss: 0.0381 -
accuracy: 0.9895 - val_loss: 12.6313 - val_accuracy: 0.3462
Epoch 12/500
54/54 [==============================] - 17s 316ms/step - loss: 0.0681 -
accuracy: 0.9760 - val_loss: 0.4219 - val_accuracy: 0.9663
Epoch 13/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0981 -
accuracy: 0.9677 - val_loss: 0.9848 - val_accuracy: 0.6562
Epoch 14/500
54/54 [==============================] - 16s 303ms/step - loss: 0.1533 -
accuracy: 0.9638 - val_loss: 1.9498 - val_accuracy: 0.3510
Epoch 15/500
54/54 [==============================] - 17s 305ms/step - loss: 0.0626 -
accuracy: 0.9824 - val_loss: 14.5133 - val_accuracy: 0.3221
Epoch 16/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0830 -
accuracy: 0.9684 - val_loss: 19.2740 - val_accuracy: 0.3365
Epoch 17/500
54/54 [==============================] - 16s 303ms/step - loss: 0.1131 -
accuracy: 0.9635 - val_loss: 26.4419 - val_accuracy: 0.3389
Epoch 18/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0438 -
accuracy: 0.9867 - val_loss: 8.7733 - val_accuracy: 0.3341
Epoch 19/500
```

```
54/54 [==============================] - 16s 303ms/step - loss: 0.0806 -
accuracy: 0.9750 - val_loss: 22.7262 - val_accuracy: 0.3365
Epoch 20/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0305 -
accuracy: 0.9914 - val_loss: 8.0728 - val_accuracy: 0.5457
Epoch 21/500
54/54 [==============================] - 17s 306ms/step - loss: 0.0672 -
accuracy: 0.9778 - val_loss: 13.9867 - val_accuracy: 0.3317
Epoch 22/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0390 -
accuracy: 0.9886 - val_loss: 3.8246 - val_accuracy: 0.4423
Epoch 23/500
54/54 [==============================] - 18s 333ms/step - loss: 0.0522 -
accuracy: 0.9830 - val_loss: 2.3932 - val_accuracy: 0.6659
Epoch 24/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0280 -
accuracy: 0.9896 - val_loss: 24.6374 - val_accuracy: 0.3365
Epoch 25/500
54/54 [==============================] - 16s 300ms/step - loss: 0.0245 -
accuracy: 0.9901 - val_loss: 24.8931 - val_accuracy: 0.3221
Epoch 26/500
54/54 [==============================] - 16s 301ms/step - loss: 0.0209 -
accuracy: 0.9952 - val_loss: 15.5425 - val_accuracy: 0.3341
Epoch 27/500
54/54 [==============================] - 16s 304ms/step - loss: 0.0311 -
accuracy: 0.9904 - val_loss: 9.2503 - val_accuracy: 0.5505
Epoch 28/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0769 -
accuracy: 0.9804 - val_loss: 28.3348 - val_accuracy: 0.3365
Epoch 29/500
54/54 [==============================] - 17s 320ms/step - loss: 0.0247 -
accuracy: 0.9958 - val_loss: 0.4850 - val_accuracy: 0.7043
Epoch 30/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0271 -
accuracy: 0.9920 - val_loss: 8.9016 - val_accuracy: 0.3317
Epoch 31/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0061 -
accuracy: 0.9986 - val_loss: 2.2905 - val_accuracy: 0.6779
Epoch 32/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0354 -
accuracy: 0.9933 - val_loss: 2.7070 - val_accuracy: 0.3269
Epoch 33/500
54/54 [==============================] - 17s 321ms/step - loss: 0.0359 -
accuracy: 0.9886 - val_loss: 13.4739 - val_accuracy: 0.3221
Epoch 34/500
54/54 [==============================] - 18s 327ms/step - loss: 0.0711 -
accuracy: 0.9792 - val_loss: 8.2792 - val_accuracy: 0.3245
Epoch 35/500
```

```
54/54 [==============================] - 18s 340ms/step - loss: 0.0457 -
accuracy: 0.9875 - val_loss: 8.7024 - val_accuracy: 0.3317
Epoch 36/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0935 -
accuracy: 0.9722 - val_loss: 19.4724 - val_accuracy: 0.3341
Epoch 37/500
54/54 [==============================] - 18s 336ms/step - loss: 0.0202 -
accuracy: 0.9950 - val_loss: 4.3731 - val_accuracy: 0.4447
Epoch 38/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0358 -
accuracy: 0.9926 - val_loss: 4.1820 - val_accuracy: 0.6082
Epoch 39/500
54/54 [==============================] - 20s 378ms/step - loss: 0.0339 -
accuracy: 0.9863 - val_loss: 17.0178 - val_accuracy: 0.3413
Epoch 40/500
54/54 [==============================] - 19s 360ms/step - loss: 0.0280 -
accuracy: 0.9921 - val_loss: 21.8703 - val_accuracy: 0.3341
Epoch 41/500
54/54 [==============================] - 21s 396ms/step - loss: 0.0107 -
accuracy: 0.9952 - val_loss: 22.4195 - val_accuracy: 0.3558
Epoch 42/500
54/54 [==============================] - 22s 400ms/step - loss: 0.0302 -
accuracy: 0.9908 - val_loss: 32.3237 - val_accuracy: 0.3317
Epoch 43/500
54/54 [==============================] - 23s 432ms/step - loss: 0.0148 -
accuracy: 0.9941 - val_loss: 33.7887 - val_accuracy: 0.3341
Epoch 44/500
54/54 [==============================] - 21s 391ms/step - loss: 0.0190 -
accuracy: 0.9924 - val_loss: 40.0359 - val_accuracy: 0.3293
Epoch 45/500
54/54 [==============================] - 20s 367ms/step - loss: 0.0222 -
accuracy: 0.9932 - val_loss: 46.1657 - val_accuracy: 0.3413
Epoch 46/500
54/54 [==============================] - 21s 384ms/step - loss: 0.0014 -
accuracy: 0.9993 - val_loss: 59.9077 - val_accuracy: 0.3365
Epoch 47/500
54/54 [==============================] - 19s 359ms/step - loss: 0.0481 -
accuracy: 0.9881 - val_loss: 36.3791 - val_accuracy: 0.3293
Epoch 48/500
54/54 [==============================] - 19s 351ms/step - loss: 0.0103 -
accuracy: 0.9975 - val_loss: 27.3736 - val_accuracy: 0.3293
Epoch 49/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0701 -
accuracy: 0.9856 - val_loss: 21.9677 - val_accuracy: 0.3341
Epoch 50/500
54/54 [==============================] - 19s 353ms/step - loss: 0.0331 -
accuracy: 0.9887 - val_loss: 29.7851 - val_accuracy: 0.3269
Epoch 51/500
```

```
54/54 [==============================] - 18s 334ms/step - loss: 0.0294 -
accuracy: 0.9943 - val_loss: 16.8720 - val_accuracy: 0.3389
Epoch 52/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0838 -
accuracy: 0.9764 - val_loss: 29.8850 - val_accuracy: 0.3413
Epoch 53/500
54/54 [==============================] - 22s 412ms/step - loss: 0.0587 -
accuracy: 0.9829 - val_loss: 25.3516 - val_accuracy: 0.3245
Epoch 54/500
54/54 [==============================] - 24s 444ms/step - loss: 0.1404 -
accuracy: 0.9698 - val_loss: 12.2010 - val_accuracy: 0.5192
Epoch 55/500
54/54 [==============================] - 25s 454ms/step - loss: 0.0748 -
accuracy: 0.9825 - val_loss: 36.4433 - val_accuracy: 0.3221
Epoch 56/500
54/54 [==============================] - 24s 442ms/step - loss: 0.0699 -
accuracy: 0.9770 - val_loss: 19.5120 - val_accuracy: 0.3798
Epoch 57/500
54/54 [==============================] - 23s 415ms/step - loss: 0.0211 -
accuracy: 0.9933 - val_loss: 54.9786 - val_accuracy: 0.3341
Epoch 58/500
54/54 [==============================] - 13s 242ms/step - loss: 0.0131 -
accuracy: 0.9957 - val_loss: 71.8453 - val_accuracy: 0.3413
Epoch 59/500
54/54 [==============================] - 16s 288ms/step - loss: 0.0026 -
accuracy: 0.9987 - val_loss: 59.1999 - val_accuracy: 0.3365
Epoch 60/500
54/54 [==============================] - 17s 316ms/step - loss: 0.0101 -
accuracy: 0.9977 - val_loss: 17.6527 - val_accuracy: 0.3197
Epoch 61/500
54/54 [==============================] - 17s 316ms/step - loss: 0.1186 -
accuracy: 0.9767 - val_loss: 1.3973 - val_accuracy: 0.4255
Epoch 62/500
54/54 [==============================] - 17s 322ms/step - loss: 0.0809 -
accuracy: 0.9723 - val_loss: 27.4339 - val_accuracy: 0.3365
Epoch 63/500
54/54 [==============================] - 17s 323ms/step - loss: 0.0869 -
accuracy: 0.9825 - val_loss: 53.9124 - val_accuracy: 0.3293
Epoch 64/500
54/54 [==============================] - 18s 326ms/step - loss: 0.0521 -
accuracy: 0.9807 - val_loss: 66.0329 - val_accuracy: 0.3221
Epoch 65/500
54/54 [==============================] - 18s 330ms/step - loss: 0.0361 -
accuracy: 0.9925 - val_loss: 23.2149 - val_accuracy: 0.3534
Epoch 66/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0319 -
accuracy: 0.9916 - val_loss: 20.0540 - val_accuracy: 0.3389
Epoch 67/500
```

```
54/54 [==============================] - 19s 347ms/step - loss: 0.0081 -
accuracy: 0.9988 - val_loss: 13.4462 - val_accuracy: 0.4928
Epoch 68/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0167 -
accuracy: 0.9969 - val_loss: 25.8290 - val_accuracy: 0.3293
Epoch 69/500
54/54 [==============================] - 16s 298ms/step - loss: 0.0283 -
accuracy: 0.9921 - val_loss: 24.0323 - val_accuracy: 0.3438
Epoch 70/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0230 -
accuracy: 0.9919 - val_loss: 32.7899 - val_accuracy: 0.3341
Epoch 71/500
54/54 [==============================] - 16s 296ms/step - loss: 0.0025 -
accuracy: 1.0000 - val_loss: 39.1873 - val_accuracy: 0.3341
Epoch 72/500
54/54 [==============================] - 16s 297ms/step - loss: 0.0088 -
accuracy: 0.9970 - val_loss: 17.9413 - val_accuracy: 0.3413
Epoch 73/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0112 -
accuracy: 0.9959 - val_loss: 0.1151 - val_accuracy: 0.9591
Epoch 74/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0259 -
accuracy: 0.9909 - val_loss: 1.9834 - val_accuracy: 0.6130
Epoch 75/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0147 -
accuracy: 0.9987 - val_loss: 34.3543 - val_accuracy: 0.3317
Epoch 76/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0157 -
accuracy: 0.9942 - val_loss: 2.7662 - val_accuracy: 0.4663
Epoch 77/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0068 -
accuracy: 0.9988 - val_loss: 7.8735 - val_accuracy: 0.4135
Epoch 78/500
54/54 [==============================] - 17s 314ms/step - loss: 0.0200 -
accuracy: 0.9940 - val_loss: 32.8413 - val_accuracy: 0.3365
Epoch 79/500
54/54 [==============================] - 17s 314ms/step - loss: 0.0128 -
accuracy: 0.9930 - val_loss: 1.5313 - val_accuracy: 0.6851
Epoch 80/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0036 -
accuracy: 0.9983 - val_loss: 1.9092 - val_accuracy: 0.6827
Epoch 81/500
54/54 [==============================] - 18s 324ms/step - loss: 0.0246 -
accuracy: 0.9934 - val_loss: 35.8909 - val_accuracy: 0.3197
Epoch 82/500
54/54 [==============================] - 18s 326ms/step - loss: 0.0171 -
accuracy: 0.9950 - val_loss: 9.7760 - val_accuracy: 0.5673
Epoch 83/500
```

