

```
[In [1]]: import tensorflow as tf
import numpy as np
import pandas as pd
from sklearn.metrics import classification_report, confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
import os

INFO:tensorflow:Enabling eager execution
INFO:tensorflow:Enabling v2 tensorshape
INFO:tensorflow:Enabling resource variables
INFO:tensorflow:Enabling tensor equality
INFO:tensorflow:Enabling control flow v2

[In [2]]: epochs = 100 # quantidade de vezes a ser executado o algoritmo, uma epoch é quanto to
batch = 32 # número de amostras que será carregado a cada execução

[In [3]]: #carrega o modelo da ResNet50V2 com os pesos aprendidos no treino da ImageNet sem a c
base_model = tf.keras.applications.ResNet50V2(weights='imagenet', include_top=False)

[In [4]]: #O restante do modelo e suas camadas são discutidos a seguir
#x recebe o final da ResNet50V2
x=base_model.output

[In [5]]: #Nova configuração para o modelo

#adiciona apos x uma camada AveragePooling2D e atribui este no a x novamente (logo x
x=tf.keras.layers.GlobalAveragePooling2D()(x)

#adiciona apos x uma camada densa com 32 neurônios com funcao de ativacao relu. Atrib
x=tf.keras.layers.Dense(128,activation='relu')(x)

#adiciona apos x uma camada densa com 64 neurônios com funcao de ativacao relu. Atrib
x=tf.keras.layers.Dense(64,activation='relu')(x)

#adiciona apos x uma camada densa com 128 neurônios com funcao de ativacao relu. Atri
x=tf.keras.layers.Dense(32,activation='relu')(x)

#adiciona apos x os neurônios que devem ser utilizados, nesse caso foram desligados 2
x=tf.keras.layers.Dropout(0.5)(x)

#adiciona apos x uma camada densa com 7 neurônios (sete classes) com funcao de ativac
pred=tf.keras.layers.Dense(7,activation='softmax')(x)

#definindo modelo final
model=tf.keras.models.Model(inputs=base_model.input,outputs=pred)

#mostrando modelo final e sua estrutura
model.summary()

Model: "model"

Layer (type) Output Shape Param # Connected to
-----
input_1 (InputLayer) [] (None, None, None, 0
conv1_pad (ZeroPadding2D) (None, None, None, 3 0 input_1[0][0]
conv1_conv (Conv2D) (None, None, None, 6 9472 conv1_pad[0][0]
pool1_pad (ZeroPadding2D) (None, None, None, 6 0 conv1_conv[0][0]
pool1_pool (MaxPooling2D) (None, None, None, 6 0 pool1_pad[0][0]
conv2_block1_preact_bn (BatchNo (None, None, None, 2 256 pool1_pool[0][0]
conv2_block1_preact_relu (Activ (None, None, None, 6 0 conv2_block1_preact_b
n[0][0]
conv2_block1_1_conv (Conv2D) (None, None, None, 6 4096 conv2_block1_preact_r
elu[0][0]
conv2_block1_1_bn (BatchNormali (None, None, None, 6 256 conv2_block1_1_conv
[0][0]
conv2_block1_1_relu (Activation (None, None, None, 6 0 conv2_block1_1_bn[0]
[0]
conv2_block1_2_pad (ZeroPadding (None, None, None, 6 0 conv2_block1_1_relu
[0][0]
conv2_block1_2_conv (Conv2D) (None, None, None, 6 36864 conv2_block1_2_pad[0]
[0]
conv2_block1_2_bn (BatchNormali (None, None, None, 6 256 conv2_block1_2_conv
[0][0]
conv2_block1_2_relu (Activation (None, None, None, 6 0 conv2_block1_2_bn[0]
[0]
conv2_block1_0_conv (Conv2D) (None, None, None, 2 16640 conv2_block1_preact_r
elu[0][0]
conv2_block1_3_conv (Conv2D) (None, None, None, 2 16640 conv2_block1_2_relu
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conv2_block1_out (Add) (None, None, None, 2 0 conv2_block1_0_conv
conv2_block1_3_conv
[0][0]
conv2_block2_preact_bn (BatchNo (None, None, None, 2 1024 conv2_block1_out[0]
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conv2_block2_preact_relu (Activ (None, None, None, 2 0 conv2_block2_preact_b
n[0][0]
conv2_block2_1_conv (Conv2D) (None, None, None, 6 16384 conv2_block2_preact_r
elu[0][0]
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conv2_block2_1_relu (Activation (None, None, None, 6 0 conv2_block2_1_bn[0]
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conv2_block2_2_pad (ZeroPadding (None, None, None, 6 0 conv2_block2_1_relu
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conv2_block2_2_conv (Conv2D) (None, None, None, 6 36864 conv2_block2_2_pad[0]
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conv2_block2_2_bn (BatchNormali (None, None, None, 6 256 conv2_block2_2_conv
[0][0]
conv2_block2_2_relu (Activation (None, None, None, 6 0 conv2_block2_2_bn[0]
[0]
conv2_block2_3_conv (Conv2D) (None, None, None, 2 16640 conv2_block2_2_relu
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conv2_block2_out (Add) (None, None, None, 2 0 conv2_block1_out[0]
conv2_block2_3_conv
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conv2_block3_preact_bn (BatchNo (None, None, None, 2 1024 conv2_block2_out[0]
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conv2_block3_preact_relu (Activ (None, None, None, 2 0 conv2_block3_preact_b
n[0][0]
conv2_block3_1_conv (Conv2D) (None, None, None, 6 16384 conv2_block3_preact_r
elu[0][0]
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conv2_block3_2_conv (Conv2D) (None, None, None, 6 36864 conv2_block3_2_pad[0]
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conv2_block3_2_relu (Activation (None, None, None, 6 0 conv2_block3_2_bn[0]
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conv2_block3_3_conv (Conv2D) (None, None, None, 2 16640 conv2_block3_2_relu
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conv2_block3_out (Add) (None, None, None, 2 0 max_pooling2d[0][0]
conv2_block3_3_conv
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conv3_block1_preact_bn (BatchNo (None, None, None, 2 1024 conv2_block3_out[0]
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elu[0][0]
conv3_block1_3_conv (Conv2D) (None, None, None, 5 66048 conv3_block1_2_relu
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conv3_block1_out (Add) (None, None, None, 5 0 conv3_block1_0_conv
conv3_block1_3_conv
