REDES NEURAIS ARTIFICIAIS

Jefferson Gund

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NEU DATABASE:

http://faculty.neu.edu.cn/yunhyan/NEU_surface_defect_database.html

Descrição do problema:

Esta rede neural convolucional foi criada para classificar 6 tipos de falhas superficiais em chapas de aço: *rolled-in scale* (RS), *patches* (Pa), *crazing* (Cr), *pitted surface* (PS), *inclusion* (In) e *scratches* (Sc). A base de dados consiste em 1800 imagens com 300 amostras de cada tipo mais comum de falhas superficiais com resolução de 200x200 pixels, criada e disponibilizada pela *Northeastern University*.

A dificuldade de se classificar as imagens é devido à similaridades das falhas de uma mesma família de defeitos, como os tipo *rolled-in scale*, *crazing*, e *pitted surface*. Adicionalmente, a influencia da iluminação e mudanças no material, altera os valores das cores dos pixels.

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1 INICIO DO ALGORITMO:

Intalação de Bibliotecas Para Google Coolab

[1]:
```
#!pip install tensorflow-gpu==2.1.0.alpha0 #only needed for google coolab␣
 ↪notebook!
#!pip  install -q tf-nightly-2.0-preview
import zipfile
#from google.colab import drive #only needed for google coolab notebook!

import glob
import os
import tensorflow as tf
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from scipy import misc
import cv2

import os.path as path
```

```
from scipy import misc
from PIL import Image
import random
```

Bibliotecas Para Redes Neurais

[2]:
```
import datetime

#inicia tensorboard
%load_ext tensorboard

#remove todos logs de opreações anteriores
#!rm -rf ./logs/

import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Flatten, Dropout
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras import utils
from tensorflow.keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from sklearn.model_selection import StratifiedKFold

from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
```

LIBERA ACESSO AO GOOGLE DRIVE

[3]:
```
from google.colab import drive
drive.mount('/content/drive/', force_remount=True)
```

```
---------------------------------------------------------------------------

ModuleNotFoundError                       Traceback (most recent call last)

<ipython-input-3-46b63aa8e6cf> in <module>
----> 1 from google.colab import drive
      2 drive.mount('/content/drive/', force_remount=True)


ModuleNotFoundError: No module named 'google.colab'
```

Diretório de arquivos para treinamento:

[3]:
```
#Para Google Coolab:
#ZIP_PATH = '/content/drive/My Drive/Colab Notebooks/Data_Test/NEU - Steel␣
 ↪Superficial Defects/NEU surface defect database.zip'
```

```
#IMAGE_PATH = '/content/drive/My Drive/Colab Notebooks/Data_Test/NEU - Steel␣
 ↪Superficial Defects/TEMPORARIO/NEU surface defect database'

#Para windowns:
ZIP_PATH = 'C:/Users/JG/Desktop/RNA GUND/Codigo/'
IMAGE_PATH = 'C:/Users/GUND/Desktop/RNA GUND/Codigo/NEU surface defect database/'
```

EXTRAI ARQUIVO COMPACTADO PARA PASTA DO GOOGLE DRIVE (É NECESSÁRIO EXTRAIR SOMENTE UMA VEZ!!)

[ ]:
```
!mkdir IMAGE_PATH

zip_ref = zipfile.ZipFile(ZIP_PATH, 'r')
zip_ref.extractall(IMAGE_PATH)
zip_ref.close()
```

Abre as imagens descompactadas previamente:

[4]:
```
#Cria lista de arquivos cuja extensão seja "BMP"
file_paths = glob.glob(path.join(IMAGE_PATH, '*.bmp'))

num_imagens = len(file_paths)
num_imagens
#print(file_paths)
```

[4]:
```
1800
```

IMPORTA AS IMAGENS CONTIDAS NA PASTA

[5]:
```
img_width  = 50
img_height = 50

images = [cv2.imread(path)   for path in file_paths]

imgs_resized = [cv2.resize(image, (img_width,img_height)) for image in images ]

images = np.asarray(imgs_resized)

image_size = np.asarray([images.shape[1], images.shape[2], images.shape[3]])
```

EXTRAI OS NOMES DAS IMAGENS PARA A CLASSIFICAÇÃO

[6]:
```
#Lê os nomes das figuras
n_images = images.shape[0]
y_classes =[]
y_img_names =[]
for i in range(n_images):
    filename = path.basename(file_paths[i])[0:-4]
```

```
    y_img_names.append(filename)
    filename = path.basename(file_paths[i])[0:2]
    y_classes.append(filename)

y_img_names[156]
y_classes[156]
```

[6]:
```
'Cr'
```

CALCULA O NÚMERO TOTAL DE CLASSES

[7]:
```
# Scale
#X_data = images / 255

#num_train, height, width, depth = images.shape
#num_test = X_test.shape[0]
#Há 1800 imagens, com 6 classes de falhas, cada uma com 300 fotos
num_classes = np.unique(y_classes).shape[0]

num_classes
```

[7]:
```
6
```

NORMALIZA TODOS OS VALORES DE CODIGOS DE CORES RGB PARA ESCALA DE 0..1

[8]:
```
X_data = images
X_data = X_data.astype('float32')
X_data = X_data / 255


X_data /= np.max(X_data)
```

APLICA ENCODER ÀS CLASSES

[9]:
```
labelencoder = LabelEncoder()

y_classes = labelencoder.fit_transform(y_classes)

Y_classes_encoded = utils.to_categorical(y_classes, num_classes) # One-hot␣
 ↪encode the labels
```

[ ]:
```
y_classes[1500:1510]
```

[ ]:
```
Y_classes_encoded[1500:1510]
```

1.0.1 Divide a base de dados entre teste e treinamento:

[10]:
```
#test_size = percentual da base de dados destinado para testes
X_train, X_test, Y_train, Y_test = train_test_split(X_data , y_classes,␣
 ↪test_size = 0.03, random_state = 0)
#X_train, X_test, Y_train, Y_test = train_test_split(X_data , y_classes,␣
 ↪test_size = 0.1, random_state = 0)

Y_train_encoded = utils.to_categorical(Y_train, num_classes)
Y_test_encoded = utils.to_categorical(Y_test, num_classes)

#X_train, X_test, Y_train_encoded, Y_test_encoded = train_test_split(X_data ,␣
 ↪Y_classes_encoded, test_size = 0.03, random_state = 0)
#X_train, X_test, Y_train_encoded, Y_test_encoded = train_test_split(X_data ,␣
 ↪Y_classes_encoded, test_size = 0.03, random_state = 400)
print(Y_train[0:10])

n_training = len(X_train)
n_test = len(X_test)
```

```
[0 5 5 0 0 0 1 4 1 2]
```

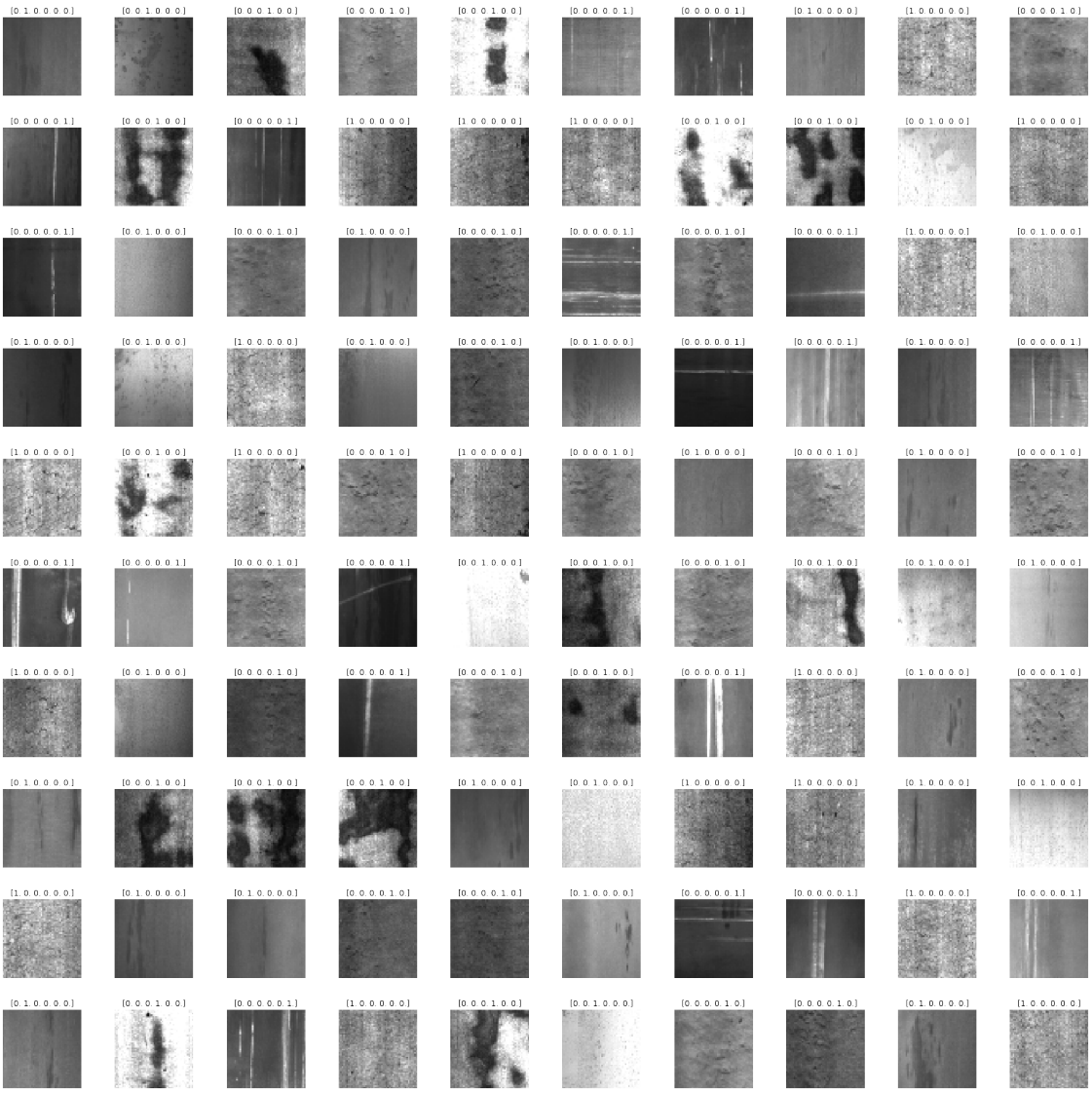
IMPRIME PARTE DA BASE DE DADOS A SER UTILIZADA PARA TREINAMENTO

[11]:
```
L_grid = 10
W_grid = 10

fig, axes = plt.subplots(L_grid, W_grid, figsize = (30,30))

axes = axes.ravel() #flatten the 28x28 image to 784 array

print("n_training = ", n_training)

index = []
#select random number from 0 to n_test

if n_training > W_grid * L_grid:
  index = random.sample(list(range(0, n_training)), (W_grid * L_grid))
  print(np.shape(index))
  print(index[0])
  for i in np.arange(0, W_grid * L_grid):
      axes[i].imshow(X_train[index[i]])
      #axes[i].set_title(y_img_names[index[i]], fontsize = 12)
      axes[i].set_title(Y_train_encoded[index[i]], fontsize = 12)
      axes[i].axis('off')
else:
  index = random.sample(list(range(0, n_training)), n_training)
  print(np.shape(index))
```

```
  print(index[0])
  for i in np.arange(0, n_training):
    axes[i].imshow(X_train[index[i]])
    #axes[i].set_title(y_img_names[index[i]], fontsize = 12)
    axes[i].set_title(Y_train_encoded[index[i]], fontsize = 12)
    axes[i].axis('off')

plt.subplots_adjust(hspace=0.4)
```

```
n_training =  1746
(100,)
1046
```

```
C:\Users\JG\.conda\envs\NEURAL NETWORKS\lib\site-
packages\matplotlib\text.py:1150: FutureWarning: elementwise comparison failed;
returning scalar instead, but in the future will perform elementwise comparison
  if s != self._text:
```

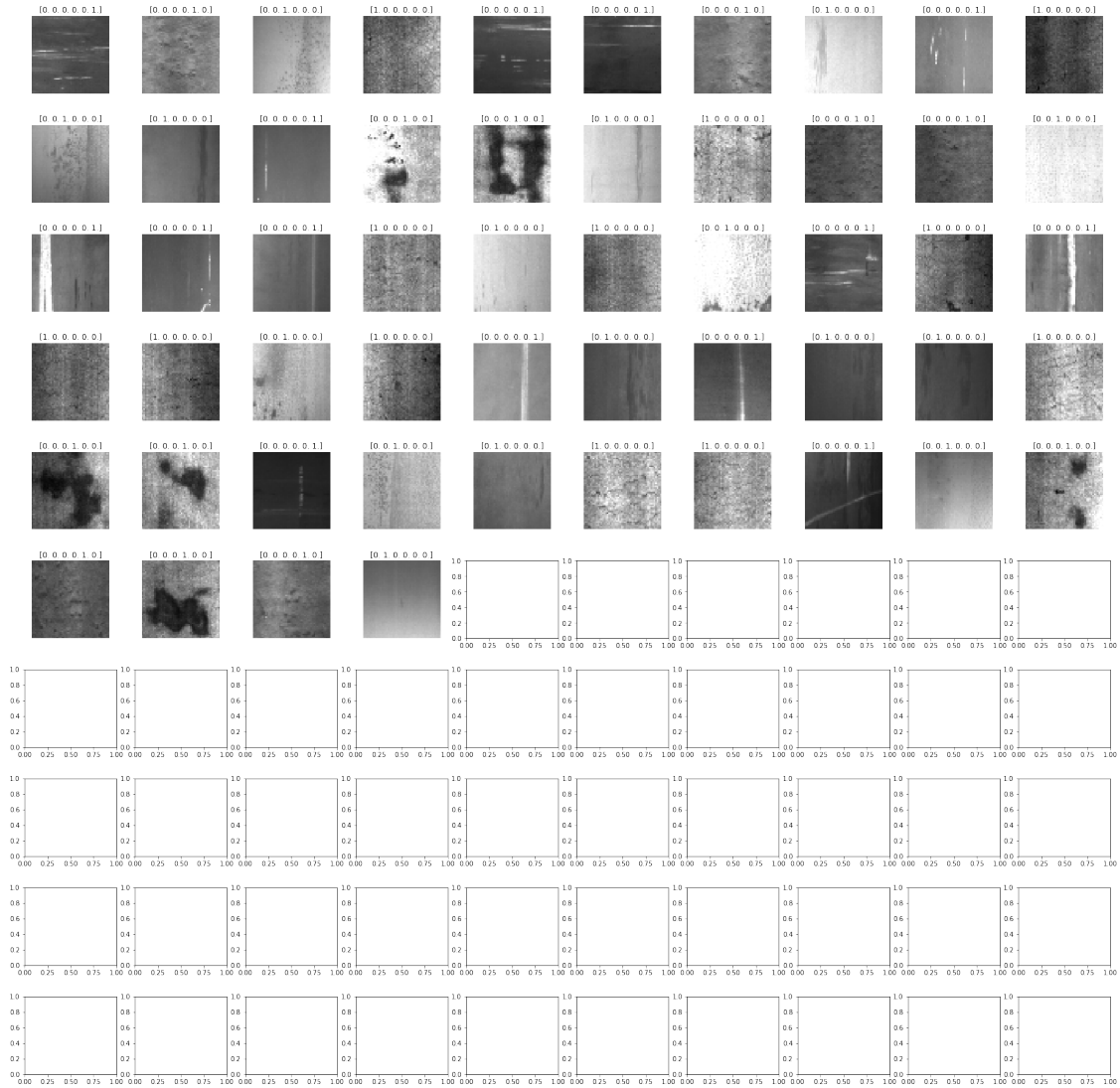


IMPRIME PARTE DA BASE DE DADOS A SER UTILIZADA PARA TESTES

[12]:
```
L_grid = 10
W_grid = 10

fig, axes = plt.subplots(L_grid, W_grid, figsize = (30,30))

axes = axes.ravel() #flatten the 28x28 image to 784 array

print("n_test = ", n_test)

index = []
#select random number from 0 to n_test
```

```
if n_test > W_grid * L_grid:

  index = random.sample(list(range(0, n_test)), (W_grid * L_grid))
  print(np.shape(index))
  print(index[0])

  for i in np.arange(0, W_grid * L_grid):
      axes[i].imshow(X_test[index[i]])
      #axes[i].set_title(y_img_names[index[i]], fontsize = 12)
      axes[i].set_title(Y_test_encoded[index[i]], fontsize = 12)
      axes[i].axis('off')
else:
  index = random.sample(list(range(0, n_test)), (n_test))
  print(np.shape(index))
  print(index[0])

  for i in np.arange(0, n_test):
    axes[i].imshow(X_test[index[i]])
    #axes[i].set_title(y_img_names[index[i]], fontsize = 12)
    axes[i].set_title(Y_test_encoded[index[i]], fontsize = 12)
    axes[i].axis('off')

plt.subplots_adjust(hspace=0.4)
```

```
n_test =  54
(54,)
41
```



INICIALIZAÇÃO DE VARIÁVEIS:

batch_size: determines the number of samples in each mini batch. Its maximum is the number of all samples, which makes gradient descent accurate, the loss will decrease towards the minimum if the learning rate is small enough, but iterations are slower. Its minimum is 1, resulting in stochastic gradient descent: Fast but the direction of the gradient step is based only on one example, the loss may jump around. batch_size allows to adjust between the two extremes: accurate gradient direction and fast iteration. Also, the maximum value for batch_size may be limited if your model + data set does not fit into the available (GPU) memory.

steps_per_epoch: the number of batch iterations before a training epoch is considered finished. If you have a training set of fixed size you can ignore it but it may be useful if you have a huge data set or if you are generating random data augmentations on the fly, i.e. if your training set has a (generated) infinite size. If you have the time to go through your whole training data set I recommend to skip this parameter.

validation_steps: similar to steps_per_epoch but on the validation data set instead on the training data. If you have the time to go through your whole validation data set I recommend to skip this parameter.