```
54/54 [==============================] - 18s 328ms/step - loss: 0.0114 -
accuracy: 0.9950 - val_loss: 3.9986 - val_accuracy: 0.6466
Epoch 84/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0150 -
accuracy: 0.9966 - val_loss: 24.8852 - val_accuracy: 0.3534
Epoch 85/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0100 -
accuracy: 0.9987 - val_loss: 16.9621 - val_accuracy: 0.3341
Epoch 86/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0078 -
accuracy: 0.9960 - val_loss: 39.5791 - val_accuracy: 0.5409
Epoch 87/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0062 -
accuracy: 0.9986 - val_loss: 9.0084 - val_accuracy: 0.4183
Epoch 88/500
54/54 [==============================] - 19s 349ms/step - loss: 0.0040 -
accuracy: 0.9993 - val_loss: 13.2334 - val_accuracy: 0.6683
Epoch 89/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0093 -
accuracy: 0.9974 - val_loss: 43.1830 - val_accuracy: 0.3389
Epoch 90/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0225 -
accuracy: 0.9912 - val_loss: 106.8340 - val_accuracy: 0.3317
Epoch 91/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0215 -
accuracy: 0.9948 - val_loss: 42.2665 - val_accuracy: 0.3197
Epoch 92/500
54/54 [==============================] - 19s 349ms/step - loss: 0.0115 -
accuracy: 0.9975 - val_loss: 0.9375 - val_accuracy: 0.6394
Epoch 93/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0012 -
accuracy: 1.0000 - val_loss: 55.8504 - val_accuracy: 0.3486
Epoch 94/500
54/54 [==============================] - 19s 348ms/step - loss: 0.0348 -
accuracy: 0.9895 - val_loss: 14.0523 - val_accuracy: 0.5168
Epoch 95/500
54/54 [==============================] - 19s 346ms/step - loss: 0.1809 -
accuracy: 0.9762 - val_loss: 14.0737 - val_accuracy: 0.3221
Epoch 96/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0919 -
accuracy: 0.9787 - val_loss: 4.0765 - val_accuracy: 0.4784
Epoch 97/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0590 -
accuracy: 0.9856 - val_loss: 46.4800 - val_accuracy: 0.3365
Epoch 98/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0470 -
accuracy: 0.9901 - val_loss: 46.4905 - val_accuracy: 0.3462
Epoch 99/500
```

```
54/54 [==============================] - 19s 348ms/step - loss: 0.0139 -
accuracy: 0.9956 - val_loss: 37.1175 - val_accuracy: 0.3510
Epoch 100/500
54/54 [==============================] - 19s 348ms/step - loss: 0.0160 -
accuracy: 0.9967 - val_loss: 2.8773 - val_accuracy: 0.6611
Epoch 101/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0114 -
accuracy: 0.9955 - val_loss: 7.3593 - val_accuracy: 0.5865
Epoch 102/500
54/54 [==============================] - 19s 353ms/step - loss: 0.0091 -
accuracy: 0.9972 - val_loss: 18.8954 - val_accuracy: 0.4375
Epoch 103/500
54/54 [==============================] - 19s 349ms/step - loss: 0.0098 -
accuracy: 0.9963 - val_loss: 10.5248 - val_accuracy: 0.4976
Epoch 104/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0040 -
accuracy: 0.9982 - val_loss: 4.9357 - val_accuracy: 0.5793
Epoch 105/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0019 -
accuracy: 0.9998 - val_loss: 9.5911 - val_accuracy: 0.3462
Epoch 106/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0376 -
accuracy: 0.9910 - val_loss: 10.7497 - val_accuracy: 0.4255
Epoch 107/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0202 -
accuracy: 0.9944 - val_loss: 33.2379 - val_accuracy: 0.3221
Epoch 108/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0110 -
accuracy: 0.9975 - val_loss: 48.3126 - val_accuracy: 0.3269
Epoch 109/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0021 -
accuracy: 0.9992 - val_loss: 1.5244 - val_accuracy: 0.7236
Epoch 110/500
54/54 [==============================] - 18s 338ms/step - loss: 0.0761 -
accuracy: 0.9772 - val_loss: 48.6761 - val_accuracy: 0.3365
Epoch 111/500
54/54 [==============================] - 18s 331ms/step - loss: 0.0070 -
accuracy: 0.9980 - val_loss: 28.7520 - val_accuracy: 0.4543
Epoch 112/500
54/54 [==============================] - 18s 328ms/step - loss: 0.0375 -
accuracy: 0.9946 - val_loss: 13.1986 - val_accuracy: 0.3870
Epoch 113/500
54/54 [==============================] - 18s 333ms/step - loss: 0.0396 -
accuracy: 0.9848 - val_loss: 57.4512 - val_accuracy: 0.3341
Epoch 114/500
54/54 [==============================] - 18s 333ms/step - loss: 0.0174 -
accuracy: 0.9963 - val_loss: 70.0984 - val_accuracy: 0.3365
Epoch 115/500
```

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54/54 [==============================] - 18s 337ms/step - loss: 0.0072 -
accuracy: 0.9980 - val_loss: 2.5083 - val_accuracy: 0.4543
Epoch 116/500
54/54 [==============================] - 19s 349ms/step - loss: 0.0107 -
accuracy: 0.9967 - val_loss: 42.8185 - val_accuracy: 0.3245
Epoch 117/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0039 -
accuracy: 1.0000 - val_loss: 9.5193 - val_accuracy: 0.5913
Epoch 118/500
54/54 [==============================] - 19s 348ms/step - loss: 0.0029 -
accuracy: 0.9984 - val_loss: 65.9858 - val_accuracy: 0.3534
Epoch 119/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0162 -
accuracy: 0.9962 - val_loss: 71.7023 - val_accuracy: 0.3389
Epoch 120/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0213 -
accuracy: 0.9974 - val_loss: 27.9667 - val_accuracy: 0.3365
Epoch 121/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0451 -
accuracy: 0.9890 - val_loss: 27.1689 - val_accuracy: 0.3269
Epoch 122/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0216 -
accuracy: 0.9951 - val_loss: 11.9578 - val_accuracy: 0.5938
Epoch 123/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0118 -
accuracy: 0.9979 - val_loss: 43.8122 - val_accuracy: 0.3413
Epoch 124/500
54/54 [==============================] - 19s 345ms/step - loss: 0.1100 -
accuracy: 0.9644 - val_loss: 4.4448 - val_accuracy: 0.4375
Epoch 125/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0382 -
accuracy: 0.9805 - val_loss: 74.3904 - val_accuracy: 0.3293
Epoch 126/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0139 -
accuracy: 0.9956 - val_loss: 94.6304 - val_accuracy: 0.3438
Epoch 127/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0033 -
accuracy: 0.9994 - val_loss: 70.4924 - val_accuracy: 0.3293
Epoch 128/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0154 -
accuracy: 0.9958 - val_loss: 109.1095 - val_accuracy: 0.3269
Epoch 129/500
54/54 [==============================] - 18s 332ms/step - loss: 0.0215 -
accuracy: 0.9919 - val_loss: 3.3741 - val_accuracy: 0.6707
Epoch 130/500
54/54 [==============================] - 18s 338ms/step - loss: 0.0046 -
accuracy: 0.9985 - val_loss: 141.9347 - val_accuracy: 0.3365
Epoch 131/500
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54/54 [==============================] - 18s 338ms/step - loss: 0.0324 -
accuracy: 0.9937 - val_loss: 69.6763 - val_accuracy: 0.3293
Epoch 132/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0026 -
accuracy: 1.0000 - val_loss: 78.8748 - val_accuracy: 0.3942
Epoch 133/500
54/54 [==============================] - 19s 348ms/step - loss: 4.2621e-04 -
accuracy: 1.0000 - val_loss: 64.7945 - val_accuracy: 0.5721
Epoch 134/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0045 -
accuracy: 0.9978 - val_loss: 169.6505 - val_accuracy: 0.3245
Epoch 135/500
54/54 [==============================] - 19s 346ms/step - loss: 4.5644e-04 -
accuracy: 0.9999 - val_loss: 69.8450 - val_accuracy: 0.4447
Epoch 136/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0012 -
accuracy: 0.9997 - val_loss: 5.8184 - val_accuracy: 0.6707
Epoch 137/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0156 -
accuracy: 0.9939 - val_loss: 116.1733 - val_accuracy: 0.3365
Epoch 138/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0078 -
accuracy: 0.9972 - val_loss: 122.7325 - val_accuracy: 0.3293
Epoch 139/500
54/54 [==============================] - 19s 342ms/step - loss: 0.0808 -
accuracy: 0.9763 - val_loss: 102.0887 - val_accuracy: 0.3966
Epoch 140/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0365 -
accuracy: 0.9881 - val_loss: 29.8844 - val_accuracy: 0.3389
Epoch 141/500
54/54 [==============================] - 19s 350ms/step - loss: 0.0260 -
accuracy: 0.9899 - val_loss: 9.1920 - val_accuracy: 0.6202
Epoch 142/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0805 -
accuracy: 0.9791 - val_loss: 3.7597 - val_accuracy: 0.6683
Epoch 143/500
54/54 [==============================] - 18s 338ms/step - loss: 0.0045 -
accuracy: 0.9982 - val_loss: 6.9729 - val_accuracy: 0.6346
Epoch 144/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0026 -
accuracy: 0.9989 - val_loss: 0.9452 - val_accuracy: 0.8966
Epoch 145/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0095 -
accuracy: 0.9974 - val_loss: 2.0514 - val_accuracy: 0.6707
Epoch 146/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0101 -
accuracy: 0.9976 - val_loss: 3.5278 - val_accuracy: 0.3942
Epoch 147/500
```