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conv3_block2_preact_bn (BatchNo (None, None, None, 5 2048 conv3_block1_out[0]
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conv3_block2_preact_relu (Activ (None, None, None, 5 0 conv3_block2_preact_b
n[0][0]
conv3_block2_1_conv (Conv2D) (None, None, None, 1 65536 conv3_block2_preact_r
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conv3_block2_1_bn (BatchNormali (None, None, None, 1 512 conv3_block2_1_conv
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conv3_block2_1_relu (Activation (None, None, None, 1 0 conv3_block2_1_bn[0]
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conv3_block2_2_pad (ZeroPadding (None, None, None, 1 0 conv3_block2_1_relu
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conv3_block2_2_conv (Conv2D) (None, None, None, 1 147456 conv3_block2_2_pad[0]
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conv3_block2_3_conv (Conv2D) (None, None, None, 5 66048 conv3_block2_2_relu
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conv3_block2_out (Add) (None, None, None, 5 0 conv3_block1_out[0]
conv3_block2_3_conv
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conv3_block3_preact_bn (BatchNo (None, None, None, 5 2048 conv3_block2_out[0]
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conv3_block3_3_conv (Conv2D) (None, None, None, 5 66048 conv3_block3_2_relu
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conv3_block3_out (Add) (None, None, None, 5 0 conv3_block2_out[0]
conv3_block3_3_conv
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conv3_block4_preact_bn (BatchNo (None, None, None, 5 2048 conv3_block3_out[0]
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conv3_block4_preact_relu (Activ (None, None, None, 5 0 conv3_block4_preact_b
n[0][0]
conv3_block4_1_conv (Conv2D) (None, None, None, 1 65536 conv3_block4_preact_r
elu[0][0]
conv3_block4_1_bn (BatchNormali (None, None, None, 1 512 conv3_block4_1_conv
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conv3_block4_1_relu (Activation (None, None, None, 1 0 conv3_block4_1_bn[0]
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conv3_block4_2_pad (ZeroPadding (None, None, None, 1 0 conv3_block4_1_relu
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conv3_block4_2_conv (Conv2D) (None, None, None, 1 147456 conv3_block4_2_pad[0]
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conv3_block4_2_bn (BatchNormali (None, None, None, 1 512 conv3_block4_2_conv
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conv3_block4_2_relu (Activation (None, None, None, 1 0 conv3_block4_2_bn[0]
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conv3_block4_3_conv (Conv2D) (None, None, None, 5 66048 conv3_block4_2_relu
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conv3_block4_out (Add) (None, None, None, 5 0 max_pooling2d[0][0]
conv3_block4_3_conv
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conv4_block1_preact_bn (BatchNo (None, None, None, 5 2048 conv3_block4_out[0]
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conv4_block1_preact_relu (Activ (None, None, None, 5 0 conv4_block1_preact_b
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elu[0][0]
conv4_block1_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block1_1_conv
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conv4_block1_1_relu (Activation (None, None, None, 2 0 conv4_block1_1_bn[0]
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conv4_block1_2_pad (ZeroPadding (None, None, None, 2 0 conv4_block1_1_relu
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conv4_block1_2_conv (Conv2D) (None, None, None, 2 589824 conv4_block1_2_pad[0]
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conv4_block1_2_bn (BatchNormali (None, None, None, 2 1024 conv4_block1_2_conv
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conv4_block1_2_relu (Activation (None, None, None, 2 0 conv4_block1_2_bn[0]
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conv4_block1_0_conv (Conv2D) (None, None, None, 1 525312 conv4_block1_preact_r
elu[0][0]
conv4_block1_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block1_2_relu
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conv4_block1_out (Add) (None, None, None, 1 0 conv4_block1_0_conv
conv4_block1_3_conv
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conv4_block2_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block1_out[0]
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conv4_block2_preact_relu (Activ (None, None, None, 1 0 conv4_block2_preact_b
n[0][0]
conv4_block2_1_conv (Conv2D) (None, None, None, 2 262144 conv4_block2_preact_r
elu[0][0]
conv4_block2_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block2_1_conv
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conv4_block2_1_relu (Activation (None, None, None, 2 0 conv4_block2_1_bn[0]
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conv4_block2_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block2_2_relu
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conv4_block2_out (Add) (None, None, None, 1 0 conv4_block1_out[0]
conv4_block2_3_conv
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conv4_block3_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block2_out[0]
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conv4_block3_preact_relu (Activ (None, None, None, 1 0 conv4_block3_preact_b
n[0][0]
conv4_block3_1_conv (Conv2D) (None, None, None, 2 262144 conv4_block3_preact_r
elu[0][0]
conv4_block3_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block3_1_conv
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conv4_block3_1_relu (Activation (None, None, None, 2 0 conv4_block3_1_bn[0]