[22]:
```
#numero de registros que irá calcular antes de atualizar os pesos (batch_size)
batch_size = 100
#num_epochs = 30
num_epochs = 40
kernel_size = (3,3)
pool_size = 2

#conv_depth_1 e conv_depth_2 -> numero de detectores (mapas) de características␣
 ↪(kernels)
conv_depth_1 = 32
conv_depth_2 = 64

#https://timodenk.com/blog/tensorflow-batch-normalization/
drop_prob_1 = 0.5
drop_prob_2 = 0.75
drop_prob_3 = 0.7


Pooling_size_1 = (2,2)
Pooling_size_2 = (2,2)


#Chute inicial para a quantidade de neurônios:
# ((img_width  - kernel_size + 1) / Pooling_size) ^ 2 -> ((50 - 3 + 1) / 2) ^ 2␣
 ↪= 576

#hidden_neurons_1 = 260
#hidden_neurons_2 = 260

hidden_neurons_1 = 128
hidden_neurons_2 = 128
```

** AVALIAÇÃO DE MELHORES PARÂMETROS PARA A ARQUITETURA DA REDE NEURAL**

[12]:
```
from tensorflow.keras.wrappers.scikit_learn import KerasClassifier
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
```

Cria Nova Rede Com Parâmetros Para Fazer Validação Cruzada:

[74]:
```
# Define the Keras TensorBoard callback.
#logdir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
logdir="logs/fit/" + "CrossValidation"
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

[13]:
```
def neural_net_steel_defects_tunning(n_dense_layers, neurons):

    classificador = Sequential()

    #1 camada de convolucao
    classificador.add(Conv2D(conv_depth_1, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    classificador.add(Conv2D(conv_depth_1, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    #Adiciona normalização à camada para aumentar a eficiencia e velocidade de␣
↪processamento
    #classificador.add(BatchNormalization())
    #Aplica janela de pooling dos pixels, de tamanho 2x2
    classificador.add(MaxPooling2D(pool_size = Pooling_size_1 ))
    #dropout de 20% para ignorar pixels aleatorios da imagem visando reduzir a␣
↪contribuição de pixels
    #que não contribuem de fato com características das falhas a serem␣
↪processadas
    classificador.add(Dropout(drop_prob_1))

    #2 camada de convolucao
    classificador.add(Conv2D(conv_depth_2, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    classificador.add(Conv2D(conv_depth_2, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    #Adiciona normalização à camada para aumentar a eficiencia e velocidade de␣
↪processamento
    #classificador.add(BatchNormalization())
    #Aplica janela de pooling dos pixels, de tamanho 2x2
    classificador.add(MaxPooling2D(pool_size = Pooling_size_1 ))
    #dropout de 20% para ignorar pixels aleatorios da imagem visando reduzir a␣
↪contribuição de pixels
    #que não contribuem de fato com características das falhas a serem␣
↪processadas
    classificador.add(Dropout(drop_prob_2))

    #classificador.add(BatchNormalization())

    classificador.add(Flatten())


    #Adiciona N camadas, para testar qual é a quantidade que causa menor erro
```

```
    for i in range(1, n_dense_layers):
      classificador.add(Dense(units = neurons, activation='relu'))
      classificador.add(Dropout(drop_prob_3))


    classificador.add(Dense(units = num_classes, activation='softmax'))


    classificador.compile(loss='categorical_crossentropy', optimizer = 'adam',␣
 ↪metrics = ['accuracy'])

    return classificador
```

[14]:
```
classificador_grid = KerasClassifier(build_fn = neural_net_steel_defects_tunning)
```

[15]:
```
#Cria um "dicionario" de parametros a serem testados
#parametros_grid = { 'batch_size': [32, 100],
#                    'epochs': [30, 50, 100],
#                     'neurons': [128, 256, 576],
#                     'n_dense_layers': [1, 2 ,3]}

parametros_grid = { 'batch_size': [100],
                    'epochs': [40],
                    'neurons': [128, 260, 576],
                    'n_dense_layers': [1, 2, 3]}
```

[16]:
```
grid_search = GridSearchCV(estimator = classificador_grid, param_grid =␣
 ↪parametros_grid, scoring = 'accuracy', cv = 5 )
#grid_search = GridSearchCV(estimator = classificador_grid, param_grid =␣
 ↪parametros_grid, scoring = 'accuracy' )
```

[17]:
```
y_classes
n_y = list(y_classes).count(0) #contagem de quantas vezes há a ocorrencia da␣
 ↪classe 3...1..5..
n_y
```

[17]: 300

[18]:
```
grid_search = grid_search.fit(X_data, y_classes)
#grid_search = grid_search.fit(X_data, y_classes, validation_split=0.1)
```

```
WARNING:tensorflow:Large dropout rate: 0.75 (>0.5). In TensorFlow 2.x, dropout()
uses dropout rate instead of keep_prob. Please ensure that this is intended.
WARNING:tensorflow:Large dropout rate: 0.75 (>0.5). In TensorFlow 2.x, dropout()
uses dropout rate instead of keep_prob. Please ensure that this is intended.
```

```
C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
WARNING:tensorflow:Large dropout rate: 0.75 (>0.5). In TensorFlow 2.x, dropout()
uses dropout rate instead of keep_prob. Please ensure that this is intended.
WARNING:tensorflow:Large dropout rate: 0.75 (>0.5). In TensorFlow 2.x, dropout()
uses dropout rate instead of keep_prob. Please ensure that this is intended.
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6905 -
accuracy: 0.2160
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6327 -
accuracy: 0.2438
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5129 -
accuracy: 0.3472
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3761 -
accuracy: 0.4458
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3321 -
accuracy: 0.4701
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1214 -
accuracy: 0.5854
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8916 -
accuracy: 0.6674
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6478 -
accuracy: 0.7583
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4436 -
accuracy: 0.8597
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3281 -
accuracy: 0.8924
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3200 -
accuracy: 0.8979
```

```
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2764 -
accuracy: 0.9090
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2516 -
accuracy: 0.9139
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1785 -
accuracy: 0.9382
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1940 -
accuracy: 0.9354
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1791 -
accuracy: 0.9382
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1536 -
accuracy: 0.9493
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2027 -
accuracy: 0.9299
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1492 -
accuracy: 0.9556
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1283 -
accuracy: 0.9597
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1331 -
accuracy: 0.9542
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1071 -
accuracy: 0.9625
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1681 -
accuracy: 0.9438
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1599 -
accuracy: 0.9514
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1054 -
accuracy: 0.9639
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1005 -
accuracy: 0.9653
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1032 -
accuracy: 0.9604
```

```
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0732 -
accuracy: 0.9771
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0943 -
accuracy: 0.9688
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0810 -
accuracy: 0.9750
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0663 -
accuracy: 0.9778
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0645 -
accuracy: 0.9819
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0673 -
accuracy: 0.9750
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0569 -
accuracy: 0.9826
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0721 -
accuracy: 0.9771
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0914 -
accuracy: 0.9694
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0649 -
accuracy: 0.9799
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0707 -
accuracy: 0.9778
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0948 -
accuracy: 0.9674
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2967 -
accuracy: 0.9000
WARNING:tensorflow:Large dropout rate: 0.75 (>0.5). In TensorFlow 2.x, dropout()
uses dropout rate instead of keep_prob. Please ensure that this is intended.
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7590 -
accuracy: 0.2153
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7281 -
accuracy: 0.2382
```

```
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6165 -
accuracy: 0.3569
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4653 -
accuracy: 0.4049
Epoch 5/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.3687 -
accuracy: 0.4410
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1476 -
accuracy: 0.5889
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8326 -
accuracy: 0.7174
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7231 -
accuracy: 0.7312
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5619 -
accuracy: 0.8146
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3782 -
accuracy: 0.8847
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3230 -
accuracy: 0.9028
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3378 -
accuracy: 0.8868
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2860 -
accuracy: 0.9076
Epoch 14/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2654 -
accuracy: 0.9167
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2281 -
accuracy: 0.9243
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2356 -
accuracy: 0.9271
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1990 -
accuracy: 0.9299
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1977 -
accuracy: 0.9347
```

```
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3101 -
accuracy: 0.9000
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2131 -
accuracy: 0.9299
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2089 -
accuracy: 0.9368
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1562 -
accuracy: 0.9500
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1436 -
accuracy: 0.9514
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1283 -
accuracy: 0.9597
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1339 -
accuracy: 0.9590
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1270 -
accuracy: 0.9611
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1731 -
accuracy: 0.9368
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1506 -
accuracy: 0.9535
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1320 -
accuracy: 0.9625
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1720 -
accuracy: 0.9368
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2106 -
accuracy: 0.9312
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1559 -
accuracy: 0.9486
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1242 -
accuracy: 0.9576
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1052 -
accuracy: 0.9674
```

```
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0861 -
accuracy: 0.9729
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0857 -
accuracy: 0.9701
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0843 -
accuracy: 0.9750
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0695 -
accuracy: 0.9792
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0811 -
accuracy: 0.9722
Epoch 40/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0862 -
accuracy: 0.9771
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 1.7251 -
accuracy: 0.2132
Epoch 2/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6489 -
accuracy: 0.2340
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4097 -
accuracy: 0.4264
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.0619 -
accuracy: 0.5875
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7546 -
accuracy: 0.6931
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6417 -
accuracy: 0.7632
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5512 -
accuracy: 0.8104
Epoch 8/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6451 -
accuracy: 0.7667
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4353 -
accuracy: 0.8347
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3445 -
```

```
accuracy: 0.8792
Epoch 11/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3726 -
accuracy: 0.8708
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3298 -
accuracy: 0.8875
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4202 -
accuracy: 0.8556
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3683 -
accuracy: 0.8813
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2921 -
accuracy: 0.9014
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2704 -
accuracy: 0.9132
Epoch 17/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2895 -
accuracy: 0.8951
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2531 -
accuracy: 0.9194
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2165 -
accuracy: 0.9292
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1817 -
accuracy: 0.9382
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1781 -
accuracy: 0.9361
Epoch 22/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1656 -
accuracy: 0.9417
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2158 -
accuracy: 0.9229
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2087 -
accuracy: 0.9250
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4512 -
accuracy: 0.8590
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2573 -
```

```
accuracy: 0.9111
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2084 -
accuracy: 0.9257
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1627 -
accuracy: 0.9472
Epoch 29/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1314 -
accuracy: 0.9590
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1433 -
accuracy: 0.9521
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1878 -
accuracy: 0.9361
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1251 -
accuracy: 0.9590
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1344 -
accuracy: 0.9549
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1219 -
accuracy: 0.9604
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1154 -
accuracy: 0.9618
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1207 -
accuracy: 0.9618
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1061 -
accuracy: 0.9632
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0885 -
accuracy: 0.9688
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1071 -
accuracy: 0.9604
Epoch 40/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1031 -
accuracy: 0.9681

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
```

```
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 1.7023 -
accuracy: 0.2028
Epoch 2/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.6616 -
accuracy: 0.2104
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6023 -
accuracy: 0.2944
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.5061 -
accuracy: 0.3667
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3915 -
accuracy: 0.4535
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3347 -
accuracy: 0.4771
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.0646 -
accuracy: 0.6125
Epoch 8/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7300 -
accuracy: 0.7410
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5938 -
accuracy: 0.7958
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4244 -
accuracy: 0.8556
Epoch 11/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3331 -
accuracy: 0.9000
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2792 -
accuracy: 0.9069
Epoch 13/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2669 -
accuracy: 0.9187
Epoch 14/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2561 -
```

```
accuracy: 0.9201
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2284 -
accuracy: 0.9194
Epoch 16/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2086 -
accuracy: 0.9319
Epoch 17/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1546 -
accuracy: 0.9479
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2249 -
accuracy: 0.9187
Epoch 19/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2579 -
accuracy: 0.9118
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1412 -
accuracy: 0.9569
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1398 -
accuracy: 0.9549
Epoch 22/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1212 -
accuracy: 0.9611
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1169 -
accuracy: 0.9590
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1100 -
accuracy: 0.9618
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1133 -
accuracy: 0.9528
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1171 -
accuracy: 0.9604
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0829 -
accuracy: 0.9764
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1172 -
accuracy: 0.9576
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1234 -
accuracy: 0.9569
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1122 -
```

```
accuracy: 0.9583
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0776 -
accuracy: 0.9792
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0639 -
accuracy: 0.9778
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0486 -
accuracy: 0.9861
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0587 -
accuracy: 0.9812
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0905 -
accuracy: 0.9681
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1109 -
accuracy: 0.9576
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0636 -
accuracy: 0.9806
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0973 -
accuracy: 0.9646
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0564 -
accuracy: 0.9778
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0904 -
accuracy: 0.9729
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7717 -
accuracy: 0.1882
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7521 -
accuracy: 0.2229
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7201 -
accuracy: 0.2924
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5808 -
accuracy: 0.3354
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4090 -
accuracy: 0.4125
Epoch 6/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3084 -
accuracy: 0.4840
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1861 -
accuracy: 0.5306
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9724 -
accuracy: 0.6382
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7210 -
accuracy: 0.7451
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5693 -
accuracy: 0.8118
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4039 -
accuracy: 0.8757
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8864 -
accuracy: 0.7007
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5798 -
accuracy: 0.7993
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4061 -
accuracy: 0.8944
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3580 -
accuracy: 0.8771
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3031 -
accuracy: 0.9042
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2612 -
accuracy: 0.9208
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2320 -
accuracy: 0.9243
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2082 -
accuracy: 0.9375
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2086 -
accuracy: 0.9361
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2123 -
accuracy: 0.9299
Epoch 22/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2005 -
accuracy: 0.9410
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1934 -
accuracy: 0.9424
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1749 -
accuracy: 0.9431
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3205 -
accuracy: 0.8924
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2175 -
accuracy: 0.9292
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1809 -
accuracy: 0.9403
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1547 -
accuracy: 0.9479
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1448 -
accuracy: 0.9535
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1382 -
accuracy: 0.9563
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1267 -
accuracy: 0.9604
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1132 -
accuracy: 0.9646
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1125 -
accuracy: 0.9681
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1093 -
accuracy: 0.9681
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1316 -
accuracy: 0.9583
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1330 -
accuracy: 0.9583
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1364 -
accuracy: 0.9569
Epoch 38/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1025 -
accuracy: 0.9694
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1087 -
accuracy: 0.9639
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1304 -
accuracy: 0.9604
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7160 -
accuracy: 0.2007
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5903 -
accuracy: 0.2806
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3008 -
accuracy: 0.5097
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8617 -
accuracy: 0.6729
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5955 -
accuracy: 0.7812
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4106 -
accuracy: 0.8493
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4255 -
accuracy: 0.8465
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3202 -
accuracy: 0.8868
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2832 -
accuracy: 0.9028
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3144 -
accuracy: 0.8924
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2750 -
accuracy: 0.9104
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2347 -
accuracy: 0.9222
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3122 -
accuracy: 0.8833
```