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54/54 [==============================] - 18s 342ms/step - loss: 0.0011 -
accuracy: 0.9991 - val_loss: 0.0643 - val_accuracy: 0.9856
Epoch 148/500
54/54 [==============================] - 19s 346ms/step - loss: 4.7868e-05 -
accuracy: 1.0000 - val_loss: 0.0736 - val_accuracy: 0.9880
Epoch 149/500
54/54 [==============================] - 19s 345ms/step - loss: 3.1516e-05 -
accuracy: 1.0000 - val_loss: 0.2402 - val_accuracy: 0.9712
Epoch 150/500
54/54 [==============================] - 19s 345ms/step - loss: 2.2070e-04 -
accuracy: 0.9999 - val_loss: 0.1989 - val_accuracy: 0.9567
Epoch 151/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0486 -
accuracy: 0.9871 - val_loss: 14.6794 - val_accuracy: 0.6562
Epoch 152/500
54/54 [==============================] - 19s 348ms/step - loss: 0.0068 -
accuracy: 0.9974 - val_loss: 18.5263 - val_accuracy: 0.5144
Epoch 153/500
54/54 [==============================] - 18s 331ms/step - loss: 0.0055 -
accuracy: 0.9977 - val_loss: 1.7204 - val_accuracy: 0.6490
Epoch 154/500
54/54 [==============================] - 18s 338ms/step - loss: 0.0015 -
accuracy: 1.0000 - val_loss: 1.0072 - val_accuracy: 0.7163
Epoch 155/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0027 -
accuracy: 1.0000 - val_loss: 0.0429 - val_accuracy: 0.9880
Epoch 156/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0747 -
accuracy: 0.9915 - val_loss: 50.3642 - val_accuracy: 0.3389
Epoch 157/500
54/54 [==============================] - 19s 348ms/step - loss: 0.0908 -
accuracy: 0.9750 - val_loss: 3.0523 - val_accuracy: 0.6370
Epoch 158/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0158 -
accuracy: 0.9934 - val_loss: 59.6182 - val_accuracy: 0.3293
Epoch 159/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0344 -
accuracy: 0.9899 - val_loss: 66.6053 - val_accuracy: 0.3317
Epoch 160/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0215 -
accuracy: 0.9953 - val_loss: 33.1099 - val_accuracy: 0.3510
Epoch 161/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0055 -
accuracy: 0.9975 - val_loss: 53.4686 - val_accuracy: 0.3269
Epoch 162/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0056 -
accuracy: 0.9978 - val_loss: 38.0449 - val_accuracy: 0.3317
Epoch 163/500
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54/54 [==============================] - 18s 340ms/step - loss: 0.0023 -
accuracy: 1.0000 - val_loss: 13.6990 - val_accuracy: 0.5192
Epoch 164/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0066 -
accuracy: 0.9986 - val_loss: 124.4887 - val_accuracy: 0.3317
Epoch 165/500
54/54 [==============================] - 19s 346ms/step - loss: 0.0022 -
accuracy: 0.9998 - val_loss: 119.7394 - val_accuracy: 0.3341
Epoch 166/500
54/54 [==============================] - 19s 344ms/step - loss: 5.6857e-04 -
accuracy: 0.9999 - val_loss: 120.6628 - val_accuracy: 0.3221
Epoch 167/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0169 -
accuracy: 0.9974 - val_loss: 104.6451 - val_accuracy: 0.3269
Epoch 168/500
54/54 [==============================] - 21s 380ms/step - loss: 0.0182 -
accuracy: 0.9975 - val_loss: 10.7130 - val_accuracy: 0.5529
Epoch 169/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0348 -
accuracy: 0.9890 - val_loss: 107.4608 - val_accuracy: 0.3293
Epoch 170/500
54/54 [==============================] - 21s 395ms/step - loss: 0.0034 -
accuracy: 0.9994 - val_loss: 114.7476 - val_accuracy: 0.3365
Epoch 171/500
54/54 [==============================] - 19s 354ms/step - loss: 2.6225e-04 -
accuracy: 1.0000 - val_loss: 112.0127 - val_accuracy: 0.3293
Epoch 172/500
54/54 [==============================] - 19s 353ms/step - loss: 5.7698e-05 -
accuracy: 1.0000 - val_loss: 40.4314 - val_accuracy: 0.4928
Epoch 173/500
54/54 [==============================] - 21s 397ms/step - loss: 2.1925e-05 -
accuracy: 1.0000 - val_loss: 7.3669 - val_accuracy: 0.6635
Epoch 174/500
54/54 [==============================] - 19s 352ms/step - loss: 8.7551e-06 -
accuracy: 1.0000 - val_loss: 1.7648 - val_accuracy: 0.7740
Epoch 175/500
54/54 [==============================] - 17s 318ms/step - loss: 1.9974e-05 -
accuracy: 1.0000 - val_loss: 0.1623 - val_accuracy: 0.9760
Epoch 176/500
54/54 [==============================] - 15s 276ms/step - loss: 8.6744e-06 -
accuracy: 1.0000 - val_loss: 0.0846 - val_accuracy: 0.9880
Epoch 177/500
54/54 [==============================] - 15s 278ms/step - loss: 5.4502e-04 -
accuracy: 0.9998 - val_loss: 89.7190 - val_accuracy: 0.3389
Epoch 178/500
54/54 [==============================] - 15s 277ms/step - loss: 0.0447 -
accuracy: 0.9902 - val_loss: 1.3296 - val_accuracy: 0.6466
Epoch 179/500
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54/54 [==============================] - 15s 279ms/step - loss: 0.0226 -
accuracy: 0.9941 - val_loss: 67.8263 - val_accuracy: 0.3317
Epoch 180/500
54/54 [==============================] - 15s 277ms/step - loss: 0.0047 -
accuracy: 0.9992 - val_loss: 91.8273 - val_accuracy: 0.3389
Epoch 181/500
54/54 [==============================] - 15s 280ms/step - loss: 0.0083 -
accuracy: 0.9984 - val_loss: 54.3687 - val_accuracy: 0.3317
Epoch 182/500
54/54 [==============================] - 15s 276ms/step - loss: 0.0157 -
accuracy: 0.9954 - val_loss: 68.0787 - val_accuracy: 0.3245
Epoch 183/500
54/54 [==============================] - 16s 289ms/step - loss: 0.0109 -
accuracy: 0.9979 - val_loss: 73.2711 - val_accuracy: 0.3317
Epoch 184/500
54/54 [==============================] - 16s 293ms/step - loss: 0.0035 -
accuracy: 0.9987 - val_loss: 4.3280 - val_accuracy: 0.4062
Epoch 185/500
54/54 [==============================] - 16s 294ms/step - loss: 0.0094 -
accuracy: 0.9987 - val_loss: 0.9301 - val_accuracy: 0.6611
Epoch 186/500
54/54 [==============================] - 16s 300ms/step - loss: 0.0169 -
accuracy: 0.9979 - val_loss: 78.3781 - val_accuracy: 0.3269
Epoch 187/500
54/54 [==============================] - 16s 301ms/step - loss: 0.0047 -
accuracy: 0.9980 - val_loss: 62.6589 - val_accuracy: 0.3606
Epoch 188/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0174 -
accuracy: 0.9954 - val_loss: 26.6324 - val_accuracy: 0.6611
Epoch 189/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0019 -
accuracy: 0.9988 - val_loss: 22.0281 - val_accuracy: 0.6707
Epoch 190/500
54/54 [==============================] - 17s 305ms/step - loss: 0.0025 -
accuracy: 0.9997 - val_loss: 1.1803 - val_accuracy: 0.7332
Epoch 191/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0399 -
accuracy: 0.9952 - val_loss: 2.9656 - val_accuracy: 0.6731
Epoch 192/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0108 -
accuracy: 0.9962 - val_loss: 57.7008 - val_accuracy: 0.3245
Epoch 193/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0074 -
accuracy: 0.9998 - val_loss: 84.0329 - val_accuracy: 0.3269
Epoch 194/500
54/54 [==============================] - 17s 311ms/step - loss: 8.6717e-04 -
accuracy: 0.9995 - val_loss: 81.6532 - val_accuracy: 0.3221
Epoch 195/500
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54/54 [==============================] - 17s 310ms/step - loss: 0.0076 -
accuracy: 0.9985 - val_loss: 98.9346 - val_accuracy: 0.3245
Epoch 196/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0013 -
accuracy: 0.9998 - val_loss: 48.7523 - val_accuracy: 0.3413
Epoch 197/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0020 -
accuracy: 0.9986 - val_loss: 50.3682 - val_accuracy: 0.3413
Epoch 198/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0032 -
accuracy: 0.9975 - val_loss: 27.6761 - val_accuracy: 0.3582
Epoch 199/500
54/54 [==============================] - 17s 311ms/step - loss: 6.5788e-04 -
accuracy: 1.0000 - val_loss: 6.1784 - val_accuracy: 0.5409
Epoch 200/500
54/54 [==============================] - 17s 314ms/step - loss: 0.0020 -
accuracy: 0.9989 - val_loss: 1.0828 - val_accuracy: 0.7668
Epoch 201/500
54/54 [==============================] - 17s 310ms/step - loss: 2.1327e-04 -
accuracy: 1.0000 - val_loss: 0.0938 - val_accuracy: 0.9832
Epoch 202/500
54/54 [==============================] - 17s 312ms/step - loss: 2.5448e-06 -
accuracy: 1.0000 - val_loss: 0.0368 - val_accuracy: 0.9952
Epoch 203/500
54/54 [==============================] - 17s 313ms/step - loss: 2.0646e-06 -
accuracy: 1.0000 - val_loss: 0.0493 - val_accuracy: 0.9952
Epoch 204/500
54/54 [==============================] - 17s 305ms/step - loss: 8.1012e-07 -
accuracy: 1.0000 - val_loss: 0.0469 - val_accuracy: 0.9952
Epoch 205/500
54/54 [==============================] - 16s 303ms/step - loss: 6.4862e-06 -
accuracy: 1.0000 - val_loss: 0.0313 - val_accuracy: 0.9952
Epoch 206/500
54/54 [==============================] - 16s 305ms/step - loss: 2.6204e-04 -
accuracy: 1.0000 - val_loss: 0.3871 - val_accuracy: 0.9327
Epoch 207/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0266 -
accuracy: 0.9969 - val_loss: 36.7802 - val_accuracy: 0.3269
Epoch 208/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0566 -
accuracy: 0.9882 - val_loss: 19.2613 - val_accuracy: 0.3534
Epoch 209/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0219 -
accuracy: 0.9933 - val_loss: 35.2791 - val_accuracy: 0.3221
Epoch 210/500
54/54 [==============================] - 17s 320ms/step - loss: 0.0134 -
accuracy: 0.9969 - val_loss: 97.3211 - val_accuracy: 0.3269
Epoch 211/500
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54/54 [==============================] - 18s 331ms/step - loss: 0.0078 -
accuracy: 0.9960 - val_loss: 103.3467 - val_accuracy: 0.3269
Epoch 212/500
54/54 [==============================] - 17s 314ms/step - loss: 0.0043 -
accuracy: 0.9971 - val_loss: 125.3893 - val_accuracy: 0.3365
Epoch 213/500
54/54 [==============================] - 17s 312ms/step - loss: 9.9037e-04 -
accuracy: 0.9997 - val_loss: 116.7638 - val_accuracy: 0.3365
Epoch 214/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0205 -
accuracy: 0.9929 - val_loss: 126.9912 - val_accuracy: 0.3365
Epoch 215/500
54/54 [==============================] - 17s 316ms/step - loss: 0.0685 -
accuracy: 0.9844 - val_loss: 83.8732 - val_accuracy: 0.3365
Epoch 216/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0153 -
accuracy: 0.9961 - val_loss: 72.9643 - val_accuracy: 0.3365
Epoch 217/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0118 -
accuracy: 0.9968 - val_loss: 0.4971 - val_accuracy: 0.8582
Epoch 218/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0149 -
accuracy: 0.9906 - val_loss: 0.2487 - val_accuracy: 0.9519
Epoch 219/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0271 -
accuracy: 0.9909 - val_loss: 109.0853 - val_accuracy: 0.3269
Epoch 220/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0152 -
accuracy: 0.9965 - val_loss: 8.9789 - val_accuracy: 0.4014
Epoch 221/500
54/54 [==============================] - 17s 315ms/step - loss: 0.0054 -
accuracy: 0.9955 - val_loss: 3.0936 - val_accuracy: 0.6178
Epoch 222/500
54/54 [==============================] - 17s 311ms/step - loss: 1.1319e-04 -
accuracy: 1.0000 - val_loss: 0.4795 - val_accuracy: 0.9351
Epoch 223/500
54/54 [==============================] - 17s 311ms/step - loss: 3.9691e-04 -
accuracy: 1.0000 - val_loss: 0.0668 - val_accuracy: 0.9880
Epoch 224/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0014 -
accuracy: 1.0000 - val_loss: 3.1132 - val_accuracy: 0.5913
Epoch 225/500
54/54 [==============================] - 17s 308ms/step - loss: 1.5566e-04 -
accuracy: 1.0000 - val_loss: 0.0916 - val_accuracy: 0.9784
Epoch 226/500
54/54 [==============================] - 17s 307ms/step - loss: 6.6134e-04 -
accuracy: 0.9998 - val_loss: 1.1883 - val_accuracy: 0.7909
Epoch 227/500
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54/54 [==============================] - 17s 312ms/step - loss: 0.1030 -
accuracy: 0.9955 - val_loss: 16.0098 - val_accuracy: 0.3269
Epoch 228/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0596 -
accuracy: 0.9853 - val_loss: 11.7751 - val_accuracy: 0.3365
Epoch 229/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0831 -
accuracy: 0.9929 - val_loss: 12.8509 - val_accuracy: 0.3702
Epoch 230/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0433 -
accuracy: 0.9898 - val_loss: 0.0908 - val_accuracy: 0.9736
Epoch 231/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0481 -
accuracy: 0.9878 - val_loss: 13.5961 - val_accuracy: 0.5457
Epoch 232/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0142 -
accuracy: 0.9959 - val_loss: 115.1288 - val_accuracy: 0.4231
Epoch 233/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0346 -
accuracy: 0.9874 - val_loss: 70.7416 - val_accuracy: 0.3438
Epoch 234/500
54/54 [==============================] - 17s 305ms/step - loss: 0.0067 -
accuracy: 0.9987 - val_loss: 0.9138 - val_accuracy: 0.8894
Epoch 235/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0151 -
accuracy: 0.9934 - val_loss: 2.9870 - val_accuracy: 0.7284
Epoch 236/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0032 -
accuracy: 0.9992 - val_loss: 9.5957 - val_accuracy: 0.6490
Epoch 237/500
54/54 [==============================] - 16s 300ms/step - loss: 0.0024 -
accuracy: 0.9995 - val_loss: 1.9733 - val_accuracy: 0.7933
Epoch 238/500
54/54 [==============================] - 17s 307ms/step - loss: 7.8776e-04 -
accuracy: 1.0000 - val_loss: 1.5001 - val_accuracy: 0.8582
Epoch 239/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0027 -
accuracy: 0.9996 - val_loss: 0.2352 - val_accuracy: 0.9832
Epoch 240/500
54/54 [==============================] - 17s 311ms/step - loss: 7.6048e-04 -
accuracy: 0.9999 - val_loss: 0.0998 - val_accuracy: 0.9928
Epoch 241/500
54/54 [==============================] - 17s 311ms/step - loss: 1.6222e-04 -
accuracy: 1.0000 - val_loss: 0.1304 - val_accuracy: 0.9880
Epoch 242/500
54/54 [==============================] - 17s 310ms/step - loss: 4.3786e-05 -
accuracy: 1.0000 - val_loss: 0.0818 - val_accuracy: 0.9928
Epoch 243/500
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54/54 [==============================] - 17s 307ms/step - loss: 1.0736e-04 -
accuracy: 1.0000 - val_loss: 0.0838 - val_accuracy: 0.9904
Epoch 244/500
54/54 [==============================] - 17s 308ms/step - loss: 2.8012e-05 -
accuracy: 1.0000 - val_loss: 0.1188 - val_accuracy: 0.9880
Epoch 245/500
54/54 [==============================] - 17s 310ms/step - loss: 2.1338e-05 -
accuracy: 1.0000 - val_loss: 0.1272 - val_accuracy: 0.9928
Epoch 246/500
54/54 [==============================] - 17s 311ms/step - loss: 7.1030e-06 -
accuracy: 1.0000 - val_loss: 0.0381 - val_accuracy: 0.9952
Epoch 247/500
54/54 [==============================] - 17s 310ms/step - loss: 3.9198e-05 -
accuracy: 1.0000 - val_loss: 0.0645 - val_accuracy: 0.9928
Epoch 248/500
54/54 [==============================] - 17s 312ms/step - loss: 9.1951e-06 -
accuracy: 1.0000 - val_loss: 0.0579 - val_accuracy: 0.9928
Epoch 249/500
54/54 [==============================] - 17s 307ms/step - loss: 6.7506e-06 -
accuracy: 1.0000 - val_loss: 0.0655 - val_accuracy: 0.9904
Epoch 250/500
54/54 [==============================] - 16s 301ms/step - loss: 1.3366e-04 -
accuracy: 1.0000 - val_loss: 0.2088 - val_accuracy: 0.9688
Epoch 251/500
54/54 [==============================] - 16s 304ms/step - loss: 0.0095 -
accuracy: 0.9979 - val_loss: 213.0587 - val_accuracy: 0.3317
Epoch 252/500
54/54 [==============================] - 16s 304ms/step - loss: 0.0059 -
accuracy: 0.9996 - val_loss: 98.8510 - val_accuracy: 0.5577
Epoch 253/500
54/54 [==============================] - 16s 300ms/step - loss: 0.0129 -
accuracy: 0.9937 - val_loss: 219.8500 - val_accuracy: 0.3389
Epoch 254/500
54/54 [==============================] - 16s 304ms/step - loss: 0.0013 -
accuracy: 0.9992 - val_loss: 166.5837 - val_accuracy: 0.3966
Epoch 255/500
54/54 [==============================] - 17s 307ms/step - loss: 1.6386e-04 -
accuracy: 1.0000 - val_loss: 55.3658 - val_accuracy: 0.6082
Epoch 256/500
54/54 [==============================] - 17s 312ms/step - loss: 6.2000e-05 -
accuracy: 1.0000 - val_loss: 3.1707 - val_accuracy: 0.7548
Epoch 257/500
54/54 [==============================] - 17s 314ms/step - loss: 1.7971e-04 -
accuracy: 1.0000 - val_loss: 0.5948 - val_accuracy: 0.9399
Epoch 258/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0069 -
accuracy: 0.9981 - val_loss: 45.5208 - val_accuracy: 0.3173
Epoch 259/500
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54/54 [==============================] - 16s 302ms/step - loss: 0.0092 -
accuracy: 0.9958 - val_loss: 82.4774 - val_accuracy: 0.3317
Epoch 260/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0082 -
accuracy: 0.9961 - val_loss: 60.1401 - val_accuracy: 0.3197
Epoch 261/500
54/54 [==============================] - 17s 306ms/step - loss: 0.0033 -
accuracy: 0.9997 - val_loss: 6.5259 - val_accuracy: 0.4111
Epoch 262/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0251 -
accuracy: 0.9915 - val_loss: 1.8188 - val_accuracy: 0.6659
Epoch 263/500
54/54 [==============================] - 17s 312ms/step - loss: 9.9255e-04 -
accuracy: 1.0000 - val_loss: 0.0595 - val_accuracy: 0.9832
Epoch 264/500
54/54 [==============================] - 17s 310ms/step - loss: 1.1432e-04 -
accuracy: 1.0000 - val_loss: 0.0369 - val_accuracy: 0.9928
Epoch 265/500
54/54 [==============================] - 17s 310ms/step - loss: 1.6088e-04 -
accuracy: 1.0000 - val_loss: 0.0281 - val_accuracy: 0.9952
Epoch 266/500
54/54 [==============================] - 17s 311ms/step - loss: 2.1226e-04 -
accuracy: 1.0000 - val_loss: 1.2125 - val_accuracy: 0.7861
Epoch 267/500
54/54 [==============================] - 17s 312ms/step - loss: 4.6161e-05 -
accuracy: 1.0000 - val_loss: 0.0675 - val_accuracy: 0.9880
Epoch 268/500
54/54 [==============================] - 17s 309ms/step - loss: 1.6477e-05 -
accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 0.9880
Epoch 269/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0104 -
accuracy: 0.9969 - val_loss: 4.9695 - val_accuracy: 0.3486
Epoch 270/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0177 -
accuracy: 0.9951 - val_loss: 8.2384 - val_accuracy: 0.5986
Epoch 271/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0045 -
accuracy: 0.9993 - val_loss: 20.6670 - val_accuracy: 0.4038
Epoch 272/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0240 -
accuracy: 0.9933 - val_loss: 121.5924 - val_accuracy: 0.3413
Epoch 273/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0013 -
accuracy: 0.9997 - val_loss: 175.7887 - val_accuracy: 0.3341
Epoch 274/500
54/54 [==============================] - 17s 314ms/step - loss: 0.0030 -
accuracy: 0.9991 - val_loss: 22.3897 - val_accuracy: 0.3269
Epoch 275/500
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54/54 [==============================] - 17s 313ms/step - loss: 0.0024 -
accuracy: 0.9992 - val_loss: 13.2568 - val_accuracy: 0.3438
Epoch 276/500
54/54 [==============================] - 17s 309ms/step - loss: 9.3775e-04 -
accuracy: 1.0000 - val_loss: 2.0511 - val_accuracy: 0.6418
Epoch 277/500
54/54 [==============================] - 17s 307ms/step - loss: 1.1806e-04 -
accuracy: 1.0000 - val_loss: 0.3532 - val_accuracy: 0.9231
Epoch 278/500
54/54 [==============================] - 17s 311ms/step - loss: 1.0192e-05 -
accuracy: 1.0000 - val_loss: 0.0976 - val_accuracy: 0.9856
Epoch 279/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0012 -
accuracy: 1.0000 - val_loss: 1.0599 - val_accuracy: 0.8630
Epoch 280/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0215 -
accuracy: 0.9966 - val_loss: 60.9927 - val_accuracy: 0.3221
Epoch 281/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0167 -
accuracy: 0.9949 - val_loss: 27.1026 - val_accuracy: 0.3269
Epoch 282/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0232 -
accuracy: 0.9919 - val_loss: 38.0822 - val_accuracy: 0.3245
Epoch 283/500
54/54 [==============================] - 16s 304ms/step - loss: 5.2509e-05 -
accuracy: 1.0000 - val_loss: 6.0436 - val_accuracy: 0.4976
Epoch 284/500
54/54 [==============================] - 16s 302ms/step - loss: 4.6440e-04 -
accuracy: 1.0000 - val_loss: 0.4862 - val_accuracy: 0.9207
Epoch 285/500
54/54 [==============================] - 16s 301ms/step - loss: 0.0181 -
accuracy: 0.9969 - val_loss: 19.3160 - val_accuracy: 0.6442
Epoch 286/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0072 -
accuracy: 0.9970 - val_loss: 4.7806 - val_accuracy: 0.6611
Epoch 287/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0048 -
accuracy: 0.9986 - val_loss: 3.2098 - val_accuracy: 0.5889
Epoch 288/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0100 -
accuracy: 0.9953 - val_loss: 201.1188 - val_accuracy: 0.3317
Epoch 289/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0039 -
accuracy: 0.9992 - val_loss: 5.4820 - val_accuracy: 0.4231
Epoch 290/500
54/54 [==============================] - 17s 312ms/step - loss: 9.4908e-04 -
accuracy: 1.0000 - val_loss: 1.8663 - val_accuracy: 0.6106
Epoch 291/500
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54/54 [==============================] - 17s 312ms/step - loss: 1.8016e-04 -
accuracy: 1.0000 - val_loss: 0.2614 - val_accuracy: 0.9255
Epoch 292/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0045 -
accuracy: 0.9989 - val_loss: 0.0917 - val_accuracy: 0.9712
Epoch 293/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0046 -
accuracy: 0.9992 - val_loss: 3.5203 - val_accuracy: 0.6490
Epoch 294/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0055 -
accuracy: 1.0000 - val_loss: 1.8396 - val_accuracy: 0.6827
Epoch 295/500
54/54 [==============================] - 16s 304ms/step - loss: 8.8978e-04 -
accuracy: 0.9998 - val_loss: 0.6158 - val_accuracy: 0.8438
Epoch 296/500
54/54 [==============================] - 16s 301ms/step - loss: 0.0159 -
accuracy: 0.9935 - val_loss: 46.2791 - val_accuracy: 0.3149
Epoch 297/500
54/54 [==============================] - 17s 305ms/step - loss: 0.0045 -
accuracy: 1.0000 - val_loss: 10.0443 - val_accuracy: 0.3365
Epoch 298/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0019 -
accuracy: 0.9994 - val_loss: 102.4854 - val_accuracy: 0.3197
Epoch 299/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0083 -
accuracy: 0.9985 - val_loss: 186.1451 - val_accuracy: 0.3269
Epoch 300/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0464 -
accuracy: 0.9829 - val_loss: 113.1238 - val_accuracy: 0.3317
Epoch 301/500
54/54 [==============================] - 17s 312ms/step - loss: 0.0082 -
accuracy: 0.9981 - val_loss: 132.8485 - val_accuracy: 0.3245
Epoch 302/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0271 -
accuracy: 0.9938 - val_loss: 38.0350 - val_accuracy: 0.3245
Epoch 303/500
54/54 [==============================] - 17s 310ms/step - loss: 8.0660e-04 -
accuracy: 0.9998 - val_loss: 127.2534 - val_accuracy: 0.3221
Epoch 304/500
54/54 [==============================] - 17s 309ms/step - loss: 0.0124 -
accuracy: 0.9968 - val_loss: 14.7443 - val_accuracy: 0.3197
Epoch 305/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0140 -
accuracy: 0.9959 - val_loss: 15.6937 - val_accuracy: 0.3630
Epoch 306/500
54/54 [==============================] - 16s 304ms/step - loss: 0.0075 -
accuracy: 0.9968 - val_loss: 7.3809 - val_accuracy: 0.6202
Epoch 307/500
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54/54 [==============================] - 16s 300ms/step - loss: 0.0091 -
accuracy: 0.9976 - val_loss: 59.1746 - val_accuracy: 0.3197
Epoch 308/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0074 -
accuracy: 0.9959 - val_loss: 8.4888 - val_accuracy: 0.3606
Epoch 309/500
54/54 [==============================] - 16s 301ms/step - loss: 0.0012 -
accuracy: 0.9996 - val_loss: 2.3146 - val_accuracy: 0.7380
Epoch 310/500
54/54 [==============================] - 17s 309ms/step - loss: 4.4547e-04 -
accuracy: 1.0000 - val_loss: 40.3080 - val_accuracy: 0.6394
Epoch 311/500
54/54 [==============================] - 18s 336ms/step - loss: 8.7519e-04 -
accuracy: 0.9999 - val_loss: 136.1943 - val_accuracy: 0.3534
Epoch 312/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0039 -
accuracy: 0.9994 - val_loss: 77.3868 - val_accuracy: 0.4399
Epoch 313/500
54/54 [==============================] - 17s 306ms/step - loss: 2.1050e-04 -
accuracy: 1.0000 - val_loss: 40.4712 - val_accuracy: 0.6130
Epoch 314/500
54/54 [==============================] - 17s 312ms/step - loss: 4.6641e-04 -
accuracy: 0.9999 - val_loss: 7.0279 - val_accuracy: 0.6851
Epoch 315/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0020 -
accuracy: 0.9997 - val_loss: 17.9665 - val_accuracy: 0.5409
Epoch 316/500
54/54 [==============================] - 17s 308ms/step - loss: 4.8699e-04 -
accuracy: 1.0000 - val_loss: 0.2254 - val_accuracy: 0.9784
Epoch 317/500
54/54 [==============================] - 16s 302ms/step - loss: 3.6538e-05 -
accuracy: 1.0000 - val_loss: 0.0663 - val_accuracy: 0.9904
Epoch 318/500
54/54 [==============================] - 16s 298ms/step - loss: 7.4784e-05 -
accuracy: 1.0000 - val_loss: 0.0484 - val_accuracy: 0.9928
Epoch 319/500
54/54 [==============================] - 16s 301ms/step - loss: 2.7479e-05 -
accuracy: 1.0000 - val_loss: 0.0468 - val_accuracy: 0.9952
Epoch 320/500
54/54 [==============================] - 16s 302ms/step - loss: 0.0059 -
accuracy: 0.9973 - val_loss: 154.8115 - val_accuracy: 0.3245
Epoch 321/500
54/54 [==============================] - 17s 315ms/step - loss: 3.9003e-04 -
accuracy: 1.0000 - val_loss: 163.0662 - val_accuracy: 0.3173
Epoch 322/500
54/54 [==============================] - 17s 315ms/step - loss: 6.2189e-05 -
accuracy: 1.0000 - val_loss: 150.2540 - val_accuracy: 0.3317
Epoch 323/500
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54/54 [==============================] - 17s 311ms/step - loss: 1.9978e-04 -
accuracy: 0.9999 - val_loss: 32.2344 - val_accuracy: 0.3245
Epoch 324/500
54/54 [==============================] - 17s 311ms/step - loss: 6.3127e-04 -
accuracy: 0.9999 - val_loss: 0.0548 - val_accuracy: 0.9928
Epoch 325/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0029 -
accuracy: 0.9973 - val_loss: 0.7241 - val_accuracy: 0.8438
Epoch 326/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0286 -
accuracy: 0.9956 - val_loss: 120.4672 - val_accuracy: 0.3389
Epoch 327/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0105 -
accuracy: 0.9969 - val_loss: 8.3452 - val_accuracy: 0.4327
Epoch 328/500
54/54 [==============================] - 17s 311ms/step - loss: 6.7081e-04 -
accuracy: 1.0000 - val_loss: 1.9350 - val_accuracy: 0.6683
Epoch 329/500
54/54 [==============================] - 17s 318ms/step - loss: 2.0056e-04 -
accuracy: 1.0000 - val_loss: 0.5134 - val_accuracy: 0.8462
Epoch 330/500
54/54 [==============================] - 17s 307ms/step - loss: 9.4060e-05 -
accuracy: 1.0000 - val_loss: 0.1644 - val_accuracy: 0.9688
Epoch 331/500
54/54 [==============================] - 17s 308ms/step - loss: 4.0560e-05 -
accuracy: 1.0000 - val_loss: 0.2595 - val_accuracy: 0.9760
Epoch 332/500
54/54 [==============================] - 17s 312ms/step - loss: 4.4680e-06 -
accuracy: 1.0000 - val_loss: 0.1188 - val_accuracy: 0.9856
Epoch 333/500
54/54 [==============================] - 17s 313ms/step - loss: 2.1494e-05 -
accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 0.9880
Epoch 334/500
54/54 [==============================] - 17s 309ms/step - loss: 3.6969e-06 -
accuracy: 1.0000 - val_loss: 0.0731 - val_accuracy: 0.9928
Epoch 335/500
54/54 [==============================] - 17s 311ms/step - loss: 2.7960e-06 -
accuracy: 1.0000 - val_loss: 0.0775 - val_accuracy: 0.9904
Epoch 336/500
54/54 [==============================] - 17s 312ms/step - loss: 2.1356e-05 -
accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 0.9904
Epoch 337/500
54/54 [==============================] - 17s 307ms/step - loss: 2.6077e-06 -
accuracy: 1.0000 - val_loss: 0.1205 - val_accuracy: 0.9928
Epoch 338/500
54/54 [==============================] - 17s 308ms/step - loss: 4.4672e-06 -
accuracy: 1.0000 - val_loss: 0.0676 - val_accuracy: 0.9952
Epoch 339/500
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54/54 [==============================] - 17s 310ms/step - loss: 1.6038e-06 -
accuracy: 1.0000 - val_loss: 0.0709 - val_accuracy: 0.9952
Epoch 340/500
54/54 [==============================] - 17s 309ms/step - loss: 3.1180e-06 -
accuracy: 1.0000 - val_loss: 0.0406 - val_accuracy: 0.9952
Epoch 341/500
54/54 [==============================] - 17s 309ms/step - loss: 9.8416e-06 -
accuracy: 1.0000 - val_loss: 0.0480 - val_accuracy: 0.9952
Epoch 342/500
54/54 [==============================] - 17s 307ms/step - loss: 7.8835e-07 -
accuracy: 1.0000 - val_loss: 0.0475 - val_accuracy: 0.9928
Epoch 343/500
54/54 [==============================] - 17s 309ms/step - loss: 1.1664e-05 -
accuracy: 1.0000 - val_loss: 0.1340 - val_accuracy: 0.9952
Epoch 344/500
54/54 [==============================] - 17s 310ms/step - loss: 1.6149e-06 -
accuracy: 1.0000 - val_loss: 0.0864 - val_accuracy: 0.9952
Epoch 345/500
54/54 [==============================] - 17s 307ms/step - loss: 3.5314e-07 -
accuracy: 1.0000 - val_loss: 0.0555 - val_accuracy: 0.9952
Epoch 346/500
54/54 [==============================] - 17s 308ms/step - loss: 2.2310e-06 -
accuracy: 1.0000 - val_loss: 0.0599 - val_accuracy: 0.9904
Epoch 347/500
54/54 [==============================] - 16s 305ms/step - loss: 3.0627e-05 -
accuracy: 1.0000 - val_loss: 0.1232 - val_accuracy: 0.9928
Epoch 348/500
54/54 [==============================] - 17s 308ms/step - loss: 0.0196 -
accuracy: 0.9960 - val_loss: 44.0763 - val_accuracy: 0.3317
Epoch 349/500
54/54 [==============================] - 16s 305ms/step - loss: 0.0408 -
accuracy: 0.9904 - val_loss: 68.9829 - val_accuracy: 0.3317
Epoch 350/500
54/54 [==============================] - 17s 319ms/step - loss: 0.0280 -
accuracy: 0.9930 - val_loss: 41.2128 - val_accuracy: 0.3894
Epoch 351/500
54/54 [==============================] - 17s 310ms/step - loss: 0.0032 -
accuracy: 0.9993 - val_loss: 13.1568 - val_accuracy: 0.5072
Epoch 352/500
54/54 [==============================] - 17s 307ms/step - loss: 0.0480 -
accuracy: 0.9891 - val_loss: 1.1000 - val_accuracy: 0.7596
Epoch 353/500
54/54 [==============================] - 16s 303ms/step - loss: 0.0177 -
accuracy: 0.9965 - val_loss: 2.2588 - val_accuracy: 0.5601
Epoch 354/500
54/54 [==============================] - 17s 306ms/step - loss: 0.0034 -
accuracy: 0.9991 - val_loss: 99.9162 - val_accuracy: 0.3269
Epoch 355/500
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54/54 [==============================] - 17s 310ms/step - loss: 0.0026 -
accuracy: 0.9998 - val_loss: 71.6443 - val_accuracy: 0.3341
Epoch 356/500
54/54 [==============================] - 17s 311ms/step - loss: 0.0235 -
accuracy: 0.9909 - val_loss: 24.4450 - val_accuracy: 0.4062
Epoch 357/500
54/54 [==============================] - 17s 313ms/step - loss: 0.0023 -
accuracy: 0.9992 - val_loss: 30.2608 - val_accuracy: 0.5264
Epoch 358/500
54/54 [==============================] - 17s 321ms/step - loss: 1.9618e-04 -
accuracy: 1.0000 - val_loss: 6.1629 - val_accuracy: 0.6659
Epoch 359/500
54/54 [==============================] - 17s 321ms/step - loss: 7.2181e-04 -
accuracy: 0.9998 - val_loss: 0.0866 - val_accuracy: 0.9736
Epoch 360/500
54/54 [==============================] - 17s 323ms/step - loss: 0.0063 -
accuracy: 0.9970 - val_loss: 0.1532 - val_accuracy: 0.9880
Epoch 361/500
54/54 [==============================] - 18s 329ms/step - loss: 0.0647 -
accuracy: 0.9913 - val_loss: 0.5304 - val_accuracy: 0.8125
Epoch 362/500
54/54 [==============================] - 18s 330ms/step - loss: 0.0471 -
accuracy: 0.9885 - val_loss: 211.8268 - val_accuracy: 0.3293
Epoch 363/500
54/54 [==============================] - 18s 334ms/step - loss: 0.0087 -
accuracy: 0.9987 - val_loss: 290.0982 - val_accuracy: 0.3341
Epoch 364/500
54/54 [==============================] - 18s 336ms/step - loss: 2.8065e-04 -
accuracy: 1.0000 - val_loss: 217.3516 - val_accuracy: 0.3750
Epoch 365/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0012 -
accuracy: 0.9997 - val_loss: 82.2165 - val_accuracy: 0.6226
Epoch 366/500
54/54 [==============================] - 19s 345ms/step - loss: 1.4902e-04 -
accuracy: 1.0000 - val_loss: 140.3148 - val_accuracy: 0.6274
Epoch 367/500
54/54 [==============================] - 19s 342ms/step - loss: 0.0016 -
accuracy: 0.9996 - val_loss: 0.1386 - val_accuracy: 0.9784
Epoch 368/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0190 -
accuracy: 0.9974 - val_loss: 109.3726 - val_accuracy: 0.0168
Epoch 369/500
54/54 [==============================] - 18s 342ms/step - loss: 4.6630e-04 -
accuracy: 1.0000 - val_loss: 40.7015 - val_accuracy: 0.2981
Epoch 370/500
54/54 [==============================] - 19s 344ms/step - loss: 3.3660e-05 -
accuracy: 1.0000 - val_loss: 2.4744 - val_accuracy: 0.6611
Epoch 371/500
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54/54 [==============================] - 19s 347ms/step - loss: 1.1767e-04 -
accuracy: 1.0000 - val_loss: 0.1195 - val_accuracy: 0.9832
Epoch 372/500
54/54 [==============================] - 18s 342ms/step - loss: 2.3844e-05 -
accuracy: 1.0000 - val_loss: 0.0521 - val_accuracy: 0.9928
Epoch 373/500
54/54 [==============================] - 19s 346ms/step - loss: 5.1356e-04 -
accuracy: 0.9995 - val_loss: 6.4172 - val_accuracy: 0.5096
Epoch 374/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0014 -
accuracy: 0.9996 - val_loss: 2.6064 - val_accuracy: 0.7139
Epoch 375/500
54/54 [==============================] - 19s 345ms/step - loss: 3.3403e-04 -
accuracy: 1.0000 - val_loss: 8.0773 - val_accuracy: 0.4952
Epoch 376/500
54/54 [==============================] - 19s 344ms/step - loss: 1.0185e-05 -
accuracy: 1.0000 - val_loss: 0.7807 - val_accuracy: 0.8990
Epoch 377/500
54/54 [==============================] - 19s 346ms/step - loss: 2.8692e-05 -
accuracy: 1.0000 - val_loss: 0.0219 - val_accuracy: 0.9952
Epoch 378/500
54/54 [==============================] - 18s 340ms/step - loss: 9.9672e-07 -
accuracy: 1.0000 - val_loss: 0.1891 - val_accuracy: 0.9976
Epoch 379/500
54/54 [==============================] - 19s 346ms/step - loss: 2.3106e-05 -
accuracy: 1.0000 - val_loss: 0.0659 - val_accuracy: 0.9928
Epoch 380/500
54/54 [==============================] - 19s 347ms/step - loss: 3.0320e-06 -
accuracy: 1.0000 - val_loss: 0.0457 - val_accuracy: 0.9952
Epoch 381/500
54/54 [==============================] - 19s 345ms/step - loss: 2.0797e-06 -
accuracy: 1.0000 - val_loss: 0.1370 - val_accuracy: 0.9976
Epoch 382/500
54/54 [==============================] - 19s 345ms/step - loss: 4.5496e-05 -
accuracy: 1.0000 - val_loss: 0.0405 - val_accuracy: 0.9952
Epoch 383/500
54/54 [==============================] - 19s 342ms/step - loss: 5.0355e-05 -
accuracy: 1.0000 - val_loss: 0.1401 - val_accuracy: 0.9928
Epoch 384/500
54/54 [==============================] - 19s 347ms/step - loss: 3.5962e-05 -
accuracy: 1.0000 - val_loss: 16.8042 - val_accuracy: 0.6851
Epoch 385/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0082 -
accuracy: 0.9981 - val_loss: 372.7028 - val_accuracy: 0.3413
Epoch 386/500
54/54 [==============================] - 19s 343ms/step - loss: 4.4516e-04 -
accuracy: 0.9998 - val_loss: 347.8006 - val_accuracy: 0.3293
Epoch 387/500
```