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conv4_block3_2_pad (ZeroPadding (None, None, None, 2 0 conv4_block3_1_relu
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conv4_block3_2_conv (Conv2D) (None, None, None, 2 589824 conv4_block3_2_pad[0]
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conv4_block3_2_bn (BatchNormali (None, None, None, 2 1024 conv4_block3_2_conv
[0][0]
conv4_block3_2_relu (Activation (None, None, None, 2 0 conv4_block3_2_bn[0]
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conv4_block3_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block3_2_relu
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conv4_block3_out (Add) (None, None, None, 1 0 conv4_block2_out[0]
conv4_block3_3_conv
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conv4_block4_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block3_out[0]
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conv4_block4_preact_relu (Activ (None, None, None, 1 0 conv4_block4_preact_b
n[0][0]
conv4_block4_1_conv (Conv2D) (None, None, None, 2 262144 conv4_block4_preact_r
elu[0][0]
conv4_block4_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block4_1_conv
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conv4_block4_1_relu (Activation (None, None, None, 2 0 conv4_block4_1_bn[0]
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conv4_block4_2_pad (ZeroPadding (None, None, None, 2 0 conv4_block4_1_relu
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conv4_block4_2_conv (Conv2D) (None, None, None, 2 589824 conv4_block4_2_pad[0]
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conv4_block4_2_bn (BatchNormali (None, None, None, 2 1024 conv4_block4_2_conv
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conv4_block4_2_relu (Activation (None, None, None, 2 0 conv4_block4_2_bn[0]
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conv4_block4_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block4_2_relu
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conv4_block4_out (Add) (None, None, None, 1 0 conv4_block3_out[0]
conv4_block4_3_conv
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conv4_block5_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block4_out[0]
[0]
conv4_block5_preact_relu (Activ (None, None, None, 1 0 conv4_block5_preact_b
n[0][0]
conv4_block5_1_conv (Conv2D) (None, None, None, 2 262144 conv4_block5_preact_r
elu[0][0]
conv4_block5_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block5_1_conv
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conv4_block5_1_relu (Activation (None, None, None, 2 0 conv4_block5_1_bn[0]
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conv4_block5_2_pad (ZeroPadding (None, None, None, 2 0 conv4_block5_1_relu
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conv4_block5_2_conv (Conv2D) (None, None, None, 2 589824 conv4_block5_2_pad[0]
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conv4_block5_2_bn (BatchNormali (None, None, None, 2 1024 conv4_block5_2_conv
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conv4_block5_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block5_2_relu
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conv4_block5_out (Add) (None, None, None, 1 0 conv4_block4_out[0]
conv4_block5_3_conv
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conv4_block6_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block5_out[0]
[0]
conv4_block6_preact_relu (Activ (None, None, None, 1 0 conv4_block6_preact_b
n[0][0]
conv4_block6_1_conv (Conv2D) (None, None, None, 2 262144 conv4_block6_preact_r
elu[0][0]
conv4_block6_1_bn (BatchNormali (None, None, None, 2 1024 conv4_block6_1_conv
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conv4_block6_1_relu (Activation (None, None, None, 2 0 conv4_block6_1_bn[0]
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conv4_block6_2_pad (ZeroPadding (None, None, None, 2 0 conv4_block6_1_relu
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conv4_block6_2_conv (Conv2D) (None, None, None, 2 589824 conv4_block6_2_pad[0]
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conv4_block6_2_bn (BatchNormali (None, None, None, 2 1024 conv4_block6_2_conv
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conv4_block6_2_relu (Activation (None, None, None, 2 0 conv4_block6_2_bn[0]
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conv4_block6_3_conv (Conv2D) (None, None, None, 1 263168 conv4_block6_2_relu
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conv4_block6_out (Add) (None, None, None, 1 0 max_pooling2d[0][0]
conv4_block6_3_conv
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conv5_block1_preact_bn (BatchNo (None, None, None, 1 4096 conv4_block6_out[0]
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conv5_block1_preact_relu (Activ (None, None, None, 1 0 conv5_block1_preact_b
n[0][0]
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elu[0][0]
conv5_block1_1_bn (BatchNormali (None, None, None, 5 2048 conv5_block1_1_conv
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conv5_block1_1_relu (Activation (None, None, None, 5 0 conv5_block1_1_bn[0]
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conv5_block1_2_pad (ZeroPadding (None, None, None, 5 0 conv5_block1_1_relu
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conv5_block1_2_conv (Conv2D) (None, None, None, 5 2359296 conv5_block1_2_pad[0]
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conv5_block1_2_bn (BatchNormali (None, None, None, 5 2048 conv5_block1_2_conv
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conv5_block1_2_relu (Activation (None, None, None, 5 0 conv5_block1_2_bn[0]
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conv5_block1_0_conv (Conv2D) (None, None, None, 2 2099200 conv5_block1_preact_r