```
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2896 -
accuracy: 0.8965
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3182 -
accuracy: 0.8896
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4557 -
accuracy: 0.8507
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4792 -
accuracy: 0.8465
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3643 -
accuracy: 0.8854
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2704 -
accuracy: 0.9049
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2474 -
accuracy: 0.9104
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2901 -
accuracy: 0.8944
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2287 -
accuracy: 0.9201
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2296 -
accuracy: 0.9208
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2013 -
accuracy: 0.9368
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1965 -
accuracy: 0.9333
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2092 -
accuracy: 0.9271
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1776 -
accuracy: 0.9382
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1614 -
accuracy: 0.9465
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1509 -
accuracy: 0.9479
```

```
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2539 -
accuracy: 0.9181
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1962 -
accuracy: 0.9340
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1655 -
accuracy: 0.9403
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1384 -
accuracy: 0.9500
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1101 -
accuracy: 0.9604
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1294 -
accuracy: 0.9569
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1004 -
accuracy: 0.9611
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0982 -
accuracy: 0.9653
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1033 -
accuracy: 0.9639
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1074 -
accuracy: 0.9632
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0977 -
accuracy: 0.9660

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6905 -
accuracy: 0.2056
Epoch 2/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6450 -
accuracy: 0.2694
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5499 -
accuracy: 0.3375
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4270 -
accuracy: 0.4181
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3578 -
accuracy: 0.4396
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2291 -
accuracy: 0.5347
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0258 -
accuracy: 0.6278
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8115 -
accuracy: 0.6868
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7674 -
accuracy: 0.7028
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5711 -
accuracy: 0.7917
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4452 -
accuracy: 0.8479
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3561 -
accuracy: 0.8882
Epoch 13/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2702 -
accuracy: 0.9111
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2355 -
accuracy: 0.9132
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2708 -
accuracy: 0.9097
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2255 -
accuracy: 0.9243
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1930 -
accuracy: 0.9368
Epoch 18/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2141 -
accuracy: 0.9410
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1930 -
accuracy: 0.9340
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1648 -
accuracy: 0.9458
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1881 -
accuracy: 0.9410
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2036 -
accuracy: 0.9312
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1672 -
accuracy: 0.9486
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1370 -
accuracy: 0.9542
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2296 -
accuracy: 0.9208
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1613 -
accuracy: 0.9458
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1881 -
accuracy: 0.9389
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2181 -
accuracy: 0.9278
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1835 -
accuracy: 0.9396
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1163 -
accuracy: 0.9632
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0963 -
accuracy: 0.9694
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0867 -
accuracy: 0.9715
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0837 -
accuracy: 0.9715
Epoch 34/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0649 -
accuracy: 0.9819
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0739 -
accuracy: 0.9736
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0788 -
accuracy: 0.9681
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0955 -
accuracy: 0.9701
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1344 -
accuracy: 0.9556
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0898 -
accuracy: 0.9660
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0602 -
accuracy: 0.9847
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7556 -
accuracy: 0.2049
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6642 -
accuracy: 0.2937
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3934 -
accuracy: 0.4549
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1232 -
accuracy: 0.5729
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9955 -
accuracy: 0.6090
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9109 -
accuracy: 0.6597
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6786 -
accuracy: 0.7465
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5451 -
accuracy: 0.8201
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5548 -
accuracy: 0.8062
```

```
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3846 -
accuracy: 0.8875
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3027 -
accuracy: 0.9083
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2734 -
accuracy: 0.9125
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3094 -
accuracy: 0.9083
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2803 -
accuracy: 0.9062
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2585 -
accuracy: 0.9174
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2504 -
accuracy: 0.9139
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2292 -
accuracy: 0.9285
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2591 -
accuracy: 0.9153
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2598 -
accuracy: 0.9146
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2397 -
accuracy: 0.9285
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2041 -
accuracy: 0.9389
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1830 -
accuracy: 0.9465
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1727 -
accuracy: 0.9500
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1527 -
accuracy: 0.9563
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1698 -
accuracy: 0.9368
```

```
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6756 -
accuracy: 0.8132
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3291 -
accuracy: 0.8868
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1975 -
accuracy: 0.9424
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1760 -
accuracy: 0.9465
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1821 -
accuracy: 0.9417
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1385 -
accuracy: 0.9597
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1487 -
accuracy: 0.9549
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1208 -
accuracy: 0.9604
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1112 -
accuracy: 0.9653
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0957 -
accuracy: 0.9708
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1055 -
accuracy: 0.9660
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0944 -
accuracy: 0.9722
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1001 -
accuracy: 0.9653
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1425 -
accuracy: 0.9528
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1534 -
accuracy: 0.9458
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7618 -
```

```
accuracy: 0.2056
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6920 -
accuracy: 0.2500
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5857 -
accuracy: 0.3021
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2471 -
accuracy: 0.4840
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8562 -
accuracy: 0.6549
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1131 -
accuracy: 0.5611
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8021 -
accuracy: 0.6931
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6479 -
accuracy: 0.7493
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5214 -
accuracy: 0.8090
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4741 -
accuracy: 0.8292
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4165 -
accuracy: 0.8493
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3550 -
accuracy: 0.8736
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3144 -
accuracy: 0.8972
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2950 -
accuracy: 0.8958
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2740 -
accuracy: 0.9069
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3131 -
accuracy: 0.8931
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4530 -
```

```
accuracy: 0.8465
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3302 -
accuracy: 0.8826
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2763 -
accuracy: 0.9069
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2462 -
accuracy: 0.9132
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3145 -
accuracy: 0.8951
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2967 -
accuracy: 0.8882
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2567 -
accuracy: 0.9174
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2116 -
accuracy: 0.9250
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1650 -
accuracy: 0.9375
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1763 -
accuracy: 0.9417
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1934 -
accuracy: 0.9306
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1816 -
accuracy: 0.9396
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1586 -
accuracy: 0.9458
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1404 -
accuracy: 0.9528
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1265 -
accuracy: 0.9597
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1285 -
accuracy: 0.9590
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1335 -
```

```
accuracy: 0.9583
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1475 -
accuracy: 0.9424
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1288 -
accuracy: 0.9507
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1295 -
accuracy: 0.9576
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1290 -
accuracy: 0.9528
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1637 -
accuracy: 0.9451
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1279 -
accuracy: 0.9618
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1050 -
accuracy: 0.9667

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7220 -
accuracy: 0.2049
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6581 -
accuracy: 0.2465
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5891 -
accuracy: 0.3340
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4282 -
accuracy: 0.4181
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3106 -
accuracy: 0.4868
```

```
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1652 -
accuracy: 0.5444
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0049 -
accuracy: 0.6111
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9634 -
accuracy: 0.6451
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8377 -
accuracy: 0.6910
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6934 -
accuracy: 0.7556
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5474 -
accuracy: 0.8139
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5541 -
accuracy: 0.7882
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4233 -
accuracy: 0.8625
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3796 -
accuracy: 0.8729
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4241 -
accuracy: 0.8444
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3336 -
accuracy: 0.8806
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3526 -
accuracy: 0.8833
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2784 -
accuracy: 0.8993
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2501 -
accuracy: 0.9167
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2531 -
accuracy: 0.9181
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2206 -
accuracy: 0.9278
```

```
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2203 -
accuracy: 0.9194
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2369 -
accuracy: 0.9222
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1868 -
accuracy: 0.9389
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1915 -
accuracy: 0.9340
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1918 -
accuracy: 0.9361
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1780 -
accuracy: 0.9396
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1993 -
accuracy: 0.9285
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1506 -
accuracy: 0.9514
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1267 -
accuracy: 0.9549
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1615 -
accuracy: 0.9417
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1258 -
accuracy: 0.9535
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1314 -
accuracy: 0.9569
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2432 -
accuracy: 0.9243
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1437 -
accuracy: 0.9472
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1063 -
accuracy: 0.9625
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1457 -
accuracy: 0.9486
```

```
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1117 -
accuracy: 0.9625
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1011 -
accuracy: 0.9674
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1105 -
accuracy: 0.9590
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7768 -
accuracy: 0.2097
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7535 -
accuracy: 0.2313
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7238 -
accuracy: 0.2604
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6010 -
accuracy: 0.3500
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5182 -
accuracy: 0.3833
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4896 -
accuracy: 0.3757
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3756 -
accuracy: 0.4458
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2353 -
accuracy: 0.5049
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0973 -
accuracy: 0.5688
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9229 -
accuracy: 0.6472
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7972 -
accuracy: 0.7097
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6939 -
accuracy: 0.7681
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7860 -
```

```
accuracy: 0.7090
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6993 -
accuracy: 0.7479
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4849 -
accuracy: 0.8521
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4472 -
accuracy: 0.8507
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3835 -
accuracy: 0.8743
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3737 -
accuracy: 0.8743
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3383 -
accuracy: 0.8924
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3137 -
accuracy: 0.8979
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2791 -
accuracy: 0.9167
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2965 -
accuracy: 0.9049
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2815 -
accuracy: 0.9097
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2912 -
accuracy: 0.9132
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3044 -
accuracy: 0.9014
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2716 -
accuracy: 0.9042
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2440 -
accuracy: 0.9146
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2100 -
accuracy: 0.9312
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2244 -
```

```
accuracy: 0.9243
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1969 -
accuracy: 0.9361
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2152 -
accuracy: 0.9319
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1957 -
accuracy: 0.9396
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2845 -
accuracy: 0.9056
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7284 -
accuracy: 0.7924
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8650 -
accuracy: 0.6806
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5240 -
accuracy: 0.8236
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3720 -
accuracy: 0.8736
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5687 -
accuracy: 0.8236
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3869 -
accuracy: 0.8778
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2819 -
accuracy: 0.9132
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7612 -
accuracy: 0.2028
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6499 -
accuracy: 0.2583
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4259 -
accuracy: 0.4125
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2657 -
accuracy: 0.5007
Epoch 5/40
```

```
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.9406 -
accuracy: 0.6576
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9395 -
accuracy: 0.6569
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7810 -
accuracy: 0.7201
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6653 -
accuracy: 0.7646
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6832 -
accuracy: 0.7486
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6299 -
accuracy: 0.7833
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5550 -
accuracy: 0.8153
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4762 -
accuracy: 0.8340
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4813 -
accuracy: 0.8285
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4516 -
accuracy: 0.8493
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4049 -
accuracy: 0.8528
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4373 -
accuracy: 0.8431
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4117 -
accuracy: 0.8507
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3850 -
accuracy: 0.8674
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4231 -
accuracy: 0.8451
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4241 -
accuracy: 0.8556
Epoch 21/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3450 -
accuracy: 0.8806
Epoch 22/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3208 -
accuracy: 0.8903
Epoch 23/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2998 -
accuracy: 0.8896
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2937 -
accuracy: 0.8924
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3142 -
accuracy: 0.8861
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3184 -
accuracy: 0.8819
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2997 -
accuracy: 0.8875
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3228 -
accuracy: 0.8854
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4306 -
accuracy: 0.8493
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3417 -
accuracy: 0.8840
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2616 -
accuracy: 0.8993
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2727 -
accuracy: 0.9056
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2621 -
accuracy: 0.9042
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2549 -
accuracy: 0.9056
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2286 -
accuracy: 0.9194
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2499 -
accuracy: 0.9062
Epoch 37/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2269 -
accuracy: 0.9285
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2290 -
accuracy: 0.9215
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3371 -
accuracy: 0.8819
Epoch 40/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2858 -
accuracy: 0.8958

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 1.7356 -
accuracy: 0.2146
Epoch 2/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.6840 -
accuracy: 0.2417
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6377 -
accuracy: 0.2965
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5074 -
accuracy: 0.3778
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4422 -
accuracy: 0.4167
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4131 -
accuracy: 0.4208
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3128 -
accuracy: 0.4674
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2600 -
accuracy: 0.4812
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1491 -
```

```
accuracy: 0.5472
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0122 -
accuracy: 0.6069
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8856 -
accuracy: 0.6583
Epoch 12/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.7986 -
accuracy: 0.7049
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7266 -
accuracy: 0.7479
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5847 -
accuracy: 0.7868
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5355 -
accuracy: 0.8208
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3832 -
accuracy: 0.8750
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4618 -
accuracy: 0.8375
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4297 -
accuracy: 0.8486
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3794 -
accuracy: 0.8625
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3324 -
accuracy: 0.8882
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2755 -
accuracy: 0.9007
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2796 -
accuracy: 0.8958
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2562 -
accuracy: 0.9035
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2413 -
accuracy: 0.9208
Epoch 25/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1806 -
```

```
accuracy: 0.9396
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1847 -
accuracy: 0.9326
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2230 -
accuracy: 0.9208
Epoch 28/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2715 -
accuracy: 0.9035
Epoch 29/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2135 -
accuracy: 0.9264
Epoch 30/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2124 -
accuracy: 0.9347
Epoch 31/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1282 -
accuracy: 0.9563
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1251 -
accuracy: 0.9549
Epoch 33/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1218 -
accuracy: 0.9569
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1069 -
accuracy: 0.9618
Epoch 35/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1331 -
accuracy: 0.9528
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1073 -
accuracy: 0.9632
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1226 -
accuracy: 0.9639
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1312 -
accuracy: 0.9479
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1564 -
accuracy: 0.9458
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1018 -
accuracy: 0.9667
Train on 1440 samples
Epoch 1/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7643 -
accuracy: 0.2042
Epoch 2/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.6873 -
accuracy: 0.3007
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3807 -
accuracy: 0.4542
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.1187 -
accuracy: 0.5653
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9471 -
accuracy: 0.6403
Epoch 6/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.0016 -
accuracy: 0.6194
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8650 -
accuracy: 0.6757
Epoch 8/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7125 -
accuracy: 0.7382
Epoch 9/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.5272 -
accuracy: 0.8333
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4942 -
accuracy: 0.8389
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3798 -
accuracy: 0.8875
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3435 -
accuracy: 0.8917
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3352 -
accuracy: 0.8944
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2512 -
accuracy: 0.9257
Epoch 15/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2610 -
accuracy: 0.9076
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2614 -
accuracy: 0.9208
Epoch 17/40
```

```
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3063 -
accuracy: 0.8951
Epoch 18/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2947 -
accuracy: 0.9021
Epoch 19/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2477 -
accuracy: 0.9160
Epoch 20/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2091 -
accuracy: 0.9292
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2142 -
accuracy: 0.9333
Epoch 22/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3435 -
accuracy: 0.8840
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2568 -
accuracy: 0.9111
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2328 -
accuracy: 0.9187
Epoch 25/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2241 -
accuracy: 0.9229
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2244 -
accuracy: 0.9215
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2317 -
accuracy: 0.9257
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1922 -
accuracy: 0.9306
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1696 -
accuracy: 0.9410
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1675 -
accuracy: 0.9479
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1872 -
accuracy: 0.9375
Epoch 32/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2355 -
accuracy: 0.9215
Epoch 33/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2286 -
accuracy: 0.9285
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1704 -
accuracy: 0.9472
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1414 -
accuracy: 0.9486
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1212 -
accuracy: 0.9611
Epoch 37/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1231 -
accuracy: 0.9590
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1408 -
accuracy: 0.9535
Epoch 39/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1685 -
accuracy: 0.9438
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1404 -
accuracy: 0.9493
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7527 -
accuracy: 0.2069
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6619 -
accuracy: 0.2486
Epoch 3/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.5042 -
accuracy: 0.3722
Epoch 4/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.1509 -
accuracy: 0.5278
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9986 -
accuracy: 0.6118
Epoch 6/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.8633 -
accuracy: 0.6833
Epoch 7/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.6252 -
accuracy: 0.7861
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6229 -
accuracy: 0.7688
```

```
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5155 -
accuracy: 0.8201
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4535 -
accuracy: 0.8472
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4325 -
accuracy: 0.8458
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5203 -
accuracy: 0.8090
Epoch 13/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3819 -
accuracy: 0.8576
Epoch 14/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3229 -
accuracy: 0.8799
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2935 -
accuracy: 0.8979
Epoch 16/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3379 -
accuracy: 0.8792
Epoch 17/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.4787 -
accuracy: 0.8292
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3735 -
accuracy: 0.8778
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3114 -
accuracy: 0.8944
Epoch 20/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2373 -
accuracy: 0.9174
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2212 -
accuracy: 0.9292
Epoch 22/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2235 -
accuracy: 0.9167
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2718 -
accuracy: 0.9049
Epoch 24/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2539 -
accuracy: 0.9069
```