```
54/54 [==============================] - 19s 343ms/step - loss: 0.0015 -
accuracy: 0.9998 - val_loss: 189.1129 - val_accuracy: 0.3654
Epoch 388/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0049 -
accuracy: 0.9992 - val_loss: 211.2339 - val_accuracy: 0.3341
Epoch 389/500
54/54 [==============================] - 19s 342ms/step - loss: 0.0121 -
accuracy: 0.9974 - val_loss: 69.4624 - val_accuracy: 0.3341
Epoch 390/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0076 -
accuracy: 0.9956 - val_loss: 1.7959 - val_accuracy: 0.6899
Epoch 391/500
54/54 [==============================] - 18s 339ms/step - loss: 8.9938e-05 -
accuracy: 1.0000 - val_loss: 2.6708 - val_accuracy: 0.7837
Epoch 392/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0038 -
accuracy: 0.9994 - val_loss: 7.4775 - val_accuracy: 0.4135
Epoch 393/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0024 -
accuracy: 0.9999 - val_loss: 2.6664 - val_accuracy: 0.6370
Epoch 394/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0014 -
accuracy: 0.9990 - val_loss: 19.8276 - val_accuracy: 0.5481
Epoch 395/500
54/54 [==============================] - 19s 343ms/step - loss: 7.1439e-05 -
accuracy: 1.0000 - val_loss: 34.3325 - val_accuracy: 0.6538
Epoch 396/500
54/54 [==============================] - 18s 340ms/step - loss: 9.7946e-05 -
accuracy: 1.0000 - val_loss: 6.0294 - val_accuracy: 0.7019
Epoch 397/500
54/54 [==============================] - 18s 342ms/step - loss: 3.1270e-04 -
accuracy: 1.0000 - val_loss: 7.2987 - val_accuracy: 0.6947
Epoch 398/500
54/54 [==============================] - 19s 344ms/step - loss: 7.3651e-05 -
accuracy: 1.0000 - val_loss: 143.3756 - val_accuracy: 0.4712
Epoch 399/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0118 -
accuracy: 0.9977 - val_loss: 50.6277 - val_accuracy: 0.3389
Epoch 400/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0199 -
accuracy: 0.9940 - val_loss: 14.2041 - val_accuracy: 0.4736
Epoch 401/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0034 -
accuracy: 0.9989 - val_loss: 13.1102 - val_accuracy: 0.5889
Epoch 402/500
54/54 [==============================] - 18s 342ms/step - loss: 1.5486e-04 -
accuracy: 1.0000 - val_loss: 1.6152 - val_accuracy: 0.7572
Epoch 403/500
```