elu[0][0]
conv5_block1_3_conv (Conv2D) (None, None, None, 2 1050624 conv5_block1_2_relu
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conv5_block1_out (Add) (None, None, None, 2 0 conv5_block1_0_conv
conv5_block1_3_conv
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conv5_block2_preact_bn (BatchNo (None, None, None, 2 8192 conv5_block1_out[0]
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conv5_block2_preact_relu (Activ (None, None, None, 2 0 conv5_block2_preact_b
n[0][0]
conv5_block2_1_conv (Conv2D) (None, None, None, 5 1048576 conv5_block2_preact_r
elu[0][0]
conv5_block2_1_bn (BatchNormali (None, None, None, 5 2048 conv5_block2_1_conv
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conv5_block2_1_relu (Activation (None, None, None, 5 0 conv5_block2_1_bn[0]
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conv5_block2_2_pad (ZeroPadding (None, None, None, 5 0 conv5_block2_1_relu
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conv5_block2_2_conv (Conv2D) (None, None, None, 5 2359296 conv5_block2_2_pad[0]
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conv5_block2_2_bn (BatchNormali (None, None, None, 5 2048 conv5_block2_2_conv
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conv5_block2_2_relu (Activation (None, None, None, 5 0 conv5_block2_2_bn[0]
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conv5_block2_3_conv (Conv2D) (None, None, None, 2 1050624 conv5_block2_2_relu
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conv5_block2_out (Add) (None, None, None, 2 0 conv5_block1_out[0]
conv5_block2_3_conv
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conv5_block3_preact_bn (BatchNo (None, None, None, 2 8192 conv5_block2_out[0]
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conv5_block3_preact_relu (Activ (None, None, None, 2 0 conv5_block3_preact_b
n[0][0]
conv5_block3_1_conv (Conv2D) (None, None, None, 5 1048576 conv5_block3_preact_r
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conv5_block3_1_bn (BatchNormali (None, None, None, 5 2048 conv5_block3_1_conv
[0][0]
conv5_block3_1_relu (Activation (None, None, None, 5 0 conv5_block3_1_bn[0]
[0]
conv5_block3_2_pad (ZeroPadding (None, None, None, 5 0 conv5_block3_1_relu
[0][0]
conv5_block3_2_conv (Conv2D) (None, None, None, 5 2359296 conv5_block3_2_pad[0]
[0]
conv5_block3_2_bn (BatchNormali (None, None, None, 5 2048 conv5_block3_2_conv
[0][0]
conv5_block3_2_relu (Activation (None, None, None, 5 0 conv5_block3_2_bn[0]
[0]
conv5_block3_3_conv (Conv2D) (None, None, None, 2 1050624 conv5_block3_2_relu
[0][0]
conv5_block3_out (Add) (None, None, None, 2 0 conv5_block2_out[0]
conv5_block3_3_conv
[0][0]
post_bn (BatchNormalization) (None, None, None, 2 8192 conv5_block3_out[0]
[0]
post_relu (Activation) (None, None, None, 2 0 post_bn[0][0]
global_average_pooling2d (Globa (None, None, None, 0 post_relu[0][0][0]
dense (Dense) (None, 128) 262272 global_average_poolin
g[0][0]
dense_1 (Dense) (None, 64) 8256 dense[0][0]
dense_2 (Dense) (None, 32) 2080 dense_1[0][0]
dropout (Dropout) (None, 32) 0 dense_2[0][0]
dense_3 (Dense) (None, 7) 231 dropout[0][0]
=====
Total params: 23,837,639
Trainable params: 23,792,199
Non-trainable params: 45,440
=====

[In [6]]: #congelando os neurônios já treinados na ImageNet, queremos retrainar somente a últim
for i in model.layers:
    if i.name.split('/')[-1][0] != 'dense':
        i.trainable=False
    else:
        i.trainable=True

[In [7]]: #iniciando objeto que apanhara todas as imagens de treino, processando as imagens com
train_data_gen = tf.keras.preprocessing.image.ImageDataGenerator(preprocessing_functi
#iniciando objeto que apanhara todas as imagens de teste, processando as imagens com
test_data_gen = tf.keras.preprocessing.image.ImageDataGenerator(preprocessing_functi

[In [8]]: #CARREGANDO PRÓPRIO DATASET PARA USO

#definindo gerador de imagens de treino
train_generator = train_data_gen.flow_from_directory('data/train',
                                                    target_size=(224, 224), # tamanho da
                                                    batch_size=batch,
                                                    class_mode='categorical',
                                                    shuffle=True)

#definindo gerador de imagens de teste
test_generator = test_data_gen.flow_from_directory('data/test',
                                                    target_size=(224, 224), # tamanho da
                                                    batch_size=batch,
                                                    class_mode='categorical',
                                                    shuffle=True)

Found 731 images belonging to 7 classes.
Found 186 images belonging to 7 classes.

[In [9]]: lr = tf.keras.optimizers.Adam(learning_rate=0.0001) #estabelece taxa de otimização
model.compile(optimizer=lr, loss='categorical_crossentropy', metrics=['accuracy'])

[In [10]]: #definindo dos steps
step_size_train = train_generator.n//train_generator.batch_size
step_size_test = test_generator.n//test_generator.batch_size

[In [11]]: #treinando e testando o modelo
history = model.fit_generator(generator=train_generator,
                             steps_per_epoch=step_size_train,
                             epochs=epochs,
                             validation_data=test_generator,
                             validation_steps=step_size_test)

c:\users\vinicius\appdata\local\programs\python\python39\lib\site-packages\tensorflow
\python\keras\engine\training.py:1940: UserWarning: Model.fit_generator() is deprecate
d and will be removed in a future version. Please use Model.fit(), which supports gene
rators.