```
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2087 -
accuracy: 0.9285
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1876 -
accuracy: 0.9368
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1641 -
accuracy: 0.9396
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2487 -
accuracy: 0.9201
Epoch 29/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.4307 -
accuracy: 0.8521
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2846 -
accuracy: 0.9118
Epoch 31/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2248 -
accuracy: 0.9250
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2270 -
accuracy: 0.9271
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2321 -
accuracy: 0.9132
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1821 -
accuracy: 0.9444
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2029 -
accuracy: 0.9326
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1587 -
accuracy: 0.9451
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1573 -
accuracy: 0.9486
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1356 -
accuracy: 0.9514
Epoch 39/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1502 -
accuracy: 0.9493
Epoch 40/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1448 -
accuracy: 0.9611
```

```
C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 8ms/sample - loss: 1.7202 -
accuracy: 0.2014
Epoch 2/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.5939 -
accuracy: 0.2937
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4035 -
accuracy: 0.4146
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.0639 -
accuracy: 0.5847
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.8185 -
accuracy: 0.6882
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5434 -
accuracy: 0.8035
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4804 -
accuracy: 0.8153
Epoch 8/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5212 -
accuracy: 0.8062
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4022 -
accuracy: 0.8556
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3316 -
accuracy: 0.8736
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2491 -
accuracy: 0.9076
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2404 -
accuracy: 0.9132
Epoch 13/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1872 -
accuracy: 0.9271
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1881 -
accuracy: 0.9229
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1512 -
accuracy: 0.9424
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1693 -
accuracy: 0.9417
Epoch 17/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1451 -
accuracy: 0.9514
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1467 -
accuracy: 0.9424
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1331 -
accuracy: 0.9465
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1580 -
accuracy: 0.9431
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1456 -
accuracy: 0.9528
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1379 -
accuracy: 0.9507
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1422 -
accuracy: 0.9438
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2407 -
accuracy: 0.9208
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3028 -
accuracy: 0.8931
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1621 -
accuracy: 0.9472
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1156 -
accuracy: 0.9590
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0907 -
accuracy: 0.9667
Epoch 29/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0987 -
accuracy: 0.9618
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1137 -
accuracy: 0.9549
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1636 -
accuracy: 0.9382
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1847 -
accuracy: 0.9451
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0904 -
accuracy: 0.9729
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0814 -
accuracy: 0.9757
Epoch 35/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0804 -
accuracy: 0.9715
Epoch 36/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1052 -
accuracy: 0.9632
Epoch 37/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0855 -
accuracy: 0.9736
Epoch 38/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0547 -
accuracy: 0.9812
Epoch 39/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0652 -
accuracy: 0.9708
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0679 -
accuracy: 0.9778
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7956 -
accuracy: 0.2160
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7452 -
accuracy: 0.2347
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7236 -
accuracy: 0.2681
Epoch 4/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.5395 -
accuracy: 0.3785
```

```
Epoch 5/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.2792 -
accuracy: 0.4840
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2137 -
accuracy: 0.5069
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9636 -
accuracy: 0.6319
Epoch 8/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.7989 -
accuracy: 0.7007
Epoch 9/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.7386 -
accuracy: 0.7160
Epoch 10/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.6288 -
accuracy: 0.7729
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4770 -
accuracy: 0.8313
Epoch 12/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3849 -
accuracy: 0.8729
Epoch 13/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3602 -
accuracy: 0.8736
Epoch 14/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3263 -
accuracy: 0.8868
Epoch 15/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3116 -
accuracy: 0.8986
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2985 -
accuracy: 0.9069
Epoch 17/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2618 -
accuracy: 0.9042
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2440 -
accuracy: 0.9201
Epoch 19/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2422 -
accuracy: 0.9125
Epoch 20/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2857 -
accuracy: 0.9118
```

```
Epoch 21/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2563 -
accuracy: 0.9146
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2108 -
accuracy: 0.9271
Epoch 23/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2172 -
accuracy: 0.9299
Epoch 24/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2075 -
accuracy: 0.9257
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1870 -
accuracy: 0.9389
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1800 -
accuracy: 0.9368
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1714 -
accuracy: 0.9479
Epoch 28/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1873 -
accuracy: 0.9382
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1603 -
accuracy: 0.9458
Epoch 30/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1686 -
accuracy: 0.9500
Epoch 31/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2751 -
accuracy: 0.9111
Epoch 32/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2428 -
accuracy: 0.9125
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2470 -
accuracy: 0.9056
Epoch 34/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1778 -
accuracy: 0.9396
Epoch 35/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1686 -
accuracy: 0.9472
Epoch 36/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1572 -
accuracy: 0.9472
```

```
Epoch 37/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1299 -
accuracy: 0.9569
Epoch 38/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1352 -
accuracy: 0.9535
Epoch 39/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1390 -
accuracy: 0.9535
Epoch 40/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1131 -
accuracy: 0.9618
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7424 -
accuracy: 0.2090
Epoch 2/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.6160 -
accuracy: 0.2917
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2556 -
accuracy: 0.5236
Epoch 4/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.9517 -
accuracy: 0.6458
Epoch 5/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.7179 -
accuracy: 0.7549
Epoch 6/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.5683 -
accuracy: 0.8000
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7117 -
accuracy: 0.7500
Epoch 8/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.4830 -
accuracy: 0.8299
Epoch 9/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.4213 -
accuracy: 0.8556
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4875 -
accuracy: 0.8285
Epoch 11/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.4047 -
accuracy: 0.8556
Epoch 12/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3279 -
```

```
accuracy: 0.8813
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3058 -
accuracy: 0.8979
Epoch 14/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2806 -
accuracy: 0.9097
Epoch 15/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3259 -
accuracy: 0.8778
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3101 -
accuracy: 0.8833
Epoch 17/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2638 -
accuracy: 0.9139
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2487 -
accuracy: 0.9125
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2233 -
accuracy: 0.9222
Epoch 20/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2137 -
accuracy: 0.9201
Epoch 21/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2431 -
accuracy: 0.9181
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2306 -
accuracy: 0.9271
Epoch 23/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.2149 -
accuracy: 0.9236
Epoch 24/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1808 -
accuracy: 0.9257
Epoch 25/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1627 -
accuracy: 0.9333
Epoch 26/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1663 -
accuracy: 0.9431
Epoch 27/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1240 -
accuracy: 0.9549
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1261 -
```

```
accuracy: 0.9549
Epoch 29/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1174 -
accuracy: 0.9563
Epoch 30/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1191 -
accuracy: 0.9569
Epoch 31/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1594 -
accuracy: 0.9382
Epoch 32/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1722 -
accuracy: 0.9382
Epoch 33/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1152 -
accuracy: 0.9632
Epoch 34/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1025 -
accuracy: 0.9660
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0999 -
accuracy: 0.9667
Epoch 36/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1004 -
accuracy: 0.9646
Epoch 37/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1198 -
accuracy: 0.9576
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1078 -
accuracy: 0.9549
Epoch 39/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0979 -
accuracy: 0.9653
Epoch 40/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1281 -
accuracy: 0.9535

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
```

```
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.8200 -
accuracy: 0.1813
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7537 -
accuracy: 0.2118
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7437 -
accuracy: 0.2347
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7107 -
accuracy: 0.2389
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6614 -
accuracy: 0.2903
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6264 -
accuracy: 0.3243
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6011 -
accuracy: 0.3403
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5823 -
accuracy: 0.3611
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5441 -
accuracy: 0.3729
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5118 -
accuracy: 0.3861
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4846 -
accuracy: 0.3750
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4630 -
accuracy: 0.4090
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4407 -
accuracy: 0.3931
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4142 -
accuracy: 0.4382
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3663 -
accuracy: 0.4417
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3079 -
accuracy: 0.4743
```

```
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2121 -
accuracy: 0.5236
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2481 -
accuracy: 0.4896
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0763 -
accuracy: 0.5833
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9685 -
accuracy: 0.6340
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8543 -
accuracy: 0.6861
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7561 -
accuracy: 0.7500
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7980 -
accuracy: 0.7292
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7300 -
accuracy: 0.7590
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6356 -
accuracy: 0.7951
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6592 -
accuracy: 0.7847
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5262 -
accuracy: 0.8236
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5065 -
accuracy: 0.8299
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4923 -
accuracy: 0.8347
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6016 -
accuracy: 0.7972
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6548 -
accuracy: 0.7771
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5077 -
accuracy: 0.8292
```

```
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4464 -
accuracy: 0.8528
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3824 -
accuracy: 0.8722
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3636 -
accuracy: 0.8667
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3626 -
accuracy: 0.8674
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3649 -
accuracy: 0.8764
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3396 -
accuracy: 0.8778
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2925 -
accuracy: 0.9049
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3190 -
accuracy: 0.9042
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7958 -
accuracy: 0.1868
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7595 -
accuracy: 0.2208
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7492 -
accuracy: 0.2431
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7315 -
accuracy: 0.2618
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7048 -
accuracy: 0.2875
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6257 -
accuracy: 0.3319
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4471 -
accuracy: 0.3938
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3170 -
```

```
accuracy: 0.4201
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2365 -
accuracy: 0.4743
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2074 -
accuracy: 0.4771
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1510 -
accuracy: 0.5361
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0760 -
accuracy: 0.5486
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0204 -
accuracy: 0.5750
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9315 -
accuracy: 0.6167
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8671 -
accuracy: 0.6507
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7601 -
accuracy: 0.7056
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6743 -
accuracy: 0.7451
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6283 -
accuracy: 0.7729
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5681 -
accuracy: 0.8208
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8589 -
accuracy: 0.6799
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6847 -
accuracy: 0.7639
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5606 -
accuracy: 0.8090
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4793 -
accuracy: 0.8326
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4827 -
```

```
accuracy: 0.8326
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4797 -
accuracy: 0.8403
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4028 -
accuracy: 0.8625
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3568 -
accuracy: 0.8694
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5490 -
accuracy: 0.8215
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4679 -
accuracy: 0.8562
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4147 -
accuracy: 0.8632
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3496 -
accuracy: 0.8764
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3180 -
accuracy: 0.9000
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3364 -
accuracy: 0.8958
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2928 -
accuracy: 0.9104
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2789 -
accuracy: 0.9076
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2817 -
accuracy: 0.9062
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2864 -
accuracy: 0.9125
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3127 -
accuracy: 0.9076
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2604 -
accuracy: 0.9201
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2848 -
```

```
accuracy: 0.9139
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.8248 -
accuracy: 0.2042
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7600 -
accuracy: 0.2097
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7423 -
accuracy: 0.2028
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7237 -
accuracy: 0.2188
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7203 -
accuracy: 0.2403
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6883 -
accuracy: 0.2347
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6201 -
accuracy: 0.2889
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5079 -
accuracy: 0.3465
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4662 -
accuracy: 0.3812
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4557 -
accuracy: 0.4160
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3684 -
accuracy: 0.4368
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3372 -
accuracy: 0.4653
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3276 -
accuracy: 0.4722
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2603 -
accuracy: 0.5014
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2009 -
accuracy: 0.5319
Epoch 16/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1264 -
accuracy: 0.5646
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1328 -
accuracy: 0.5507
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0671 -
accuracy: 0.5764
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0765 -
accuracy: 0.5951
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9941 -
accuracy: 0.6076
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9259 -
accuracy: 0.6625
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0613 -
accuracy: 0.6118
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9044 -
accuracy: 0.6507
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8464 -
accuracy: 0.6889
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8974 -
accuracy: 0.6708
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7756 -
accuracy: 0.7201
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7556 -
accuracy: 0.7382
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7168 -
accuracy: 0.7368
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6355 -
accuracy: 0.7785
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6893 -
accuracy: 0.7688
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6549 -
accuracy: 0.7785
Epoch 32/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6117 -
accuracy: 0.7951
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5802 -
accuracy: 0.7972
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5516 -
accuracy: 0.8257
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4889 -
accuracy: 0.8319
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5299 -
accuracy: 0.8222
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4108 -
accuracy: 0.8597
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3772 -
accuracy: 0.8701
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7615 -
accuracy: 0.7674
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5602 -
accuracy: 0.8153

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7577 -
accuracy: 0.2201
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6960 -
accuracy: 0.2201
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6348 -
accuracy: 0.2708
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5776 -
```

```
accuracy: 0.3243
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5291 -
accuracy: 0.3688
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4579 -
accuracy: 0.3972
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4361 -
accuracy: 0.4076
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3830 -
accuracy: 0.4201
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2847 -
accuracy: 0.4812
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0059 -
accuracy: 0.6410
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8511 -
accuracy: 0.7132
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8222 -
accuracy: 0.7056
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6372 -
accuracy: 0.7778
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5078 -
accuracy: 0.8243
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4510 -
accuracy: 0.8583
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3504 -
accuracy: 0.8813
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3145 -
accuracy: 0.8889
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3486 -
accuracy: 0.8757
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2844 -
accuracy: 0.9014
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2497 -
```

```
accuracy: 0.9090
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2400 -
accuracy: 0.9146
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2324 -
accuracy: 0.9181
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2525 -
accuracy: 0.9090
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1787 -
accuracy: 0.9389
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1978 -
accuracy: 0.9278
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1995 -
accuracy: 0.9250
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1667 -
accuracy: 0.9375
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1716 -
accuracy: 0.9479
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2305 -
accuracy: 0.9215
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1394 -
accuracy: 0.9549
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1313 -
accuracy: 0.9521
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3099 -
accuracy: 0.9014
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1696 -
accuracy: 0.9444
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1435 -
accuracy: 0.9458
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1828 -
accuracy: 0.9340
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1378 -
```

```
accuracy: 0.9618
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.0934 -
accuracy: 0.9715
Epoch 38/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.0922 -
accuracy: 0.9681
Epoch 39/40
1440/1440 [==============================] - 1972s 1s/sample - loss: 0.0900 -
accuracy: 0.9667
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.1594 -
accuracy: 0.9514
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.8052 -
accuracy: 0.1972
Epoch 2/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.7609 -
accuracy: 0.2201
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7476 -
accuracy: 0.2076
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7345 -
accuracy: 0.2306
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7409 -
accuracy: 0.1993
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.7230 -
accuracy: 0.2417
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6943 -
accuracy: 0.2903
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.5724 -
accuracy: 0.3646
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4516 -
accuracy: 0.4181
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4938 -
accuracy: 0.3792
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3093 -
accuracy: 0.4417
Epoch 12/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.2056 -
accuracy: 0.4708
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1176 -
accuracy: 0.5424
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0696 -
accuracy: 0.5535
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9669 -
accuracy: 0.6056
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9423 -
accuracy: 0.5986
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8804 -
accuracy: 0.6319
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.9252 -
accuracy: 0.6160
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7881 -
accuracy: 0.6806
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7949 -
accuracy: 0.6521
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8154 -
accuracy: 0.6347
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0345 -
accuracy: 0.5799
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8495 -
accuracy: 0.6535
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6922 -
accuracy: 0.7146
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5798 -
accuracy: 0.7646
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5016 -
accuracy: 0.8250
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4389 -
accuracy: 0.8403
Epoch 28/40
```

```
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4233 -
accuracy: 0.8618
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3806 -
accuracy: 0.8694
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4267 -
accuracy: 0.8569
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3072 -
accuracy: 0.8924
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3083 -
accuracy: 0.8986
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4072 -
accuracy: 0.8715
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4007 -
accuracy: 0.8694
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3285 -
accuracy: 0.8861
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3353 -
accuracy: 0.8875
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2718 -
accuracy: 0.9118
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2417 -
accuracy: 0.9174
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2139 -
accuracy: 0.9292
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2348 -
accuracy: 0.9250
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7757 -
accuracy: 0.1833
Epoch 2/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.6533 -
accuracy: 0.2160
Epoch 3/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4979 -
accuracy: 0.2868
```

```
Epoch 4/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.4255 -
accuracy: 0.3847
Epoch 5/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3352 -
accuracy: 0.4917
Epoch 6/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.3639 -
accuracy: 0.4840
Epoch 7/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.1970 -
accuracy: 0.5924
Epoch 8/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 1.0253 -
accuracy: 0.6375
Epoch 9/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.8714 -
accuracy: 0.6931
Epoch 10/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7568 -
accuracy: 0.7306
Epoch 11/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.7471 -
accuracy: 0.7292
Epoch 12/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6618 -
accuracy: 0.7785
Epoch 13/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.6118 -
accuracy: 0.7931
Epoch 14/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5615 -
accuracy: 0.8056
Epoch 15/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5634 -
accuracy: 0.8083
Epoch 16/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5269 -
accuracy: 0.8236
Epoch 17/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.5249 -
accuracy: 0.8264
Epoch 18/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4672 -
accuracy: 0.8361
Epoch 19/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3986 -
accuracy: 0.8562
```