```
54/54 [==============================] - 19s 343ms/step - loss: 0.0331 -
accuracy: 0.9926 - val_loss: 46.6000 - val_accuracy: 0.0529
Epoch 404/500
54/54 [==============================] - 18s 340ms/step - loss: 0.0012 -
accuracy: 1.0000 - val_loss: 123.4665 - val_accuracy: 0.3269
Epoch 405/500
54/54 [==============================] - 18s 331ms/step - loss: 9.2115e-04 -
accuracy: 1.0000 - val_loss: 113.7809 - val_accuracy: 0.3293
Epoch 406/500
54/54 [==============================] - 18s 327ms/step - loss: 0.0175 -
accuracy: 0.9980 - val_loss: 4.7175 - val_accuracy: 0.5024
Epoch 407/500
54/54 [==============================] - 18s 329ms/step - loss: 0.0205 -
accuracy: 0.9942 - val_loss: 81.9235 - val_accuracy: 0.3245
Epoch 408/500
54/54 [==============================] - 18s 333ms/step - loss: 0.0129 -
accuracy: 0.9988 - val_loss: 1.2342 - val_accuracy: 0.7019
Epoch 409/500
54/54 [==============================] - 18s 338ms/step - loss: 4.2944e-04 -
accuracy: 1.0000 - val_loss: 0.0533 - val_accuracy: 0.9904
Epoch 410/500
54/54 [==============================] - 18s 341ms/step - loss: 1.1396e-04 -
accuracy: 1.0000 - val_loss: 0.0426 - val_accuracy: 0.9904
Epoch 411/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0018 -
accuracy: 0.9997 - val_loss: 9.9194 - val_accuracy: 0.4351
Epoch 412/500
54/54 [==============================] - 19s 348ms/step - loss: 6.2459e-04 -
accuracy: 1.0000 - val_loss: 0.1456 - val_accuracy: 0.9663
Epoch 413/500
54/54 [==============================] - 21s 380ms/step - loss: 1.3266e-04 -
accuracy: 1.0000 - val_loss: 0.0404 - val_accuracy: 0.9928
Epoch 414/500
54/54 [==============================] - 18s 338ms/step - loss: 0.0018 -
accuracy: 0.9990 - val_loss: 58.7406 - val_accuracy: 0.3438
Epoch 415/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0379 -
accuracy: 0.9931 - val_loss: 54.6556 - val_accuracy: 0.3486
Epoch 416/500
54/54 [==============================] - 18s 336ms/step - loss: 0.0028 -
accuracy: 0.9994 - val_loss: 87.3058 - val_accuracy: 0.3173
Epoch 417/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0057 -
accuracy: 0.9974 - val_loss: 71.8763 - val_accuracy: 0.3317
Epoch 418/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0017 -
accuracy: 0.9991 - val_loss: 5.5865 - val_accuracy: 0.5889
Epoch 419/500
```