warnings.warn('Model.fit_generator() is deprecated and ')

22/22 [=====] - 65s 3s/step - loss: 2.0703 - accuracy: 0.1468
- val_loss: 1.8955 - val_accuracy: 0.2375
2/100
```



```
22/22 [=====] - 63s 3s/step - loss: 1.8994 - accuracy: 0.2156
Epoch 3/100
22/22 [=====] - 62s 3s/step - loss: 1.7947 - accuracy: 0.2929
- val_loss: 1.6705 - val_accuracy: 0.3313
Epoch 4/100
22/22 [=====] - 63s 3s/step - loss: 1.7497 - accuracy: 0.3044
- val_loss: 1.6021 - val_accuracy: 0.4688
Epoch 5/100
22/22 [=====] - 64s 3s/step - loss: 1.6049 - accuracy: 0.3748
- val_loss: 1.5083 - val_accuracy: 0.4938
Epoch 6/100
22/22 [=====] - 65s 3s/step - loss: 1.5574 - accuracy: 0.3947
- val_loss: 1.4403 - val_accuracy: 0.5000
Epoch 7/100
22/22 [=====] - 64s 3s/step - loss: 1.4828 - accuracy: 0.3708
- val_loss: 1.4040 - val_accuracy: 0.5000
Epoch 8/100
22/22 [=====] - 64s 3s/step - loss: 1.4363 - accuracy: 0.4810
- val_loss: 1.3288 - val_accuracy: 0.5000
Epoch 9/100
22/22 [=====] - 64s 3s/step - loss: 1.4203 - accuracy: 0.4448
- val_loss: 1.2939 - val_accuracy: 0.5188
Epoch 10/100
22/22 [=====] - 64s 3s/step - loss: 1.3751 - accuracy: 0.4678
- val_loss: 1.2759 - val_accuracy: 0.5625
Epoch 11/100
22/22 [=====] - 63s 3s/step - loss: 1.3324 - accuracy: 0.4797
- val_loss: 1.2524 - val_accuracy: 0.5063
Epoch 12/100
22/22 [=====] - 63s 3s/step - loss: 1.3285 - accuracy: 0.4764
- val_loss: 1.2291 - val_accuracy: 0.5312
Epoch 13/100
22/22 [=====] - 64s 3s/step - loss: 1.2475 - accuracy: 0.5179
- val_loss: 1.2189 - val_accuracy: 0.5300
Epoch 14/100
22/22 [=====] - 63s 3s/step - loss: 1.3234 - accuracy: 0.4538
- val_loss: 1.1870 - val_accuracy: 0.5188
Epoch 15/100
22/22 [=====] - 64s 3s/step - loss: 1.2862 - accuracy: 0.5034
- val_loss: 1.1838 - val_accuracy: 0.5188
Epoch 16/100
22/22 [=====] - 64s 3s/step - loss: 1.2199 - accuracy: 0.5113
- val_loss: 1.1916 - val_accuracy: 0.5125
Epoch 17/100
22/22 [=====] - 64s 3s/step - loss: 1.2080 - accuracy: 0.5353
- val_loss: 1.1776 - val_accuracy: 0.5063
Epoch 18/100
22/22 [=====] - 64s 3s/step - loss: 1.1820 - accuracy: 0.5388
- val_loss: 1.1571 - val_accuracy: 0.5188
Epoch 19/100
22/22 [=====] - 63s 3s/step - loss: 1.1899 - accuracy: 0.5532
- val_loss: 1.1338 - val_accuracy: 0.5875
Epoch 20/100
22/22 [=====] - 64s 3s/step - loss: 1.1563 - accuracy: 0.5917
- val_loss: 1.1372 - val_accuracy: 0.5500
Epoch 21/100
22/22 [=====] - 64s 3s/step - loss: 1.1193 - accuracy: 0.5885
- val_loss: 1.1243 - val_accuracy: 0.5250
Epoch 22/100
22/22 [=====] - 64s 3s/step - loss: 1.1174 - accuracy: 0.5696
- val_loss: 1.1210 - val_accuracy: 0.5750
Epoch 23/100
22/22 [=====] - 64s 3s/step - loss: 1.1298 - accuracy: 0.5735
- val_loss: 1.0757 - val_accuracy: 0.5437
Epoch 24/100
22/22 [=====] - 64s 3s/step - loss: 1.0699 - accuracy: 0.5768
- val_loss: 1.0928 - val_accuracy: 0.5312
Epoch 25/100
22/22 [=====] - 64s 3s/step - loss: 1.0142 - accuracy: 0.6406
- val_loss: 1.0760 - val_accuracy: 0.5350
Epoch 26/100
22/22 [=====] - 64s 3s/step - loss: 1.0280 - accuracy: 0.6216
- val_loss: 1.1006 - val_accuracy: 0.5000
Epoch 27/100
22/22 [=====] - 64s 3s/step - loss: 1.0525 - accuracy: 0.6106
- val_loss: 1.0644 - val_accuracy: 0.5500
Epoch 28/100
22/22 [=====] - 64s 3s/step - loss: 1.0559 - accuracy: 0.5884
- val_loss: 1.0804 - val_accuracy: 0.5125
Epoch 29/100
22/22 [=====] - 64s 3s/step - loss: 1.0248 - accuracy: 0.6338
- val_loss: 1.0873 - val_accuracy: 0.5063
Epoch 30/100
22/22 [=====] - 64s 3s/step - loss: 1.0396 - accuracy: 0.5846
- val_loss: 1.0691 - val_accuracy: 0.5375
Epoch 31/100
22/22 [=====] - 64s 3s/step - loss: 0.9526 - accuracy: 0.6325
- val_loss: 1.0508 - val_accuracy: 0.5500