```
Epoch 20/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.4141 -
accuracy: 0.8618
Epoch 21/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3802 -
accuracy: 0.8674
Epoch 22/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3586 -
accuracy: 0.8806
Epoch 23/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3223 -
accuracy: 0.8889
Epoch 24/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3214 -
accuracy: 0.8861
Epoch 25/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3155 -
accuracy: 0.8917
Epoch 26/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2663 -
accuracy: 0.9042
Epoch 27/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2746 -
accuracy: 0.9069
Epoch 28/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2353 -
accuracy: 0.9160
Epoch 29/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2126 -
accuracy: 0.9222
Epoch 30/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2461 -
accuracy: 0.9146
Epoch 31/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2763 -
accuracy: 0.9125
Epoch 32/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3052 -
accuracy: 0.8979
Epoch 33/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3161 -
accuracy: 0.8917
Epoch 34/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2329 -
accuracy: 0.9181
Epoch 35/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2426 -
accuracy: 0.9153
```

```
Epoch 36/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2195 -
accuracy: 0.9250
Epoch 37/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.3005 -
accuracy: 0.9007
Epoch 38/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2434 -
accuracy: 0.9215
Epoch 39/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2049 -
accuracy: 0.9236
Epoch 40/40
1440/1440 [==============================] - 9s 6ms/sample - loss: 0.2174 -
accuracy: 0.9243

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 1.7600 -
accuracy: 0.2111
Epoch 2/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6814 -
accuracy: 0.2556
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6328 -
accuracy: 0.2861
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.5679 -
accuracy: 0.3368
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4962 -
accuracy: 0.3583
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4248 -
accuracy: 0.3931
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4296 -
accuracy: 0.4111
Epoch 8/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3858 -
accuracy: 0.4347
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2739 -
accuracy: 0.5000
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.1700 -
accuracy: 0.5535
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.0951 -
accuracy: 0.5875
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9967 -
accuracy: 0.6090
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9401 -
accuracy: 0.6396
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.8091 -
accuracy: 0.7000
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7351 -
accuracy: 0.7215
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6255 -
accuracy: 0.7882
Epoch 17/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 0.6564 -
accuracy: 0.7535
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5014 -
accuracy: 0.8326
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5459 -
accuracy: 0.8097
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9480 -
accuracy: 0.6646
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5545 -
accuracy: 0.8194
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3850 -
accuracy: 0.8757
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4053 -
accuracy: 0.8667
Epoch 24/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3365 -
accuracy: 0.8889
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2324 -
accuracy: 0.9243
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2300 -
accuracy: 0.9187
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2115 -
accuracy: 0.9299
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2312 -
accuracy: 0.9194
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1663 -
accuracy: 0.9438
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1611 -
accuracy: 0.9479
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1719 -
accuracy: 0.9479
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1675 -
accuracy: 0.9417
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1168 -
accuracy: 0.9667
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1305 -
accuracy: 0.9569
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1079 -
accuracy: 0.9653
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1131 -
accuracy: 0.9646
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0949 -
accuracy: 0.9618
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1517 -
accuracy: 0.9465
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1038 -
accuracy: 0.9653
Epoch 40/40
```

```
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.0939 -
accuracy: 0.9736
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 7ms/sample - loss: 1.7883 -
accuracy: 0.2021
Epoch 2/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7424 -
accuracy: 0.2326
Epoch 3/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.7262 -
accuracy: 0.2625
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6852 -
accuracy: 0.3007
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.5823 -
accuracy: 0.3479
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3987 -
accuracy: 0.4250
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2771 -
accuracy: 0.4701
Epoch 8/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2991 -
accuracy: 0.4694
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.2910 -
accuracy: 0.4583
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.1443 -
accuracy: 0.5556
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.9963 -
accuracy: 0.5882
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.8688 -
accuracy: 0.6667
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.7410 -
accuracy: 0.7375
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6030 -
accuracy: 0.8007
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5504 -
accuracy: 0.8278
```

```
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6956 -
accuracy: 0.7563
Epoch 17/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4871 -
accuracy: 0.8535
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3769 -
accuracy: 0.8826
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3478 -
accuracy: 0.8924
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2973 -
accuracy: 0.9000
Epoch 21/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3011 -
accuracy: 0.8958
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3764 -
accuracy: 0.8813
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2906 -
accuracy: 0.8972
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2656 -
accuracy: 0.9139
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2686 -
accuracy: 0.9174
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2309 -
accuracy: 0.9194
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2376 -
accuracy: 0.9278
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2232 -
accuracy: 0.9271
Epoch 29/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1865 -
accuracy: 0.9375
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1820 -
accuracy: 0.9410
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2039 -
accuracy: 0.9354
```

```
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2181 -
accuracy: 0.9271
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2216 -
accuracy: 0.9215
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1958 -
accuracy: 0.9292
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1548 -
accuracy: 0.9431
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1961 -
accuracy: 0.9326
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1536 -
accuracy: 0.9424
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1579 -
accuracy: 0.9382
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4446 -
accuracy: 0.8611
Epoch 40/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5408 -
accuracy: 0.8215
Train on 1440 samples
Epoch 1/40
1440/1440 [==============================] - 11s 8ms/sample - loss: 1.7620 -
accuracy: 0.2021
Epoch 2/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.6637 -
accuracy: 0.2201
Epoch 3/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 1.4898 -
accuracy: 0.3139
Epoch 4/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3921 -
accuracy: 0.4222
Epoch 5/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.4305 -
accuracy: 0.4097
Epoch 6/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.3116 -
accuracy: 0.4542
Epoch 7/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 1.0500 -
```

```
accuracy: 0.5833
Epoch 8/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.8353 -
accuracy: 0.7076
Epoch 9/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6730 -
accuracy: 0.7639
Epoch 10/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.6013 -
accuracy: 0.7882
Epoch 11/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.5350 -
accuracy: 0.8083
Epoch 12/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4838 -
accuracy: 0.8326
Epoch 13/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4945 -
accuracy: 0.8264
Epoch 14/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4848 -
accuracy: 0.8201
Epoch 15/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4717 -
accuracy: 0.8354
Epoch 16/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.4691 -
accuracy: 0.8375
Epoch 17/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3667 -
accuracy: 0.8736
Epoch 18/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3289 -
accuracy: 0.8813
Epoch 19/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3975 -
accuracy: 0.8521
Epoch 20/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3398 -
accuracy: 0.8785
Epoch 21/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.3290 -
accuracy: 0.8813
Epoch 22/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2712 -
accuracy: 0.9056
Epoch 23/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.3198 -
```

```
accuracy: 0.8910
Epoch 24/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2888 -
accuracy: 0.9035
Epoch 25/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2851 -
accuracy: 0.9056
Epoch 26/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2476 -
accuracy: 0.9181
Epoch 27/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2054 -
accuracy: 0.9236
Epoch 28/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1926 -
accuracy: 0.9389
Epoch 29/40
1440/1440 [==============================] - 9s 7ms/sample - loss: 0.1816 -
accuracy: 0.9354
Epoch 30/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1705 -
accuracy: 0.9403
Epoch 31/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1720 -
accuracy: 0.9438
Epoch 32/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1591 -
accuracy: 0.9479
Epoch 33/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.2085 -
accuracy: 0.9326
Epoch 34/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1978 -
accuracy: 0.9354
Epoch 35/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1824 -
accuracy: 0.9389
Epoch 36/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1517 -
accuracy: 0.9479
Epoch 37/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1459 -
accuracy: 0.9549
Epoch 38/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1342 -
accuracy: 0.9542
Epoch 39/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1315 -
```

```
accuracy: 0.9604
Epoch 40/40
1440/1440 [==============================] - 10s 7ms/sample - loss: 0.1298 -
accuracy: 0.9521

C:\Users\GUND\.conda\envs\deeplearning\lib\site-
packages\sklearn\model_selection\_validation.py:536: FitFailedWarning: Estimator
fit failed. The score on this train-test partition for these parameters will be
set to nan. Details:
ValueError: A target array with shape (1440, 5) was passed for an output of
shape (None, 6) while using as loss `categorical_crossentropy`. This loss
expects targets to have the same shape as the output.

  FitFailedWarning)

Train on 1800 samples
Epoch 1/40
1800/1800 [==============================] - 12s 7ms/sample - loss: 1.7715 -
accuracy: 0.1761
Epoch 2/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 1.6853 -
accuracy: 0.2394
Epoch 3/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 1.5806 -
accuracy: 0.3233
Epoch 4/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 1.4243 -
accuracy: 0.4183
Epoch 5/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 1.1792 -
accuracy: 0.5706
Epoch 6/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.8963 -
accuracy: 0.6722
Epoch 7/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.6916 -
accuracy: 0.7639
Epoch 8/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.4715 -
accuracy: 0.8644
Epoch 9/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.3701 -
accuracy: 0.8906
Epoch 10/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.3121 -
accuracy: 0.8994
Epoch 11/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.2822 -
accuracy: 0.8972
```

```
Epoch 12/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.3024 -
accuracy: 0.9017
Epoch 13/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.2642 -
accuracy: 0.9061
Epoch 14/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1824 -
accuracy: 0.9356
Epoch 15/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1811 -
accuracy: 0.9428
Epoch 16/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1717 -
accuracy: 0.9378
Epoch 17/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.3709 -
accuracy: 0.8783
Epoch 18/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.3758 -
accuracy: 0.8661
Epoch 19/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.2434 -
accuracy: 0.9211
Epoch 20/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1940 -
accuracy: 0.9417
Epoch 21/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1475 -
accuracy: 0.9522
Epoch 22/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1339 -
accuracy: 0.9589
Epoch 23/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1202 -
accuracy: 0.9578
Epoch 24/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1185 -
accuracy: 0.9567
Epoch 25/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1293 -
accuracy: 0.9567
Epoch 26/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1127 -
accuracy: 0.9633
Epoch 27/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1074 -
accuracy: 0.9644
```

```
Epoch 28/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1018 -
accuracy: 0.9639
Epoch 29/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1766 -
accuracy: 0.9383
Epoch 30/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1355 -
accuracy: 0.9472
Epoch 31/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0846 -
accuracy: 0.9744
Epoch 32/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1386 -
accuracy: 0.9478
Epoch 33/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0955 -
accuracy: 0.9700
Epoch 34/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1038 -
accuracy: 0.9661
Epoch 35/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.1353 -
accuracy: 0.9539
Epoch 36/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0963 -
accuracy: 0.9694
Epoch 37/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0689 -
accuracy: 0.9761
Epoch 38/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0647 -
accuracy: 0.9778
Epoch 39/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0653 -
accuracy: 0.9772
Epoch 40/40
1800/1800 [==============================] - 11s 6ms/sample - loss: 0.0596 -
accuracy: 0.9794
```

[19]:
```
melhores_parametros = grid_search.best_params_
melhor_precisao = grid_search.best_score_
```

[20]:
```
melhores_parametros
```

[20]:
```
{'batch_size': 100, 'epochs': 40, 'n_dense_layers': 1, 'neurons': 128}
```

[21]:
```
melhor_precisao
```

[21]:
```
nan
```

[ ]:
```
%load_ext tensorboard.notebook
%tensorboard --logdir logs
```

1.0.2 Cria a Estrutura da Rede Neural Baseado Nos Parâmetros "Ótimos":

[23]:
```
def criar_rede_steel_defects():
    classificador = Sequential()

    classificador = Sequential()

    #1 camada de convolucao
    classificador.add(Conv2D(conv_depth_1, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    classificador.add(Conv2D(conv_depth_1, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    #Adiciona normalização à camada para aumentar a eficiencia e velocidade de␣
↪processamento
    #classificador.add(BatchNormalization())
    #Aplica janela de pooling dos pixels, de tamanho 2x2
    classificador.add(MaxPooling2D(pool_size = Pooling_size_1 ))
    #dropout de 20% para ignorar pixels aleatorios da imagem visando reduzir a␣
↪contribuição de pixels
    #que não contribuem de fato com características das falhas a serem␣
↪processadas
    classificador.add(Dropout(drop_prob_1))

    #2 camada de convolucao
    classificador.add(Conv2D(conv_depth_2, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    classificador.add(Conv2D(conv_depth_2, kernel_size,␣
↪input_shape=(img_width,img_height,3),  padding='same', activation='relu'))
    #classificador.add(BatchNormalization())
    #Adiciona normalização à camada para aumentar a eficiencia e velocidade de␣
↪processamento
    #classificador.add(BatchNormalization())
    #Aplica janela de pooling dos pixels, de tamanho 2x2
    classificador.add(MaxPooling2D(pool_size = Pooling_size_1 ))
    #dropout de 20% para ignorar pixels aleatorios da imagem visando reduzir a␣
↪contribuição de pixels
```

```
    #que não contribuem de fato com características das falhas a serem␣
 ↪processadas
    classificador.add(Dropout(drop_prob_2))

    #classificador.add(BatchNormalization())

    classificador.add(Flatten())




    #1 Camada Oculta
    classificador.add(Dense(units = hidden_neurons_1, activation='relu'))
    #classificador.add(BatchNormalization())
    classificador.add(Dropout(drop_prob_2 ))



    '''
    #2 Camada Oculta
    classificador.add(Dense(units = hidden_neurons_2, activation='relu'))
    classificador.add(Dropout(drop_prob_2 ))

    #3 Camada Oculta
    classificador.add(Dense(units = hidden_neurons_2, activation='relu'))
    classificador.add(Dropout(drop_prob_2 ))
    '''

    classificador.add(Dense(units = num_classes, activation='softmax'))

    classificador.compile(loss='categorical_crossentropy', optimizer = 'adam',␣
 ↪metrics = ['accuracy'])

    return classificador

classificador_Steel_defects = criar_rede_steel_defects()


classificador_Steel_defects.summary()
```

```
Model: "sequential_47"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_184 (Conv2D)          (None, 50, 50, 32)        896
_________________________________________________________________
conv2d_185 (Conv2D)          (None, 50, 50, 32)        9248
```

```
_________________________________________________________________
max_pooling2d_92 (MaxPooling (None, 25, 25, 32)        0
_________________________________________________________________
dropout_137 (Dropout)        (None, 25, 25, 32)        0
_________________________________________________________________
conv2d_186 (Conv2D)          (None, 25, 25, 64)        18496
_________________________________________________________________
conv2d_187 (Conv2D)          (None, 25, 25, 64)        36928
_________________________________________________________________
max_pooling2d_93 (MaxPooling (None, 12, 12, 64)        0
_________________________________________________________________
dropout_138 (Dropout)        (None, 12, 12, 64)        0
_________________________________________________________________
flatten_46 (Flatten)         (None, 9216)              0
_________________________________________________________________
dense_91 (Dense)             (None, 128)               1179776
_________________________________________________________________
dropout_139 (Dropout)        (None, 128)               0
_________________________________________________________________
dense_92 (Dense)             (None, 6)                 774
=================================================================
Total params: 1,246,118
Trainable params: 1,246,118
Non-trainable params: 0
_________________________________________________________________
```

AVALIAÇÂO DE PERFORMANCE DA REDE NEURAL COM A BASE DE DADOS

VALIDAÇÃO CRUZADA - KFOLD (DIVIDE A BASE DE DADOS EM PARTES ESPECIFICADAS E TREINA MULTIPLAS VEZES SEPARANDO UMA PARCELA PARA TREINO E OUTRA PARA TESTES, DE MODO A ENCONTRAR A COMBINAÇÃO DE PARTES QUE MINIMIZE O ERRO. ESTA PRATICA É AMPLAMENTE UTILIZADA NO MEIO CIENTÍFICO PARA ASSEGURAR QUE NENHUMA PARTE IMPORTANTE DA BASE DE DADOS SEJA IGNORADA E INFLUENCIE SIGNIFICATIVAMENTE NA VARIÂNCIA DO MODELO TREINADO)

[45]:
```
import tensorflow.keras
from tensorflow.keras.wrappers.scikit_learn import KerasClassifier
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
```

[46]:
```
classificador_steel_def_KFOLD =␣
 ↪KerasClassifier(build_fn=criar_rede_steel_defects, epochs = 40, batch_size =␣
 ↪100)
```

[47]:
```
#cv -> numero de vezes que executará o teste (implica também no numero de partes␣
 ↪que será dividida a base de dados)
resultados = cross_val_score(estimator = classificador_steel_def_KFOLD, X =␣
 ↪X_data, y = y_classes, cv = 10, scoring = 'accuracy')
```