```
54/54 [==============================] - 19s 357ms/step - loss: 9.7831e-04 -
accuracy: 0.9995 - val_loss: 3.0799 - val_accuracy: 0.7861
Epoch 420/500
54/54 [==============================] - 20s 359ms/step - loss: 5.6785e-04 -
accuracy: 1.0000 - val_loss: 0.1304 - val_accuracy: 0.9832
Epoch 421/500
54/54 [==============================] - 18s 339ms/step - loss: 4.8747e-05 -
accuracy: 1.0000 - val_loss: 0.0503 - val_accuracy: 0.9928
Epoch 422/500
54/54 [==============================] - 18s 336ms/step - loss: 1.7236e-04 -
accuracy: 1.0000 - val_loss: 0.0212 - val_accuracy: 0.9976
Epoch 423/500
54/54 [==============================] - 18s 334ms/step - loss: 0.0195 -
accuracy: 0.9978 - val_loss: 2.4839 - val_accuracy: 0.6010
Epoch 424/500
54/54 [==============================] - 18s 336ms/step - loss: 0.0012 -
accuracy: 1.0000 - val_loss: 0.1861 - val_accuracy: 0.9712
Epoch 425/500
54/54 [==============================] - 19s 342ms/step - loss: 1.0648e-04 -
accuracy: 1.0000 - val_loss: 0.0489 - val_accuracy: 0.9928
Epoch 426/500
54/54 [==============================] - 19s 345ms/step - loss: 1.4283e-05 -
accuracy: 1.0000 - val_loss: 0.1163 - val_accuracy: 0.9952
Epoch 427/500
54/54 [==============================] - 18s 342ms/step - loss: 9.7820e-04 -
accuracy: 0.9998 - val_loss: 0.0484 - val_accuracy: 0.9952
Epoch 428/500
54/54 [==============================] - 19s 343ms/step - loss: 6.6616e-04 -
accuracy: 1.0000 - val_loss: 0.0942 - val_accuracy: 0.9952
Epoch 429/500
54/54 [==============================] - 19s 343ms/step - loss: 2.7956e-04 -
accuracy: 1.0000 - val_loss: 0.2233 - val_accuracy: 0.9880
Epoch 430/500
54/54 [==============================] - 18s 336ms/step - loss: 9.4633e-05 -
accuracy: 1.0000 - val_loss: 0.4814 - val_accuracy: 0.9760
Epoch 431/500
54/54 [==============================] - 18s 334ms/step - loss: 1.9222e-04 -
accuracy: 1.0000 - val_loss: 0.1608 - val_accuracy: 0.9904
Epoch 432/500
54/54 [==============================] - 19s 345ms/step - loss: 1.4848e-04 -
accuracy: 1.0000 - val_loss: 0.3546 - val_accuracy: 0.9808
Epoch 433/500
54/54 [==============================] - 18s 332ms/step - loss: 3.7270e-06 -
accuracy: 1.0000 - val_loss: 0.1916 - val_accuracy: 0.9904
Epoch 434/500
54/54 [==============================] - 18s 338ms/step - loss: 5.7110e-05 -
accuracy: 1.0000 - val_loss: 0.0237 - val_accuracy: 0.9928
Epoch 435/500
```