Epoch 32/100
22/22 [=====] - 64s 3s/step - loss: 0.9609 - accuracy: 0.6437
- val_loss: 1.0536 - val_accuracy: 0.5813
Epoch 33/100
22/22 [=====] - 64s 3s/step - loss: 0.9713 - accuracy: 0.6529
- val_loss: 1.0723 - val_accuracy: 0.5188
Epoch 34/100
22/22 [=====] - 64s 3s/step - loss: 0.9360 - accuracy: 0.6569
- val_loss: 1.0534 - val_accuracy: 0.5125
Epoch 35/100
22/22 [=====] - 64s 3s/step - loss: 0.9243 - accuracy: 0.6595
- val_loss: 1.0401 - val_accuracy: 0.6062
Epoch 36/100
22/22 [=====] - 64s 3s/step - loss: 0.9284 - accuracy: 0.6594
- val_loss: 1.0623 - val_accuracy: 0.5300
Epoch 37/100
22/22 [=====] - 64s 3s/step - loss: 0.8833 - accuracy: 0.6672
- val_loss: 1.0896 - val_accuracy: 0.5188
Epoch 38/100
22/22 [=====] - 64s 3s/step - loss: 0.8211 - accuracy: 0.7165
- val_loss: 1.0486 - val_accuracy: 0.5500
Epoch 39/100
22/22 [=====] - 64s 3s/step - loss: 0.8180 - accuracy: 0.7114
- val_loss: 1.0654 - val_accuracy: 0.5063
Epoch 40/100
22/22 [=====] - 64s 3s/step - loss: 0.8359 - accuracy: 0.6675
- val_loss: 1.1034 - val_accuracy: 0.5188
Epoch 41/100
22/22 [=====] - 64s 3s/step - loss: 0.8540 - accuracy: 0.6855
- val_loss: 1.0427 - val_accuracy: 0.5500
Epoch 42/100
22/22 [=====] - 64s 3s/step - loss: 0.8664 - accuracy: 0.6866
- val_loss: 1.0428 - val_accuracy: 0.5312
Epoch 43/100
22/22 [=====] - 64s 3s/step - loss: 0.8004 - accuracy: 0.6999
- val_loss: 1.0900 - val_accuracy: 0.5125
Epoch 44/100
22/22 [=====] - 63s 3s/step - loss: 0.8604 - accuracy: 0.6828
- val_loss: 1.0473 - val_accuracy: 0.5625
Epoch 45/100
22/22 [=====] - 64s 3s/step - loss: 0.8264 - accuracy: 0.6669
- val_loss: 1.0515 - val_accuracy: 0.5000
Epoch 46/100
22/22 [=====] - 64s 3s/step - loss: 0.8165 - accuracy: 0.6961
- val_loss: 1.1045 - val_accuracy: 0.5312
Epoch 47/100
22/22 [=====] - 63s 3s/step - loss: 0.8047 - accuracy: 0.7213
- val_loss: 1.0602 - val_accuracy: 0.5188
Epoch 48/100
22/22 [=====] - 64s 3s/step - loss: 0.7383 - accuracy: 0.7693
- val_loss: 1.0957 - val_accuracy: 0.5875
Epoch 49/100
22/22 [=====] - 64s 3s/step - loss: 0.7575 - accuracy: 0.7560
- val_loss: 1.0044 - val_accuracy: 0.5750
Epoch 50/100
22/22 [=====] - 64s 3s/step - loss: 0.7456 - accuracy: 0.7641
- val_loss: 1.0542 - val_accuracy: 0.5437
Epoch 51/100
22/22 [=====] - 64s 3s/step - loss: 0.7327 - accuracy: 0.7311
- val_loss: 1.0787 - val_accuracy: 0.5250
Epoch 52/100
22/22 [=====] - 64s 3s/step - loss: 0.7350 - accuracy: 0.7370
- val_loss: 1.0354 - val_accuracy: 0.5500
Epoch 53/100
22/22 [=====] - 64s 3s/step - loss: 0.7021 - accuracy: 0.7305
- val_loss: 1.0579 - val_accuracy: 0.5125
Epoch 54/100
22/22 [=====] - 66s 3s/step - loss: 0.6317 - accuracy: 0.7726
- val_loss: 1.1361 - val_accuracy: 0.5312
Epoch 55/100
22/22 [=====] - 64s 3s/step - loss: 0.6674 - accuracy: 0.7895
- val_loss: 1.1038 - val_accuracy: 0.5312
Epoch 56/100
22/22 [=====] - 64s 3s/step - loss: 0.6825 - accuracy: 0.7634
- val_loss: 1.0970 - val_accuracy: 0.5063
Epoch 57/100
22/22 [=====] - 64s 3s/step - loss: 0.6919 - accuracy: 0.7352
- val_loss: 1.1083 - val_accuracy: 0.5000
Epoch 58/100
22/22 [=====] - 63s 3s/step - loss: 0.6444 - accuracy: 0.7907
- val_loss: 1.1158 - val_accuracy: 0.4750
Epoch 59/100
22/22 [=====] - 63s 3s/step - loss: 0.6892 - accuracy: 0.7640
- val_loss: 1.0645 - val_accuracy: 0.5375
Epoch 60/100
22/22 [=====] - 63s 3s/step - loss: 0.6181 - accuracy: 0.7799
- val_loss: 1.0338 - val_accuracy: 0.5562
Epoch 61/100
22/22 [=====] - 64s 3s/step - loss: 0.5642 - accuracy: 0.8198
- val_loss: 1.1020 - val_accuracy: 0.5250
Epoch 62/100
22/22 [=====] - 63s 3s/step - loss: 0.5785 - accuracy: 0.7891