```
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7875 -
accuracy: 0.1846
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7563 -
accuracy: 0.2086
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7029 -
accuracy: 0.2438
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6088 -
accuracy: 0.3074
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5534 -
accuracy: 0.3642
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5304 -
accuracy: 0.3556
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4551 -
accuracy: 0.3809
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4373 -
accuracy: 0.4160
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2868 -
accuracy: 0.5019
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2193 -
accuracy: 0.5080
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1688 -
accuracy: 0.5457
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0477 -
accuracy: 0.5988
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0634 -
accuracy: 0.5759
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0103 -
accuracy: 0.6136
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9719 -
accuracy: 0.6352
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9061 -
```

```
accuracy: 0.6605
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8724 -
accuracy: 0.6895
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8013 -
accuracy: 0.7062
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7730 -
accuracy: 0.7253
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7540 -
accuracy: 0.7247
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6392 -
accuracy: 0.7728
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6448 -
accuracy: 0.7741
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5577 -
accuracy: 0.8142
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5630 -
accuracy: 0.8210
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5325 -
accuracy: 0.8247
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4126 -
accuracy: 0.8728
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3797 -
accuracy: 0.8741
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3563 -
accuracy: 0.8870
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3281 -
accuracy: 0.8944
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3044 -
accuracy: 0.9049
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3220 -
accuracy: 0.9000
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3117 -
```

```
accuracy: 0.8870
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3021 -
accuracy: 0.8981
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2397 -
accuracy: 0.9253
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2921 -
accuracy: 0.9019
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2564 -
accuracy: 0.9204
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1977 -
accuracy: 0.9346
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1917 -
accuracy: 0.9389
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4639 -
accuracy: 0.8525
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3398 -
accuracy: 0.8883
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7904 -
accuracy: 0.1747
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7446 -
accuracy: 0.2142
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6634 -
accuracy: 0.2981
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6040 -
accuracy: 0.3142
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4093 -
accuracy: 0.4321
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1913 -
accuracy: 0.5383
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0642 -
accuracy: 0.6043
Epoch 8/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8714 -
accuracy: 0.6901
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7972 -
accuracy: 0.7099
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6992 -
accuracy: 0.7580
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6813 -
accuracy: 0.7685
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5537 -
accuracy: 0.8086
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5033 -
accuracy: 0.8302
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4250 -
accuracy: 0.8549
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4172 -
accuracy: 0.8623
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3956 -
accuracy: 0.8642
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5827 -
accuracy: 0.8086
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5428 -
accuracy: 0.8111
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3840 -
accuracy: 0.8735
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3478 -
accuracy: 0.8802
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3041 -
accuracy: 0.8981
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2909 -
accuracy: 0.9019
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3112 -
accuracy: 0.8944
Epoch 24/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2968 -
accuracy: 0.8981
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2557 -
accuracy: 0.9148
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2960 -
accuracy: 0.9012
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2440 -
accuracy: 0.9154
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2314 -
accuracy: 0.9154
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2073 -
accuracy: 0.9265
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2035 -
accuracy: 0.9333
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2063 -
accuracy: 0.9228
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1929 -
accuracy: 0.9309
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1816 -
accuracy: 0.9377
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2288 -
accuracy: 0.9253
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2222 -
accuracy: 0.9185
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1836 -
accuracy: 0.9395
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1679 -
accuracy: 0.9383
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1376 -
accuracy: 0.9531
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1375 -
accuracy: 0.9531
Epoch 40/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1701 -
accuracy: 0.9457
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7617 -
accuracy: 0.1975
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7059 -
accuracy: 0.2179
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6277 -
accuracy: 0.2772
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4977 -
accuracy: 0.3512
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.3215 -
accuracy: 0.4414
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1850 -
accuracy: 0.4932
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9554 -
accuracy: 0.6370
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8149 -
accuracy: 0.7019
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7397 -
accuracy: 0.7296
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6269 -
accuracy: 0.7710
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5317 -
accuracy: 0.8247
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4648 -
accuracy: 0.8383
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4475 -
accuracy: 0.8451
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3968 -
accuracy: 0.8617
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4010 -
accuracy: 0.8549
```

```
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3989 -
accuracy: 0.8623
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3820 -
accuracy: 0.8660
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3306 -
accuracy: 0.8877
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2904 -
accuracy: 0.8994
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2763 -
accuracy: 0.9000
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2741 -
accuracy: 0.9043
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2443 -
accuracy: 0.9167
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2097 -
accuracy: 0.9302
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3028 -
accuracy: 0.8883
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2442 -
accuracy: 0.9228
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2353 -
accuracy: 0.9247
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2556 -
accuracy: 0.9154
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2293 -
accuracy: 0.9235
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1841 -
accuracy: 0.9407
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1517 -
accuracy: 0.9444
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1491 -
accuracy: 0.9488
```

```
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1415 -
accuracy: 0.9525
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1884 -
accuracy: 0.9414
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1665 -
accuracy: 0.9414
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1446 -
accuracy: 0.9593
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1901 -
accuracy: 0.9389
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1732 -
accuracy: 0.9463
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1428 -
accuracy: 0.9556
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1393 -
accuracy: 0.9475
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1124 -
accuracy: 0.9617
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 12s 7ms/sample - loss: 1.7804 -
accuracy: 0.1827
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7379 -
accuracy: 0.2105
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6878 -
accuracy: 0.2636
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6318 -
accuracy: 0.3142
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5596 -
accuracy: 0.3327
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5191 -
accuracy: 0.3562
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5085 -
```

```
accuracy: 0.3654
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4595 -
accuracy: 0.3833
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4080 -
accuracy: 0.4296
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.3025 -
accuracy: 0.4679
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2523 -
accuracy: 0.4963
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1596 -
accuracy: 0.5383
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0907 -
accuracy: 0.5907
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9914 -
accuracy: 0.6401
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9172 -
accuracy: 0.6512
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7919 -
accuracy: 0.7340
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6987 -
accuracy: 0.7741
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7567 -
accuracy: 0.7222
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7691 -
accuracy: 0.7284
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5461 -
accuracy: 0.8383
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4525 -
accuracy: 0.8512
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3856 -
accuracy: 0.8654
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3449 -
```

```
accuracy: 0.8895
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3273 -
accuracy: 0.8877
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3040 -
accuracy: 0.9006
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3168 -
accuracy: 0.8883
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2971 -
accuracy: 0.9025
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3158 -
accuracy: 0.9000
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3473 -
accuracy: 0.8926
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2980 -
accuracy: 0.9012
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2682 -
accuracy: 0.9142
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2206 -
accuracy: 0.9259
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2646 -
accuracy: 0.9105
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2277 -
accuracy: 0.9210
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2332 -
accuracy: 0.9265
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2188 -
accuracy: 0.9284
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2034 -
accuracy: 0.9290
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2247 -
accuracy: 0.9235
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2370 -
```

```
accuracy: 0.9123
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2378 -
accuracy: 0.9222
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7739 -
accuracy: 0.1858
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7205 -
accuracy: 0.2426
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6744 -
accuracy: 0.2870
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5984 -
accuracy: 0.3222
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5384 -
accuracy: 0.3272
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4581 -
accuracy: 0.3654
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.3561 -
accuracy: 0.4549
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1985 -
accuracy: 0.5401
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9470 -
accuracy: 0.6432
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7747 -
accuracy: 0.7235
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5980 -
accuracy: 0.7914
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5494 -
accuracy: 0.8000
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5707 -
accuracy: 0.7975
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4421 -
accuracy: 0.8451
Epoch 15/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4601 -
accuracy: 0.8395
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3724 -
accuracy: 0.8660
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3310 -
accuracy: 0.8895
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3441 -
accuracy: 0.8833
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3501 -
accuracy: 0.8809
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4383 -
accuracy: 0.8481
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3763 -
accuracy: 0.8574
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3174 -
accuracy: 0.8914
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5656 -
accuracy: 0.8241
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4394 -
accuracy: 0.8475
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2725 -
accuracy: 0.9117
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2433 -
accuracy: 0.9136
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2356 -
accuracy: 0.9272
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2498 -
accuracy: 0.9142
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2432 -
accuracy: 0.9148
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2103 -
accuracy: 0.9327
Epoch 31/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2703 -
accuracy: 0.9154
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2117 -
accuracy: 0.9216
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1877 -
accuracy: 0.9358
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1937 -
accuracy: 0.9346
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1756 -
accuracy: 0.9457
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1839 -
accuracy: 0.9438
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1668 -
accuracy: 0.9389
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1471 -
accuracy: 0.9494
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2034 -
accuracy: 0.9333
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1896 -
accuracy: 0.9420
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7885 -
accuracy: 0.1827
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7418 -
accuracy: 0.2086
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6146 -
accuracy: 0.2654
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4439 -
accuracy: 0.3914
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2922 -
accuracy: 0.4667
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1070 -
accuracy: 0.5401
```

```
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9611 -
accuracy: 0.6370
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8289 -
accuracy: 0.7111
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7336 -
accuracy: 0.7364
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6254 -
accuracy: 0.7914
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5701 -
accuracy: 0.8105
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5737 -
accuracy: 0.8080
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5233 -
accuracy: 0.8364
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4148 -
accuracy: 0.8654
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3898 -
accuracy: 0.8747
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4040 -
accuracy: 0.8704
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4229 -
accuracy: 0.8586
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4018 -
accuracy: 0.8685
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3341 -
accuracy: 0.8988
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3529 -
accuracy: 0.8809
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3772 -
accuracy: 0.8815
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3043 -
accuracy: 0.9062
```

```
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2881 -
accuracy: 0.9019
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3683 -
accuracy: 0.8691
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2864 -
accuracy: 0.9148
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2772 -
accuracy: 0.9062
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2690 -
accuracy: 0.9154
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2407 -
accuracy: 0.9222
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2268 -
accuracy: 0.9228
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1984 -
accuracy: 0.9290
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2807 -
accuracy: 0.9154
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2435 -
accuracy: 0.9198
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2317 -
accuracy: 0.9241
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2677 -
accuracy: 0.9105
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2342 -
accuracy: 0.9204
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1954 -
accuracy: 0.9370
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2210 -
accuracy: 0.9198
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1794 -
accuracy: 0.9401
```

```
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1814 -
accuracy: 0.9370
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1789 -
accuracy: 0.9377
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7857 -
accuracy: 0.1821
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7273 -
accuracy: 0.2148
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5579 -
accuracy: 0.3247
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1969 -
accuracy: 0.5191
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0078 -
accuracy: 0.6148
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8443 -
accuracy: 0.6735
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7078 -
accuracy: 0.7506
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6803 -
accuracy: 0.7586
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5911 -
accuracy: 0.7914
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6027 -
accuracy: 0.8056
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5451 -
accuracy: 0.8142
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4265 -
accuracy: 0.8605
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4053 -
accuracy: 0.8784
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4051 -
```

```
accuracy: 0.8722
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3424 -
accuracy: 0.8840
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3420 -
accuracy: 0.8907
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3388 -
accuracy: 0.8833
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2707 -
accuracy: 0.9148
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3087 -
accuracy: 0.8963
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3486 -
accuracy: 0.8877
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3083 -
accuracy: 0.8988
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3390 -
accuracy: 0.8969
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3020 -
accuracy: 0.8963
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2847 -
accuracy: 0.9136
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2764 -
accuracy: 0.9204
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2355 -
accuracy: 0.9198
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2269 -
accuracy: 0.9247
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2310 -
accuracy: 0.9216
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2031 -
accuracy: 0.9290
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2067 -
```

```
accuracy: 0.9247
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1972 -
accuracy: 0.9364
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1993 -
accuracy: 0.9315
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1742 -
accuracy: 0.9426
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1607 -
accuracy: 0.9475
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1509 -
accuracy: 0.9568
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2755 -
accuracy: 0.9185
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2316 -
accuracy: 0.9130
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2073 -
accuracy: 0.9346
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1486 -
accuracy: 0.9500
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1545 -
accuracy: 0.9444
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 12s 7ms/sample - loss: 1.7864 -
accuracy: 0.1895
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7399 -
accuracy: 0.2012
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7095 -
accuracy: 0.2488
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6297 -
accuracy: 0.3086
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5262 -
accuracy: 0.3327
Epoch 6/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4909 -
accuracy: 0.3654
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4405 -
accuracy: 0.4031
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2213 -
accuracy: 0.5136
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0390 -
accuracy: 0.6093
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8730 -
accuracy: 0.7056
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7781 -
accuracy: 0.7302
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6895 -
accuracy: 0.7580
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6730 -
accuracy: 0.7710
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6827 -
accuracy: 0.7698
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5999 -
accuracy: 0.8086
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5494 -
accuracy: 0.8247
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5470 -
accuracy: 0.8204
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5947 -
accuracy: 0.7889
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4474 -
accuracy: 0.8364
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3767 -
accuracy: 0.8833
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3813 -
accuracy: 0.8691
Epoch 22/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3465 -
accuracy: 0.8833
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2990 -
accuracy: 0.9012
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3136 -
accuracy: 0.9062
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3038 -
accuracy: 0.9031
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2853 -
accuracy: 0.9080
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2669 -
accuracy: 0.9012
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2501 -
accuracy: 0.9136
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2340 -
accuracy: 0.9272
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2498 -
accuracy: 0.9148
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2502 -
accuracy: 0.9074
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2360 -
accuracy: 0.9259
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2053 -
accuracy: 0.9302
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2159 -
accuracy: 0.9278
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2423 -
accuracy: 0.9080
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2505 -
accuracy: 0.9099
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1883 -
accuracy: 0.9383
Epoch 38/40
```

```
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1667 -
accuracy: 0.9407
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1681 -
accuracy: 0.9414
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1418 -
accuracy: 0.9562
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7611 -
accuracy: 0.1796
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6823 -
accuracy: 0.2630
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6436 -
accuracy: 0.3222
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6125 -
accuracy: 0.3519
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5241 -
accuracy: 0.3846
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4703 -
accuracy: 0.4019
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.3569 -
accuracy: 0.4457
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2738 -
accuracy: 0.4784
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.1403 -
accuracy: 0.5358
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0738 -
accuracy: 0.5969
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9946 -
accuracy: 0.6407
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.9470 -
accuracy: 0.6549
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8648 -
accuracy: 0.7031
```

```
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7880 -
accuracy: 0.7340
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7553 -
accuracy: 0.7414
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7117 -
accuracy: 0.7679
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6274 -
accuracy: 0.7951
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7207 -
accuracy: 0.7593
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5861 -
accuracy: 0.8086
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5453 -
accuracy: 0.8179
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5986 -
accuracy: 0.8136
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5268 -
accuracy: 0.8278
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4593 -
accuracy: 0.8543
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4087 -
accuracy: 0.8580
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4337 -
accuracy: 0.8525
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3893 -
accuracy: 0.8710
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3642 -
accuracy: 0.8784
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4001 -
accuracy: 0.8728
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3924 -
accuracy: 0.8685
```

```
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3561 -
accuracy: 0.8821
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3764 -
accuracy: 0.8728
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3584 -
accuracy: 0.8765
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3584 -
accuracy: 0.8809
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3291 -
accuracy: 0.9000
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3422 -
accuracy: 0.8790
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3638 -
accuracy: 0.8809
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3513 -
accuracy: 0.8778
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2910 -
accuracy: 0.9019
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3214 -
accuracy: 0.8907
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3852 -
accuracy: 0.8809
Train on 1620 samples
Epoch 1/40
1620/1620 [==============================] - 11s 7ms/sample - loss: 1.7570 -
accuracy: 0.1981
Epoch 2/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.7103 -
accuracy: 0.2037
Epoch 3/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6541 -
accuracy: 0.3099
Epoch 4/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.6504 -
accuracy: 0.3475
Epoch 5/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.5593 -
```

```
accuracy: 0.3556
Epoch 6/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.4501 -
accuracy: 0.4179
Epoch 7/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.2463 -
accuracy: 0.5383
Epoch 8/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 1.0910 -
accuracy: 0.5858
Epoch 9/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.8886 -
accuracy: 0.6870
Epoch 10/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.7458 -
accuracy: 0.7340
Epoch 11/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.6093 -
accuracy: 0.8031
Epoch 12/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.5438 -
accuracy: 0.8272
Epoch 13/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4890 -
accuracy: 0.8315
Epoch 14/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4235 -
accuracy: 0.8679
Epoch 15/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4516 -
accuracy: 0.8549
Epoch 16/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4117 -
accuracy: 0.8691
Epoch 17/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3631 -
accuracy: 0.8759
Epoch 18/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3271 -
accuracy: 0.8895
Epoch 19/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3334 -
accuracy: 0.8994
Epoch 20/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3147 -
accuracy: 0.8969
Epoch 21/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2770 -
```