```
54/54 [==============================] - 18s 338ms/step - loss: 2.2855e-05 -
accuracy: 1.0000 - val_loss: 0.0358 - val_accuracy: 0.9928
Epoch 436/500
54/54 [==============================] - 19s 347ms/step - loss: 2.9779e-06 -
accuracy: 1.0000 - val_loss: 0.0283 - val_accuracy: 0.9952
Epoch 437/500
54/54 [==============================] - 19s 345ms/step - loss: 2.6554e-04 -
accuracy: 1.0000 - val_loss: 80.7220 - val_accuracy: 0.4111
Epoch 438/500
54/54 [==============================] - 18s 341ms/step - loss: 0.0173 -
accuracy: 0.9967 - val_loss: 3.4390 - val_accuracy: 0.3654
Epoch 439/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0205 -
accuracy: 0.9984 - val_loss: 0.6388 - val_accuracy: 0.7115
Epoch 440/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0087 -
accuracy: 0.9975 - val_loss: 90.4615 - val_accuracy: 0.2909
Epoch 441/500
54/54 [==============================] - 18s 340ms/step - loss: 0.0152 -
accuracy: 0.9925 - val_loss: 3.4633 - val_accuracy: 0.6514
Epoch 442/500
54/54 [==============================] - 19s 344ms/step - loss: 0.0011 -
accuracy: 0.9998 - val_loss: 128.8319 - val_accuracy: 0.3101
Epoch 443/500
54/54 [==============================] - 18s 337ms/step - loss: 8.2414e-04 -
accuracy: 1.0000 - val_loss: 136.9113 - val_accuracy: 0.3197
Epoch 444/500
54/54 [==============================] - 18s 336ms/step - loss: 2.6583e-04 -
accuracy: 1.0000 - val_loss: 0.7369 - val_accuracy: 0.9014
Epoch 445/500
54/54 [==============================] - 19s 347ms/step - loss: 0.0022 -
accuracy: 0.9987 - val_loss: 0.7469 - val_accuracy: 0.9135
Epoch 446/500
54/54 [==============================] - 19s 347ms/step - loss: 2.6374e-04 -
accuracy: 1.0000 - val_loss: 0.0244 - val_accuracy: 0.9976
Epoch 447/500
54/54 [==============================] - 19s 344ms/step - loss: 1.4499e-04 -
accuracy: 1.0000 - val_loss: 0.2677 - val_accuracy: 0.9928
Epoch 448/500
54/54 [==============================] - 19s 345ms/step - loss: 0.0043 -
accuracy: 0.9993 - val_loss: 9.1079 - val_accuracy: 0.6827
Epoch 449/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0051 -
accuracy: 0.9986 - val_loss: 2.8010 - val_accuracy: 0.5264
Epoch 450/500
54/54 [==============================] - 18s 333ms/step - loss: 0.0239 -
accuracy: 0.9952 - val_loss: 6.5534 - val_accuracy: 0.5312
Epoch 451/500
```

```
54/54 [==============================] - 18s 329ms/step - loss: 0.0029 -
accuracy: 0.9997 - val_loss: 31.0955 - val_accuracy: 0.3654
Epoch 452/500
54/54 [==============================] - 18s 333ms/step - loss: 3.0669e-04 -
accuracy: 0.9997 - val_loss: 4.4112 - val_accuracy: 0.5793
Epoch 453/500
54/54 [==============================] - 18s 339ms/step - loss: 0.0107 -
accuracy: 0.9987 - val_loss: 2.6460 - val_accuracy: 0.7861
Epoch 454/500
54/54 [==============================] - 19s 343ms/step - loss: 1.2096e-05 -
accuracy: 1.0000 - val_loss: 0.7585 - val_accuracy: 0.9615
Epoch 455/500
54/54 [==============================] - 19s 345ms/step - loss: 2.3990e-05 -
accuracy: 1.0000 - val_loss: 0.2753 - val_accuracy: 0.9736
Epoch 456/500
54/54 [==============================] - 19s 344ms/step - loss: 1.6210e-04 -
accuracy: 1.0000 - val_loss: 0.0941 - val_accuracy: 0.9928
Epoch 457/500
54/54 [==============================] - 19s 344ms/step - loss: 3.7532e-06 -
accuracy: 1.0000 - val_loss: 0.0726 - val_accuracy: 0.9952
Epoch 458/500
54/54 [==============================] - 18s 340ms/step - loss: 6.0835e-06 -
accuracy: 1.0000 - val_loss: 0.1273 - val_accuracy: 0.9952
Epoch 459/500
54/54 [==============================] - 19s 343ms/step - loss: 1.4543e-05 -
accuracy: 1.0000 - val_loss: 0.1001 - val_accuracy: 0.9976
Epoch 460/500
54/54 [==============================] - 19s 342ms/step - loss: 1.2346e-05 -
accuracy: 1.0000 - val_loss: 0.0105 - val_accuracy: 0.9976
Epoch 461/500
54/54 [==============================] - 18s 335ms/step - loss: 1.0344e-06 -
accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 0.9952
Epoch 462/500
54/54 [==============================] - 19s 345ms/step - loss: 8.5478e-04 -
accuracy: 1.0000 - val_loss: 0.5174 - val_accuracy: 0.9591
Epoch 463/500
54/54 [==============================] - 18s 338ms/step - loss: 7.0041e-05 -
accuracy: 1.0000 - val_loss: 0.2515 - val_accuracy: 0.9880
Epoch 464/500
54/54 [==============================] - 19s 343ms/step - loss: 6.8003e-07 -
accuracy: 1.0000 - val_loss: 0.2195 - val_accuracy: 0.9928
Epoch 465/500
54/54 [==============================] - 19s 345ms/step - loss: 2.5375e-05 -
accuracy: 1.0000 - val_loss: 0.0154 - val_accuracy: 0.9952
Epoch 466/500
54/54 [==============================] - 18s 338ms/step - loss: 2.9942e-05 -
accuracy: 1.0000 - val_loss: 0.0587 - val_accuracy: 0.9952
Epoch 467/500
```

```
54/54 [==============================] - 18s 341ms/step - loss: 3.1883e-05 -
accuracy: 1.0000 - val_loss: 0.0106 - val_accuracy: 0.9976
Epoch 468/500
54/54 [==============================] - 18s 339ms/step - loss: 8.5506e-06 -
accuracy: 1.0000 - val_loss: 0.0098 - val_accuracy: 0.9976
Epoch 469/500
54/54 [==============================] - 18s 339ms/step - loss: 3.4980e-07 -
accuracy: 1.0000 - val_loss: 0.0167 - val_accuracy: 0.9952
Epoch 470/500
54/54 [==============================] - 18s 338ms/step - loss: 4.7907e-06 -
accuracy: 1.0000 - val_loss: 0.0859 - val_accuracy: 0.9976
Epoch 471/500
54/54 [==============================] - 18s 337ms/step - loss: 2.2695e-07 -
accuracy: 1.0000 - val_loss: 7.5850e-05 - val_accuracy: 1.0000
Epoch 472/500
54/54 [==============================] - 19s 342ms/step - loss: 1.6598e-07 -
accuracy: 1.0000 - val_loss: 0.0111 - val_accuracy: 0.9976
Epoch 473/500
54/54 [==============================] - 18s 342ms/step - loss: 7.5358e-09 -
accuracy: 1.0000 - val_loss: 0.0134 - val_accuracy: 0.9976
Epoch 474/500
54/54 [==============================] - 19s 343ms/step - loss: 5.9463e-05 -
accuracy: 1.0000 - val_loss: 0.0992 - val_accuracy: 0.9976
Epoch 475/500
54/54 [==============================] - 19s 349ms/step - loss: 6.1155e-08 -
accuracy: 1.0000 - val_loss: 0.0195 - val_accuracy: 0.9976
Epoch 476/500
54/54 [==============================] - 19s 343ms/step - loss: 1.5712e-06 -
accuracy: 1.0000 - val_loss: 0.0143 - val_accuracy: 0.9976
Epoch 477/500
54/54 [==============================] - 19s 346ms/step - loss: 4.5837e-08 -
accuracy: 1.0000 - val_loss: 0.0767 - val_accuracy: 0.9952
Epoch 478/500
54/54 [==============================] - 19s 349ms/step - loss: 0.0481 -
accuracy: 0.9966 - val_loss: 291.7560 - val_accuracy: 0.3341
Epoch 479/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0756 -
accuracy: 0.9849 - val_loss: 30.8915 - val_accuracy: 0.5264
Epoch 480/500
54/54 [==============================] - 18s 330ms/step - loss: 0.0021 -
accuracy: 0.9999 - val_loss: 40.7386 - val_accuracy: 0.5409
Epoch 481/500
54/54 [==============================] - 18s 337ms/step - loss: 0.0273 -
accuracy: 0.9922 - val_loss: 202.3821 - val_accuracy: 0.3317
Epoch 482/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0025 -
accuracy: 0.9994 - val_loss: 173.0067 - val_accuracy: 0.3365
Epoch 483/500
```

```
54/54 [==============================] - 18s 342ms/step - loss: 0.0027 -
accuracy: 0.9990 - val_loss: 54.3070 - val_accuracy: 0.5144
Epoch 484/500
54/54 [==============================] - 18s 338ms/step - loss: 0.2638 -
accuracy: 0.9798 - val_loss: 9.7696 - val_accuracy: 0.3678
Epoch 485/500
54/54 [==============================] - 18s 342ms/step - loss: 0.0046 -
accuracy: 0.9970 - val_loss: 108.9033 - val_accuracy: 0.3317
Epoch 486/500
54/54 [==============================] - 18s 332ms/step - loss: 0.0052 -
accuracy: 0.9978 - val_loss: 0.1429 - val_accuracy: 0.9808
Epoch 487/500
54/54 [==============================] - 18s 338ms/step - loss: 6.4841e-04 -
accuracy: 0.9999 - val_loss: 0.3336 - val_accuracy: 0.9375
Epoch 488/500
54/54 [==============================] - 19s 353ms/step - loss: 0.0015 -
accuracy: 0.9994 - val_loss: 0.4299 - val_accuracy: 0.8630
Epoch 489/500
54/54 [==============================] - 19s 346ms/step - loss: 7.9616e-05 -
accuracy: 1.0000 - val_loss: 0.0784 - val_accuracy: 0.9784
Epoch 490/500
54/54 [==============================] - 19s 345ms/step - loss: 2.5110e-05 -
accuracy: 1.0000 - val_loss: 0.0399 - val_accuracy: 0.9928
Epoch 491/500
54/54 [==============================] - 19s 346ms/step - loss: 3.4926e-04 -
accuracy: 0.9997 - val_loss: 0.0375 - val_accuracy: 0.9952
Epoch 492/500
54/54 [==============================] - 19s 358ms/step - loss: 0.0100 -
accuracy: 0.9973 - val_loss: 86.2996 - val_accuracy: 0.3197
Epoch 493/500
54/54 [==============================] - 19s 343ms/step - loss: 0.0026 -
accuracy: 0.9976 - val_loss: 0.1907 - val_accuracy: 0.9760
Epoch 494/500
54/54 [==============================] - 19s 348ms/step - loss: 3.3758e-05 -
accuracy: 1.0000 - val_loss: 0.0684 - val_accuracy: 0.9904
Epoch 495/500
54/54 [==============================] - 18s 340ms/step - loss: 4.5837e-06 -
accuracy: 1.0000 - val_loss: 0.0583 - val_accuracy: 0.9952
Epoch 496/500
54/54 [==============================] - 18s 337ms/step - loss: 4.6772e-05 -
accuracy: 1.0000 - val_loss: 0.0173 - val_accuracy: 0.9952
Epoch 497/500
54/54 [==============================] - 18s 340ms/step - loss: 6.0888e-06 -
accuracy: 1.0000 - val_loss: 0.0401 - val_accuracy: 0.9928
Epoch 498/500
54/54 [==============================] - 18s 341ms/step - loss: 2.8502e-07 -
accuracy: 1.0000 - val_loss: 0.1800 - val_accuracy: 0.9952
Epoch 499/500
```