- val_loss: 1.1519 - val_accuracy: 0.5125
Epoch 63/100
22/22 [=====] - 63s 3s/step - loss: 0.6300 - accuracy: 0.7893
- val_loss: 1.0811 - val_accuracy: 0.5250
Epoch 64/100
22/22 [=====] - 63s 3s/step - loss: 0.6226 - accuracy: 0.7881
- val_loss: 1.0484 - val_accuracy: 0.5500
Epoch 65/100
22/22 [=====] - 63s 3s/step - loss: 0.5675 - accuracy: 0.8158
- val_loss: 1.1287 - val_accuracy: 0.5125
Epoch 66/100
22/22 [=====] - 63s 3s/step - loss: 0.5679 - accuracy: 0.8294
- val_loss: 1.0571 - val_accuracy: 0.5500
Epoch 67/100
22/22 [=====] - 63s 3s/step - loss: 0.5470 - accuracy: 0.8071
- val_loss: 1.1183 - val_accuracy: 0.5562
Epoch 68/100
22/22 [=====] - 62s 3s/step - loss: 0.5796 - accuracy: 0.7911
- val_loss: 1.0790 - val_accuracy: 0.5562
Epoch 69/100
22/22 [=====] - 63s 3s/step - loss: 0.5238 - accuracy: 0.8203
- val_loss: 1.1297 - val_accuracy: 0.5250
Epoch 70/100
22/22 [=====] - 63s 3s/step - loss: 0.5429 - accuracy: 0.7967
- val_loss: 1.1050 - val_accuracy: 0.5698
Epoch 71/100
22/22 [=====] - 63s 3s/step - loss: 0.5273 - accuracy: 0.8172
- val_loss: 1.1818 - val_accuracy: 0.5500
Epoch 72/100
22/22 [=====] - 63s 3s/step - loss: 0.5865 - accuracy: 0.7962
- val_loss: 1.0735 - val_accuracy: 0.5500
Epoch 73/100
22/22 [=====] - 63s 3s/step - loss: 0.4805 - accuracy: 0.8399
- val_loss: 1.1202 - val_accuracy: 0.5500
Epoch 74/100
22/22 [=====] - 63s 3s/step - loss: 0.4926 - accuracy: 0.8270
- val_loss: 1.1369 - val_accuracy: 0.5312
Epoch 75/100
22/22 [=====] - 63s 3s/step - loss: 0.5234 - accuracy: 0.8335
- val_loss: 1.1331 - val_accuracy: 0.5375
Epoch 76/100
22/22 [=====] - 63s 3s/step - loss: 0.5255 - accuracy: 0.8246
- val_loss: 1.1927 - val_accuracy: 0.5312
Epoch 77/100
22/22 [=====] - 63s 3s/step - loss: 0.4715 - accuracy: 0.8416
- val_loss: 1.2127 - val_accuracy: 0.5625
Epoch 78/100
22/22 [=====] - 64s 3s/step - loss: 0.4773 - accuracy: 0.8522
- val_loss: 1.0920 - val_accuracy: 0.5688
Epoch 79/100
22/22 [=====] - 63s 3s/step - loss: 0.4726 - accuracy: 0.8305
- val_loss: 1.1465 - val_accuracy: 0.5188
Epoch 80/100
22/22 [=====] - 63s 3s/step - loss: 0.4685 - accuracy: 0.8425
- val_loss: 1.1406 - val_accuracy: 0.5300
Epoch 81/100
22/22 [=====] - 63s 3s/step - loss: 0.4852 - accuracy: 0.8390
- val_loss: 1.1704 - val_accuracy: 0.5188
Epoch 82/100
22/22 [=====] - 63s 3s/step - loss: 0.4479 - accuracy: 0.8439
- val_loss: 1.1779 - val_accuracy: 0.5625
Epoch 83/100
22/22 [=====] - 63s 3s/step - loss: 0.4536 - accuracy: 0.8494
- val_loss: 1.1744 - val_accuracy: 0.5437
Epoch 84/100
22/22 [=====] - 63s 3s/step - loss: 0.4248 - accuracy: 0.8527
- val_loss: 1.2091 - val_accuracy: 0.5437
Epoch 85/100
22/22 [=====] - 63s 3s/step - loss: 0.4030 - accuracy: 0.8734
- val_loss: 1.1879 - val_accuracy: 0.5125
Epoch 86/100
22/22 [=====] - 63s 3s/step - loss: 0.3814 - accuracy: 0.8888
- val_loss: 1.2421 - val_accuracy: 0.5125
Epoch 87/100
22/22 [=====] - 63s 3s/step - loss: 0.3823 - accuracy: 0.8792
- val_loss: 1.2815 - val_accuracy: 0.5125
Epoch 88/100
22/22 [=====] - 63s 3s/step - loss: 0.4389 - accuracy: 0.8749
- val_loss: 1.2524 - val_accuracy: 0.5625
Epoch 89/100
22/22 [=====] - 63s 3s/step - loss: 0.3919 - accuracy: 0.8821
- val_loss: 1.3318 - val_accuracy: 0.5562
Epoch 90/100
22/22 [=====] - 63s 3s/step - loss: 0.3384 - accuracy: 0.8985
- val_loss: 1.2454 - val_accuracy: 0.5562
Epoch 91/100
22/22 [=====] - 63s 3s/step - loss: 0.3380 - accuracy: 0.8866
- val_loss: 1.2037 - val_accuracy: 0.5375
Epoch 92/100
22/22 [=====] - 63s 3s/step - loss: 0.3507 - accuracy: 0.8918
- val_loss: 1.2222 - val_accuracy: 0.5312
Epoch 93/100
22/22 [=====] - 63s 3s/step - loss: 0.3613 - accuracy: 0.8757