```
accuracy: 0.9080
Epoch 22/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2660 -
accuracy: 0.9117
Epoch 23/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2271 -
accuracy: 0.9272
Epoch 24/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2451 -
accuracy: 0.9284
Epoch 25/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.4914 -
accuracy: 0.8469
Epoch 26/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.3617 -
accuracy: 0.8741
Epoch 27/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2805 -
accuracy: 0.9105
Epoch 28/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2958 -
accuracy: 0.8975
Epoch 29/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2598 -
accuracy: 0.9111
Epoch 30/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2025 -
accuracy: 0.9370
Epoch 31/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2075 -
accuracy: 0.9352
Epoch 32/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2097 -
accuracy: 0.9272
Epoch 33/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2884 -
accuracy: 0.9031
Epoch 34/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2235 -
accuracy: 0.9321
Epoch 35/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1989 -
accuracy: 0.9352
Epoch 36/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1847 -
accuracy: 0.9340
Epoch 37/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1782 -
```

```
accuracy: 0.9420
Epoch 38/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.2145 -
accuracy: 0.9284
Epoch 39/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1811 -
accuracy: 0.9327
Epoch 40/40
1620/1620 [==============================] - 10s 6ms/sample - loss: 0.1670 -
accuracy: 0.9438
```

[48]:
```
resultados
```

[48]:
```
array([0.82222222, 0.99444444, 0.72777778, 0.96666667, 0.97222222,
       0.63333333, 0.84444444, 0.99444444, 0.86666667, 0.49444444])
```

[49]:
```
resultados.mean()
```

[49]:
```
0.8316666666666667
```

Quanto maior o valor do desvio padrão, mais overfitting há na rede neural

[50]:
```
resultados.std()
```

[50]:
```
0.16009352976183933
```

[ ]:
```
y_classes[0:10]
```

2 SEM AUGUMENTATION:

Roda treinamento e em seguida aplica o teste, verificando o percentual de acerto (val_accuracy):

*quanto maior o "val_accuracy" e menor é o valor do "val_loss", obtidos a partir da base de dados de teste, melhor é a capacidade de generalização da rede

[24]:
```
epochs_hist = classificador_Steel_defects.fit(X_train, Y_train_encoded,␣
↪steps_per_epoch = round(n_training / batch_size),
          batch_size=batch_size, epochs=num_epochs,
          validation_data=(X_test, Y_test_encoded))
```

```
Train on 1746 samples, validate on 54 samples
Epoch 1/40
1700/1746 [============================>.] - ETA: 0s - loss: 1.7768 - accuracy:
0.1835 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 2/40
1646/1746 [============================>..] - ETA: 0s - loss: 1.7019 - accuracy:
0.2448 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 3/40
1646/1746 [============================>..] - ETA: 0s - loss: 1.6235 - accuracy:
0.2892 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 4/40
```

```
1646/1746 [===========================>..] - ETA: 0s - loss: 1.5325 - accuracy:
0.3196 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 5/40
1646/1746 [===========================>..] - ETA: 0s - loss: 1.5561 - accuracy:
0.3165 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 6/40
1646/1746 [===========================>..] - ETA: 0s - loss: 1.4614 - accuracy:
0.3688 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 7/40
1646/1746 [===========================>..] - ETA: 0s - loss: 1.3458 - accuracy:
0.4502 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 8/40
1646/1746 [===========================>..] - ETA: 0s - loss: 1.1748 - accuracy:
0.5346 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 9/40
1646/1746 [===========================>..] - ETA: 0s - loss: 1.0106 - accuracy:
0.6112 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 10/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.7862 - accuracy:
0.7224 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 11/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.6313 - accuracy:
0.7989 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 12/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.7735 - accuracy:
0.7290 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 13/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.5647 - accuracy:
0.8038 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 14/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.5332 - accuracy:
0.8232 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 15/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.4875 - accuracy:
0.8420 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 16/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.3831 - accuracy:
0.8761 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 17/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.3803 - accuracy:
0.8767 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 18/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.3979 - accuracy:
0.8670 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 19/40
1700/1746 [============================>.] - ETA: 0s - loss: 0.3721 - accuracy:
0.8818 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 20/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.3320 - accuracy:
0.8888 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 21/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.2780 - accuracy:
0.9040 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 22/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.2920 - accuracy:
0.8961 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 23/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.2581 - accuracy:
0.9174 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 24/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.2426 - accuracy:
0.9125 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 25/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.1979 - accuracy:
0.9289 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 26/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.2683 - accuracy:
0.9052 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 27/40
1646/1746 [===========================>..] - ETA: 0s - loss: 0.3668 - accuracy:
0.8870 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 28/40
```

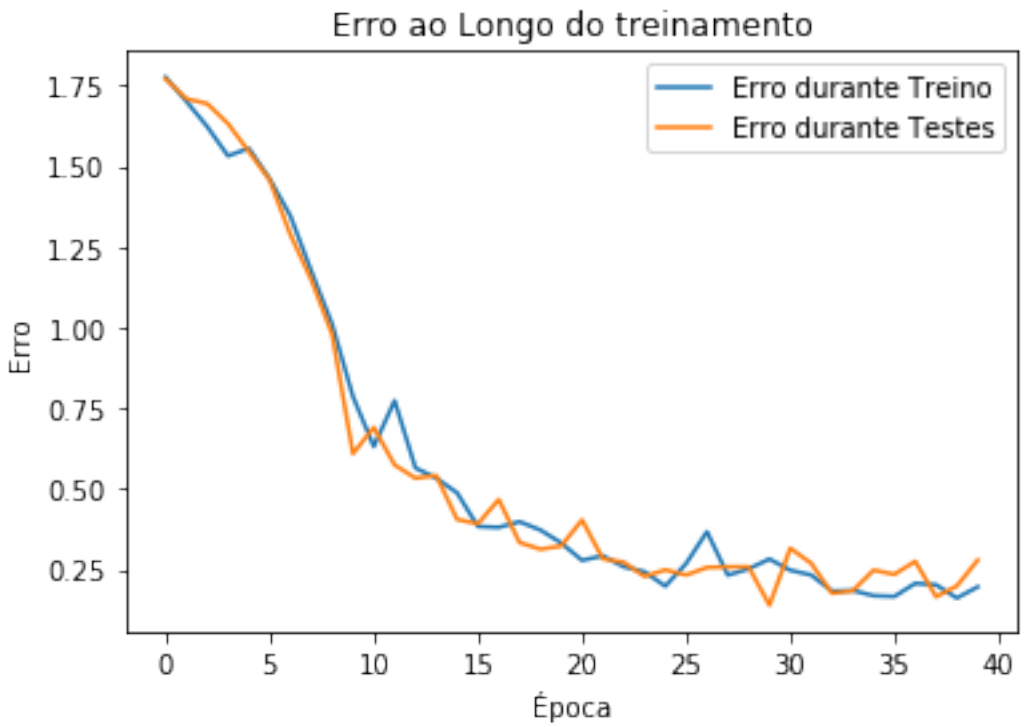
```
1646/1746 [============================>..] - ETA: 0s - loss: 0.2321 - accuracy:
0.9216 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 29/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.2515 - accuracy:
0.9162 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 30/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.2821 - accuracy:
0.9101 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 31/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.2474 - accuracy:
0.9149 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 32/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.2327 - accuracy:
0.9374 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 33/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1827 - accuracy:
0.9441 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 34/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1845 - accuracy:
0.9386 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 35/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1684 - accuracy:
0.9435 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 36/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1660 - accuracy:
0.9484 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 37/40
1700/1746 [============================>.] - ETA: 0s - loss: 0.2066 - accuracy:
0.9329 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 38/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.2022 - accuracy:
0.9368 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 39/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1610 - accuracy:
0.9496 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00Epoch 40/40
1646/1746 [============================>..] - ETA: 0s - loss: 0.1959 - accuracy:
0.9386 - val_loss: 0.0000e+00 - val_accuracy: 0.0000e+00
```

[25]:
```
epochs_hist.history.keys()
```

[25]:
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

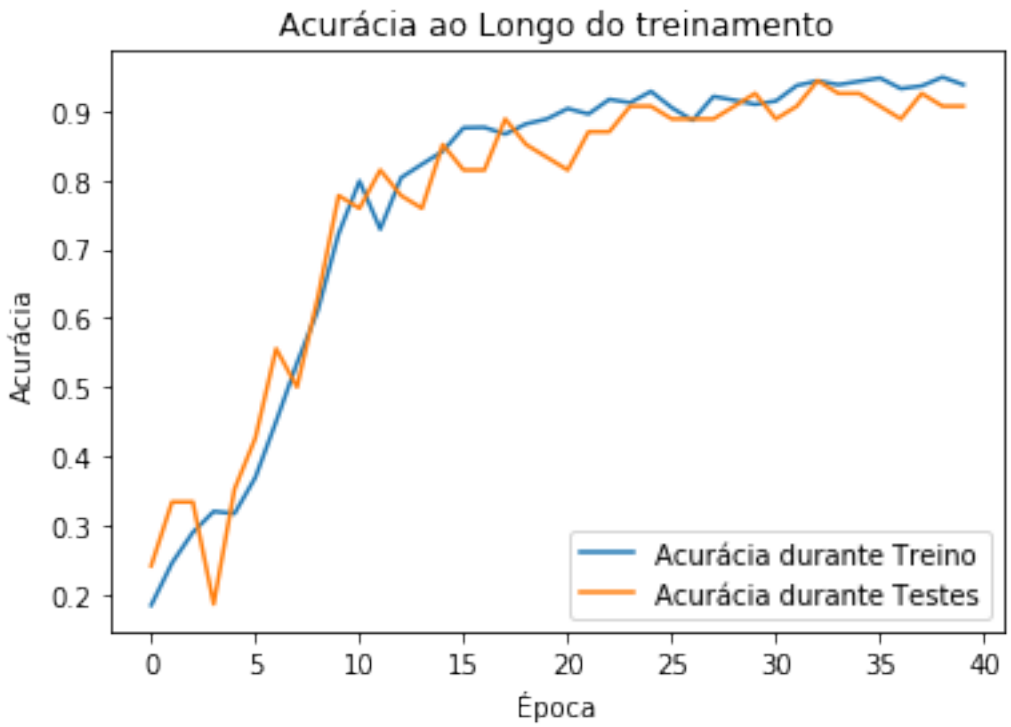
[26]:
```
plt.plot(epochs_hist.history['loss'])
plt.plot(epochs_hist.history['val_loss'])
plt.title('Erro ao Longo do treinamento')
plt.xlabel('Época')
plt.ylabel('Erro')
plt.legend(['Erro durante Treino', 'Erro durante Testes'])
```

[26]:
```
<matplotlib.legend.Legend at 0x186d0917e08>
```



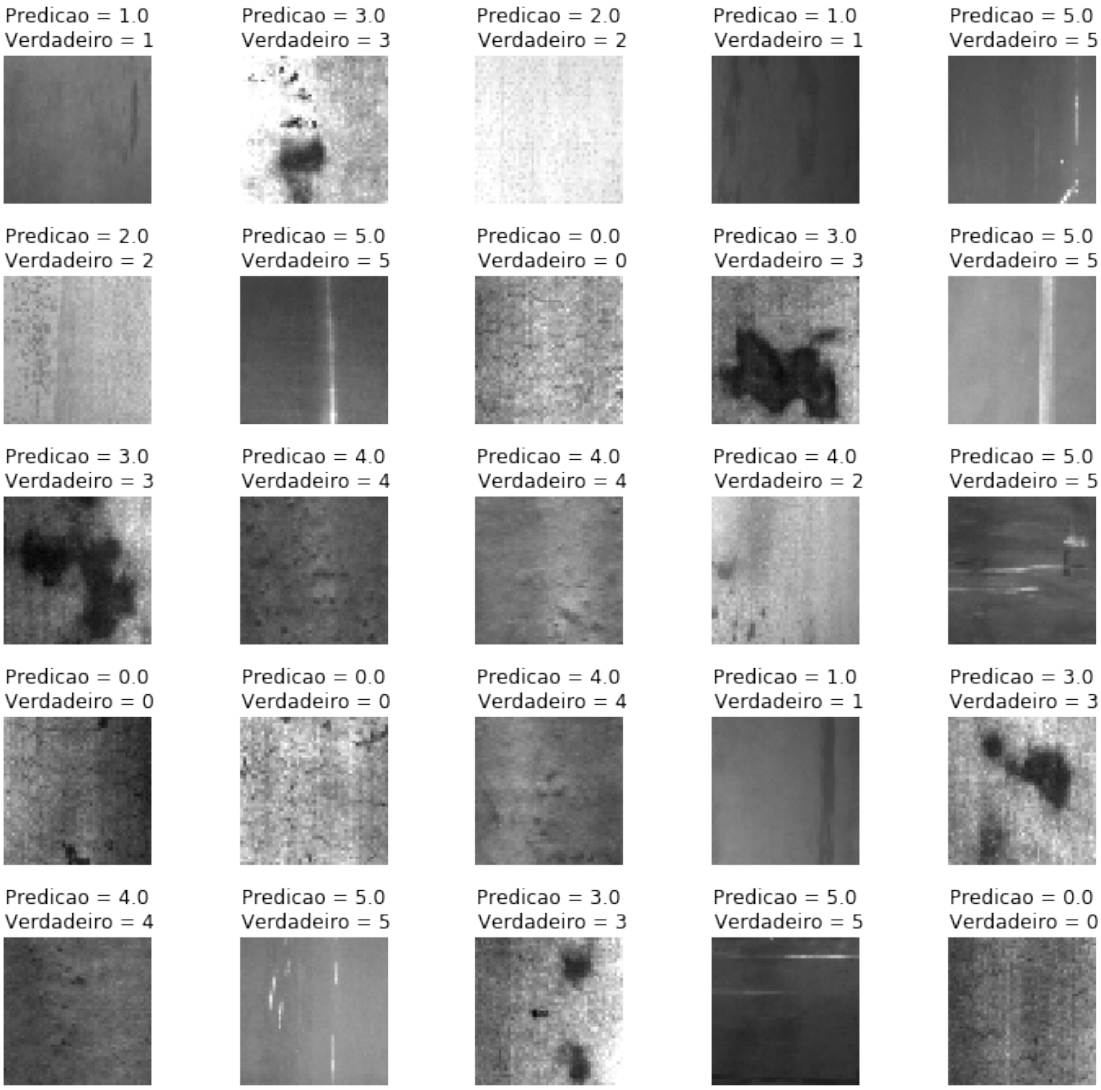
[27]:
```
plt.plot(epochs_hist.history['accuracy'])
plt.plot(epochs_hist.history['val_accuracy'])
plt.title('Acurácia ao Longo do treinamento')
plt.xlabel('Época')
plt.ylabel('Acurácia')
plt.legend(['Acurácia durante Treino', 'Acurácia durante Testes'])
```

[27]:
```
<matplotlib.legend.Legend at 0x186d09bec88>
```



[28]:
```
# get the predictions for the test data
predicted_classes = classificador_Steel_defects.predict_classes(X_test)
```

[29]:
```
L = 5
W = 5
fig, axes = plt.subplots(L, W, figsize = (12,12))
axes = axes.ravel() #

for i in np.arange(0, L * W):
    axes[i].imshow(X_test[i])
    axes[i].set_title("Predicao = {:0.1f}\n Verdadeiro = {}".
 ↪format(predicted_classes[i], Y_test[i]))
    axes[i].axis('off')

plt.subplots_adjust(wspace = 0.6)
```



2.0.1 COM "AUGUMENTATION": cria novas entradas de "imagens" a partir das existentes, rotacionando, "esticando", invertendo...

[223]:
```
#For use in google coolab
# Define the Keras TensorBoard callback.
#logdir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
#logdir="logs/fit/" + "Augumentation"



#For use in Windows?
'''
logs_base_dir = "./logs/fit/Augumentation"
```

```
os.makedirs(logs_base_dir, exist_ok=True)
os.join.path()

'''

logdir = './logs/fit/'


if not os.path.exists(logdir):
    os.mkdir(logdir)
dir_augumentation = os.path.join(logdir, "Augumentation")