```
54/54 [==============================] - 18s 337ms/step - loss: 3.3212e-06 -
accuracy: 1.0000 - val_loss: 0.0834 - val_accuracy: 0.9952
Epoch 500/500
54/54 [==============================] - 18s 334ms/step - loss: 1.2247e-05 -
accuracy: 1.0000 - val_loss: 0.0252 - val_accuracy: 0.9952
```

6 Acurácia

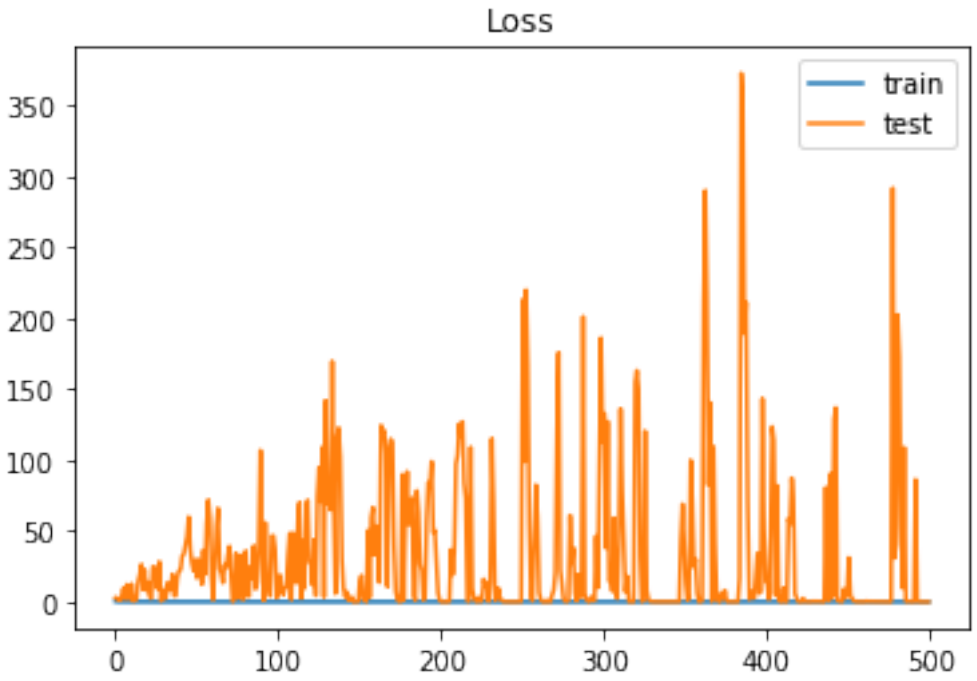
[8]:
```
results = model.evaluate_generator(test_generator, 10) # Função para calcular a␣
↪acurácia
print('Acc: %.3f, Loss: %.3f' % (results[1], results[0]))
```

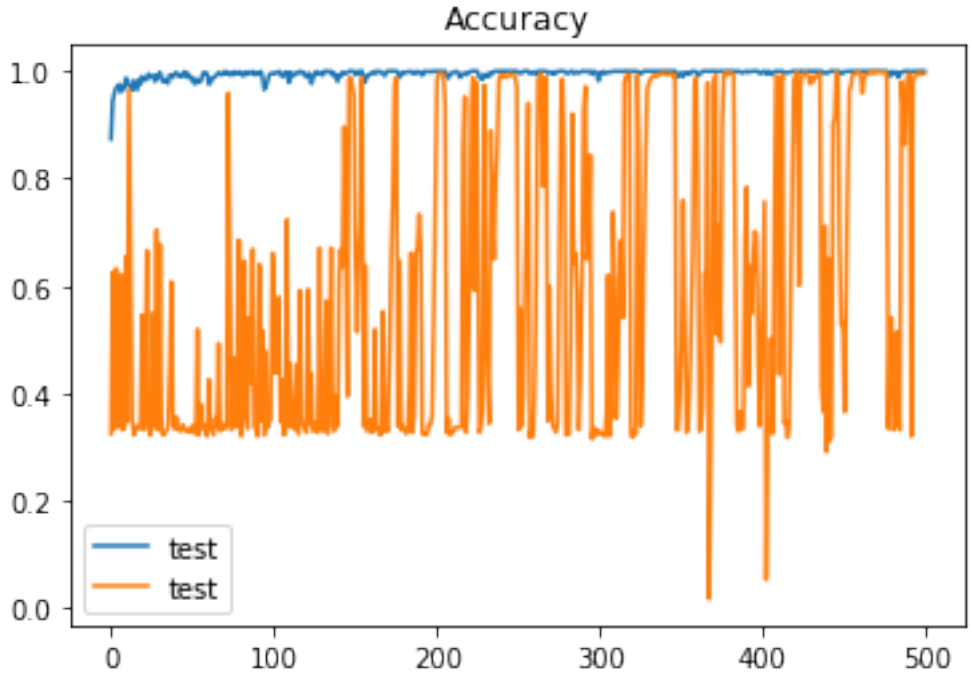
```
C:\ProgramData\Anaconda3\lib\site-
packages\tensorflow\python\keras\engine\training.py:1877: UserWarning:
`Model.evaluate_generator` is deprecated and will be removed in a future
version. Please use `Model.evaluate`, which supports generators.
  warnings.warn('`Model.evaluate_generator` is deprecated and '
```

```
Acc: 0.994, Loss: 0.095
```

7 Curvas de Aprendizado do modelo

[9]:
```
plt.title('Loss')
plt.plot(history.history['loss'], label='train')
plt.plot(history.history['val_loss'], label='test')
plt.legend()
plt.show()
# Criando graficos para visualização dos resultados
print()
print()
plt.title('Accuracy')
plt.plot(history.history['accuracy'], label='test')
plt.plot(history.history['val_accuracy'], label='test')
plt.legend()
plt.show()
```


Loss
train
test
350
300
250
200
150
100
50
0
0
100
200
300
400
500


Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
test
test
0
100
200
300
400
500

8 Resultados Classificação e Matriz de Confusão

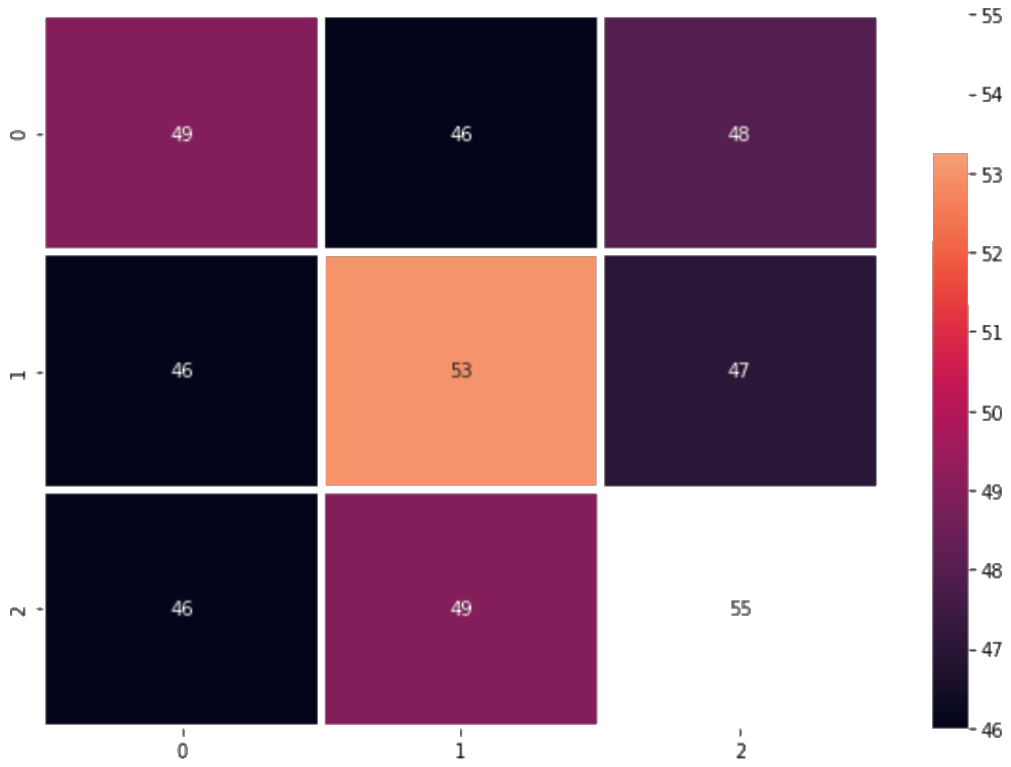
- Para obter os resultados do treinamento e usar o modelo treinado, precisa-se de fato realizar as previsões no dataset a fim de descobrir se o modelo está conseguindo prever de forma correta.
- Foi utilizada a função metrics.classification_report da biblioteca 'sklearn'.
- Dessa biblioteca, usamos os critérios de 'precision', 'recall' e 'f1-score' para obter as métricas de avaliação de resultados.
- Foram testadas 143 imagens da classe 'papel', 146 imagens da classe 'pedra' e 150 imagens da classe 'tesoura'
- Por fim, foi utilizado a biblioteca 'seaborn' para a apresentação da matriz de confusão, que é responsável por mostrar a quantidade de imagens previstas corretamente ou incorretamente.

[10]:
```
test_steps_per_epoch = np.math.ceil(test_generator.samples / test_generator.
 ↪batch_size) # Testes por época
predictions = model.predict_generator(test_generator,␣
 ↪steps=test_steps_per_epoch) # Criação das predições a partir do,␣
 ↪predict_generator do modelo
predicted_classes = np.argmax(predictions, axis=1)# classes de predição
true_classes = test_generator.classes #Classes de predição
class_labels = list(test_generator.class_indices.keys())
report = classification_report(true_classes, predicted_classes,␣
 ↪target_names=class_labels)
print(report)
matrix = confusion_matrix(true_classes,predicted_classes)
df_cm = pd.DataFrame(matrix, index = [i for i in range(3)],
columns = [i for i in range(3)])
plt.figure(figsize = (10,7))
sns.heatmap(df_cm, annot=True, linewidths=2.5)
```

```
C:\ProgramData\Anaconda3\lib\site-
packages\tensorflow\python\keras\engine\training.py:1905: UserWarning:
`Model.predict_generator` is deprecated and will be removed in a future version.
Please use `Model.predict`, which supports generators.
  warnings.warn('`Model.predict_generator` is deprecated and '
```

	precision	recall	f1-score	support
paper	0.35	0.34	0.35	143
rock	0.36	0.36	0.36	146
scissors	0.37	0.37	0.37	150
accuracy			0.36	439
macro avg	0.36	0.36	0.36	439
weighted avg	0.36	0.36	0.36	439

```
Matriz de Confusão:
```


49
46
48
46
53
47
46
49
55
0
1
2
0
1
2
55
54
53
52
51
50
49
48
47
46