- val_loss: 1.2080 - val_accuracy: 0.5250
Epoch 94/100
22/22 [=====] - 63s 3s/step - loss: 0.3542 - accuracy: 0.8906
- val_loss: 1.2611 - val_accuracy: 0.5312
Epoch 95/100
22/22 [=====] - 63s 3s/step - loss: 0.3801 - accuracy: 0.8590
- val_loss: 1.3220 - val_accuracy: 0.5562
Epoch 96/100
22/22 [=====] - 63s 3s/step - loss: 0.3373 - accuracy: 0.9115
- val_loss: 1.3352 - val_accuracy: 0.5437
Epoch 97/100
22/22 [=====] - 63s 3s/step - loss: 0.3810 - accuracy: 0.8801
- val_loss: 1.3072 - val_accuracy: 0.5000
Epoch 98/100
22/22 [=====] - 63s 3s/step - loss: 0.3485 - accuracy: 0.8718
- val_loss: 1.2840 - val_accuracy: 0.5688
Epoch 99/100
22/22 [=====] - 63s 3s/step - loss: 0.3407 - accuracy: 0.8821
- val_loss: 1.2888 - val_accuracy: 0.5250
```

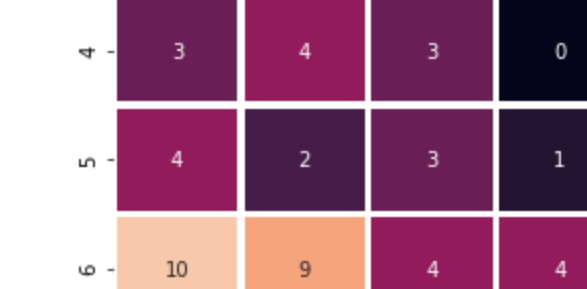
```
In [12]: #Avaliando o modelo
loss_train, train_acc = model.evaluate_generator(train_generator, steps=step_size_train)
loss_test, test_acc = model.evaluate_generator(test_generator, steps=step_size_test)
print('Train: %.3f, Test: %.3f' % (train_acc, test_acc))
```

```
c:\Users\vinicius\AppData\Local\Programs\Python\Python39\lib\site-packages\tensorflow\python\keras\engine\training.py:1973: UserWarning: Model.evaluate_generator is deprecated and will be removed in a future version. Please use 'Model.evaluate', which supports generators.
warnings.warn('Model.evaluate_generator' is deprecated and
Train: 0.91, Test: 0.50
```

```
In [13]: #Apresentando resultados em graficos
plt.title('Loss')
plt.plot(history.history['loss'], label='train')
plt.plot(history.history['val_loss'], label='test')
plt.legend()
plt.show()
```



```
In [14]: # Criando graficos para visualização dos resultados
print()
plt.title('Accuracy')
plt.plot(history.history['accuracy'], label='train')
plt.plot(history.history['val_accuracy'], label='test')
plt.legend()
plt.show()
```



```
In [15]: print('Criando classificações...')
labels = os.listdir('Database')
print('Rótulos:', labels)
# Criando estrutura para métricas de avaliação, processo um pouco mais demorado
Y_pred = model.predict_generator(test_generator)
print('Preds Created')
y_pred = np.argmax(Y_pred, axis=1)
print('Preds ID created')
```

```
Criando classificações...
Rótulos ('carcinoma_in_situ', 'light_dysplastic', 'moderate_dysplastic', 'normal_columnar', 'normal_intermediate', 'normal_superficial', 'severe_dysplastic')
c:\Users\vinicius\AppData\Local\Programs\Python\Python39\lib\site-packages\tensorflow\python\keras\engine\training.py:2001: UserWarning: Model.predict_generator is deprecated and will be removed in a future version. Please use 'Model.predict', which supports generators.
warnings.warn('Model.predict_generator' is deprecated and
Preds Created
Preds ID created
```

```
In [16]: classification = classification_report(test_generator.classes, y_pred, target_names=labels)
print('-----CLASSIFICATION-----')
print(classification)
matrix = confusion_matrix(test_generator.classes, y_pred)
df_cm = pd.DataFrame(matrix, index=[i for i in range(7)],
                      columns=[i for i in range(7)])
plt.figure(figsize=(10,7))
sn.heatmap(df_cm, annot=True, linewidths=2.5)
```

		precision	recall	f1-score	support
carcinoma_in_situ	0.12	0.17	0.14	0.15	30
light_dysplastic	0.17	0.16	0.16	0.16	37
moderate_dysplastic	0.12	0.10	0.11	0.11	30
normal_columnar	0.08	0.05	0.06	0.06	20
normal_intermediate	0.00	0.00	0.00	0.00	14
normal_superficial	0.12	0.13	0.13	0.13	15
severe_dysplastic	0.20	0.23	0.21	0.22	40
accuracy					186
macro avg	0.12	0.12	0.12	0.12	186
weighted avg	0.13	0.14	0.14	0.14	186

```
Out[16]: <AxesSubplot:~>
```



```
In [17]:
```