#%tensorboard --logdir {logs_base_dir}
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=dir_augumentation,
 ↪profile_batch = 100000000)
```

[32]:
```
gerador_treinamento = ImageDataGenerator(rotation_range= 7,
 ↪horizontal_flip=True, shear_range=0.2, height_shift_range=0.07, zoom_range=0.2)
```

Augumentation com variação de luminosidade:

[33]:
```
gerador_treinamento = ImageDataGenerator(rotation_range= 7,
 ↪horizontal_flip=True, shear_range=0.2, height_shift_range=0.07, zoom_range=0.
 ↪2, brightness_range=[0.2,1.0])
```

[34]:
```
gerador_teste = ImageDataGenerator()
```

[35]:
```
#base_treinamento = gerador_treinamento.flow(X_train, Y_train_encoded,
 ↪batch_size = batch_size )
gerador_treinamento.fit(X_train)
base_treinamento = gerador_treinamento.flow(X_train, Y_train_encoded, batch_size
 ↪= batch_size )
```

[36]:
```
#base_teste = gerador_teste.flow(X_test, Y_test_encoded, batch_size = batch_size)
gerador_teste.fit(X_test)
base_teste = gerador_teste.flow(X_test, Y_test_encoded, batch_size = batch_size)
```

[38]:
```
#steps_per_epoch -> numero total de etapas/lotes de amostras a serem geradas
 ↪pelo gerador antes de declarar uma época concluída. Coca-se a quantidade de
 ↪imagens que temos, dividido pelo batch size
#classificador.fit_generator(base_treinamento, steps_per_epoch= 600000 / 128,
 ↪epochs = 5, validation_data = base_teste, validation_steps= 10000 / 128)
#epochs_hist_augumentation = classificador_Steel_defects.
 ↪fit_generator(base_treinamento, steps_per_epoch = num_imagens / batch_size,
 ↪epochs = num_epochs, validation_data = base_teste, validation_steps= 10000 /
 ↪batch_size)
```

```
#epochs_hist_augumentation = classificador_Steel_defects.
 ↪fit_generator(base_treinamento, steps_per_epoch = num_imagens / 2, epochs =␣
 ↪num_epochs, validation_data = base_teste, validation_steps= 1000 )
#epochs_hist_augumentation = classificador_Steel_defects.fit_generator(datagen.
 ↪flow(X_train, Y_train_encoded, batch_size = batch_size), steps_per_epoch =␣
 ↪n_training / batch_size, epochs = 2,  validation_data = base_teste)
epochs_hist_augumentation = classificador_Steel_defects.
 ↪fit_generator(base_treinamento, steps_per_epoch = round(n_training /␣
 ↪batch_size), epochs = 20,  validation_data = base_teste)
```

```
Epoch 1/20
17/17 [==============================] - 20s 1s/step - loss: 13.4735 - accuracy:
0.1665 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 2/20
17/17 [==============================] - 20s 1s/step - loss: 13.4409 - accuracy:
0.1659 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 3/20
17/17 [==============================] - 20s 1s/step - loss: 13.4884 - accuracy:
0.1628 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 4/20
17/17 [==============================] - 20s 1s/step - loss: 13.4874 - accuracy:
0.1622 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 5/20
17/17 [==============================] - 20s 1s/step - loss: 13.6394 - accuracy:
0.1525 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 6/20
17/17 [==============================] - 20s 1s/step - loss: 13.2699 - accuracy:
0.1768 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 7/20
17/17 [==============================] - 20s 1s/step - loss: 13.5771 - accuracy:
0.1576 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 8/20
17/17 [==============================] - 20s 1s/step - loss: 13.3120 - accuracy:
0.1768 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 9/20
17/17 [==============================] - 20s 1s/step - loss: 13.7459 - accuracy:
0.1470 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 10/20
17/17 [==============================] - 20s 1s/step - loss: 13.4419 - accuracy:
0.1665 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 11/20
17/17 [==============================] - 20s 1s/step - loss: 13.3310 - accuracy:
0.1756 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 12/20
17/17 [==============================] - 19s 1s/step - loss: 13.5271 - accuracy:
0.1627 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 13/20
```

```
17/17 [==============================] - 20s 1s/step - loss: 13.5494 - accuracy:
0.1616 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 14/20
17/17 [==============================] - 20s 1s/step - loss: 13.5108 - accuracy:
0.1618 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 15/20
17/17 [==============================] - 19s 1s/step - loss: 13.3077 - accuracy:
0.1702 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 16/20
17/17 [==============================] - 20s 1s/step - loss: 13.5866 - accuracy:
0.1571 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 17/20
17/17 [==============================] - 20s 1s/step - loss: 13.4294 - accuracy:
0.1652 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 18/20
17/17 [==============================] - 20s 1s/step - loss: 13.5315 - accuracy:
0.1634 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 19/20
17/17 [==============================] - 20s 1s/step - loss: 13.3894 - accuracy:
0.1665 - val_loss: 11.9393 - val_accuracy: 0.2593
Epoch 20/20
17/17 [==============================] - 20s 1s/step - loss: 13.5179 - accuracy:
0.1616 - val_loss: 11.9393 - val_accuracy: 0.2593
```

com callback para tensorboard:

[ ]:
```
#steps_per_epoch -> numero total de etapas/lotes de amostras a serem geradas␣
 ↪pelo gerador antes de declarar uma época concluída. Coca-se a quantidade de␣
 ↪imagens que temos, dividido pelo batch size
epochs_hist_augumentation = classificador_Steel_defects.
 ↪fit_generator(base_treinamento, steps_per_epoch = n_training / batch_size,␣
 ↪epochs = 10,  validation_data = base_teste,  callbacks=[tensorboard_callback])
```

[ ]:
```
#Para google coolab:
#%load_ext tensorboard.notebook

#Para windows:
%load_ext tensorboard


%tensorboard --logdir dir_augumentation
```

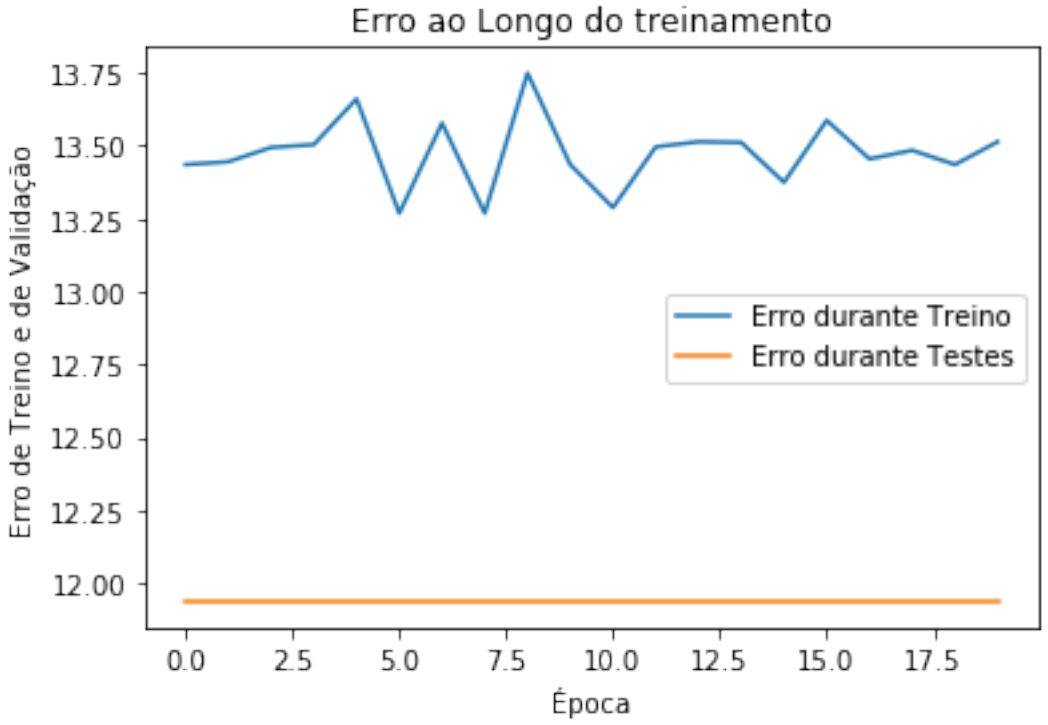
[39]:
```
epochs_hist_augumentation.history.keys()
```

[39]:
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

[40]:
```
plt.plot(epochs_hist_augumentation.history['loss'])
plt.plot(epochs_hist_augumentation.history['val_loss'])
```

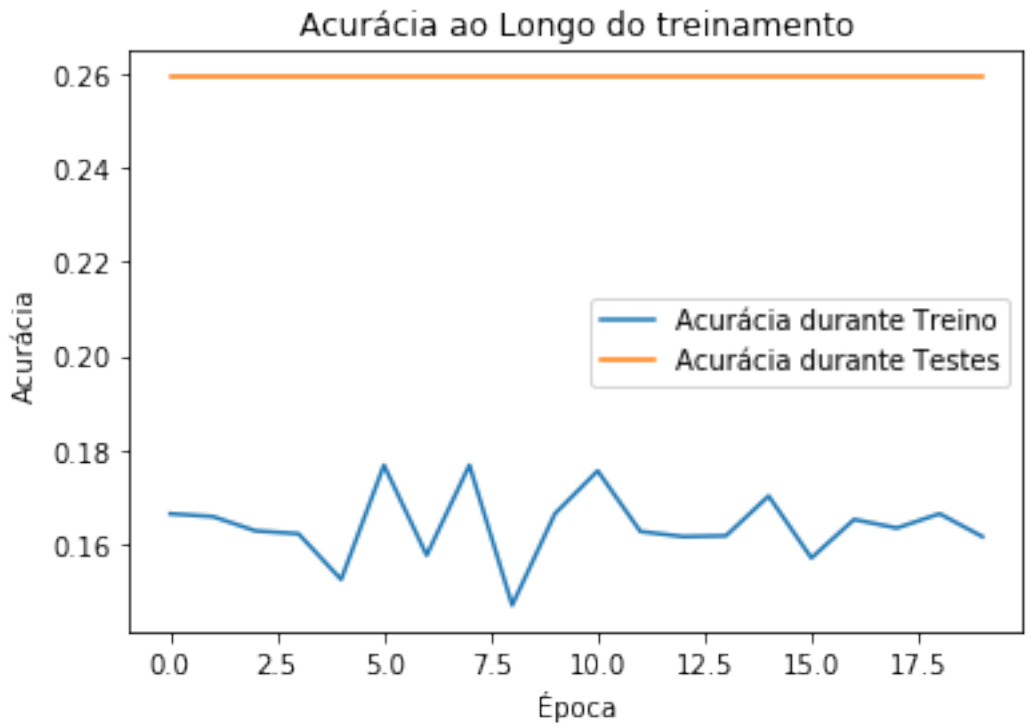
```
plt.title('Erro ao Longo do treinamento')
plt.xlabel('Época')
plt.ylabel('Erro de Treino e de Validação')
plt.legend(['Erro durante Treino', 'Erro durante Testes'])
```

[40]: <matplotlib.legend.Legend at 0x186f1d100c8>



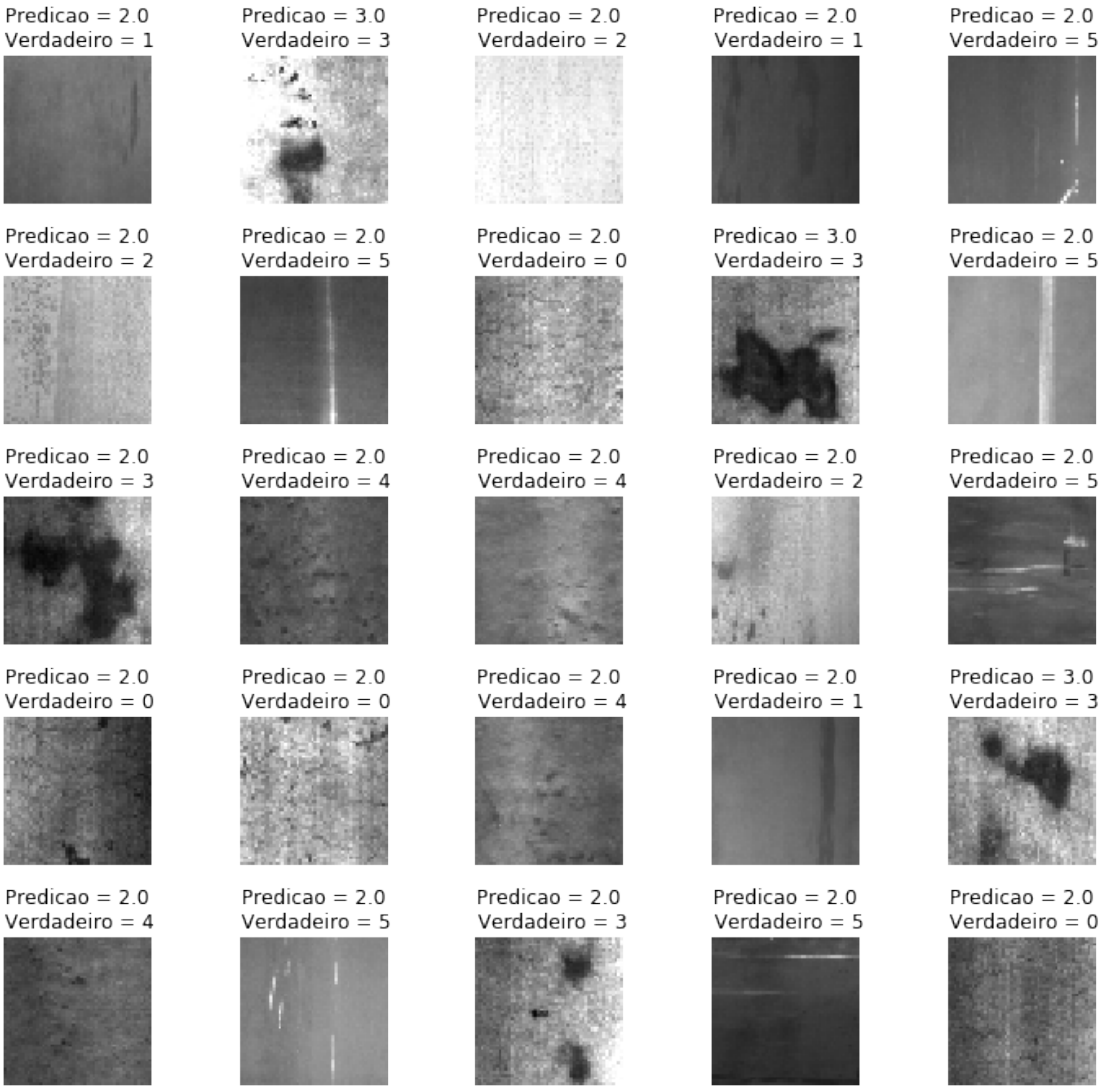
[41]:
```
plt.plot(epochs_hist_augumentation.history['accuracy'])
plt.plot(epochs_hist_augumentation.history['val_accuracy'])
plt.title('Acurácia ao Longo do treinamento')
plt.xlabel('Época')
plt.ylabel('Acurácia')
plt.legend(['Acurácia durante Treino', 'Acurácia durante Testes'])
```

[41]: <matplotlib.legend.Legend at 0x186f1d85488>



[80]:
```
# get the predictions for the test data
predicted_classes = classificador_Steel_defects.predict_classes(X_test)
```

[81]:
```
L = 5
W = 5
fig, axes = plt.subplots(L, W, figsize = (12,12))
axes = axes.ravel() #

for i in np.arange(0, L * W):
    axes[i].imshow(X_test[i])
    axes[i].set_title("Predicao = {:0.1f}\n Verdadeiro = {}".
 ↪format(predicted_classes[i], Y_test[i]))
    axes[i].axis('off')

plt.subplots_adjust(wspace = 0.6)
```


Predicao = 2.0
Verdadeiro = 1
Predicao = 3.0
Verdadeiro = 3
Predicao = 2.0
Verdadeiro = 2
Predicao = 2.0
Verdadeiro = 1
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 2
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 0
Predicao = 3.0
Verdadeiro = 3
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 3
Predicao = 2.0
Verdadeiro = 4
Predicao = 2.0
Verdadeiro = 4
Predicao = 2.0
Verdadeiro = 2
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 0
Predicao = 2.0
Verdadeiro = 0
Predicao = 2.0
Verdadeiro = 4
Predicao = 2.0
Verdadeiro = 1
Predicao = 3.0
Verdadeiro = 3
Predicao = 2.0
Verdadeiro = 4
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 3
Predicao = 2.0
Verdadeiro = 5
Predicao = 2.0
Verdadeiro = 0

[ ]: