

https://keras.io/api/applications/xception/

```
In [1]: import tensorflow as tf
import numpy as np
import pandas as pd
import 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 tensor 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 InceptionResNetV2 com os pesos aprendidos no treino de Inception
base_model = tf.keras.applications.Xception(weights='imagenet', include_top=False)

In [4]: # O restante do modelo e suas camadas são discutidos a seguir
# x recebe o final da InceptionResNetV2
x = base_model.output

In [5]: #Nova configuração para o modelo
#Adiciona apos x uma camada GlobalMaxPooling2D e atribui este no a x novamente (logo
x = tf.keras.layers.GlobalMaxPooling2D()(x)

#Adiciona apos x uma camada densa com 128 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 32 neurônios com funcao de ativacao relu. Atrib
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
#preds=tf.keras.layers.Dense(3,activation='softmax')(x)
preds=tf.keras.layers.Dense(3,activation='sigmoid')(x)

#Definindo modelo final
model=tf.keras.models.Model(inputs=base_model.input.outputs+preds)

#Mostrando modelo final e sua estrutura
Model.summary()

Model: "model"
-----
Layer (type) Output Shape Param # Connected to
-----
input_1 (InputLayer) [None, None, None, 0
-----
block1_conv1 (Conv2D) (None, None, None, 3 864 input_1[0][0]
-----
block1_conv1_bn (BatchNormaliz (None, None, None, 3 128 block1_conv1[0][0]
-----
block1_conv1_act (Activation) (None, None, None, 3 0 block1_conv1_bn[0][0]
-----
block1_conv2 (Conv2D) (None, None, None, 6 18432 block1_conv1_act[0]
-----
block1_conv2_bn (BatchNormaliz (None, None, None, 6 256 block1_conv2[0][0]
-----
block1_conv2_act (Activation) (None, None, None, 6 0 block1_conv2_bn[0][0]
-----
block2_sepconv1 (SeparableConv2 (None, None, None, 1 8768 block1_conv2_act[0]
-----
block2_sepconv1_bn (BatchNormal (None, None, None, 1 512 block2_sepconv1[0][0]
-----
block2_sepconv2_act (Activation (None, None, None, 1 0 block2_sepconv1_bn[0]
-----
block2_sepconv2 (SeparableConv2 (None, None, None, 1 17536 block2_sepconv2_act
-----
block2_sepconv2_bn (BatchNormal (None, None, None, 1 512 block2_sepconv2[0][0]
-----
conv2d_1 (Conv2D) (None, None, None, 1 8192 block1_conv2_act[0]
-----
block2_pool (MaxPooling2D) (None, None, None, 1 0 block2_sepconv2_bn[0]
-----
batch_normalization (BatchNorm (None, None, None, 1 512 conv2d_1[0][0]
-----
add (Add) (None, None, None, 1 0 block2_pool[0][0]
-----
batch_normalization (None, None, None, 1 0 batch_normalization
-----
block3_sepconv1_act (Activation (None, None, None, 1 0 add[0][0]
-----
block3_sepconv1 (SeparableConv2 (None, None, None, 2 33920 block3_sepconv1_act
-----
block3_sepconv1_bn (BatchNormal (None, None, None, 2 1024 block3_sepconv1[0][0]
-----
block3_sepconv2_act (Activation (None, None, None, 2 0 block3_sepconv1_bn[0]
-----
block3_sepconv2 (SeparableConv2 (None, None, None, 2 67840 block3_sepconv2_act
-----
block3_sepconv2_bn (BatchNormal (None, None, None, 2 1024 block3_sepconv2[0][0]
-----
conv2d_1_1 (Conv2D) (None, None, None, 2 32768 add[0][0]
-----
block3_pool (MaxPooling2D) (None, None, None, 2 0 block3_sepconv2_bn[0]
-----
batch_normalization_1 (BatchNor (None, None, None, 2 1024 conv2d_1_1[0][0]
-----
add_1 (Add) (None, None, None, 2 0 block3_pool[0][0]
-----
batch_normalization_1 (None, None, None, 2 0 batch_normalization_
-----
block4_sepconv1_act (Activation (None, None, None, 2 0 add_1[0][0]
-----
block4_sepconv1 (SeparableConv2 (None, None, None, 7 188672 block4_sepconv1_act
-----
block4_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block4_sepconv1[0][0]
-----
block4_sepconv2_act (Activation (None, None, None, 7 0 block4_sepconv1_bn[0]
-----
block4_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block4_sepconv2_act
-----
block4_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block4_sepconv2[0][0]
-----
conv2d_2 (Conv2D) (None, None, None, 7 186368 add_1[0][0]
-----
block4_pool (MaxPooling2D) (None, None, None, 7 0 block4_sepconv2_bn[0]
-----
batch_normalization_2 (BatchNor (None, None, None, 7 2912 conv2d_2[0][0]
-----
add_2 (Add) (None, None, None, 7 0 block4_pool[0][0]
-----
batch_normalization_2 (None, None, None, 7 0 batch_normalization_2
-----
block5_sepconv1_act (Activation (None, None, None, 7 0 add_2[0][0]
-----
block5_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block5_sepconv1_act
-----
block5_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block5_sepconv1[0][0]
-----
block5_sepconv2_act (Activation (None, None, None, 7 0 block5_sepconv1_bn[0]
-----
block5_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block5_sepconv2_act
-----
block5_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block5_sepconv2[0][0]
-----
block5_sepconv3_act (Activation (None, None, None, 7 0 block5_sepconv2_bn[0]
-----
block5_sepconv3 (SeparableConv2 (None, None, None, 7 536536 block5_sepconv3_act
-----
block5_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block5_sepconv3[0][0]
-----
add_3 (Add) (None, None, None, 7 0 block5_sepconv3_bn[0]
-----
batch_normalization_3 (BatchNor (None, None, None, 7 2912 add_3[0][0]
-----
block6_sepconv1_act (Activation (None, None, None, 7 0 add_3[0][0]
-----
block6_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block6_sepconv1_act
-----
block6_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block6_sepconv1[0][0]
-----
block6_sepconv2_act (Activation (None, None, None, 7 0 block6_sepconv1_bn[0]
-----
block6_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block6_sepconv2_act
-----
block6_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block6_sepconv2[0][0]
-----
block6_sepconv3_act (Activation (None, None, None, 7 0 block6_sepconv2_bn[0]
-----
block6_sepconv3 (SeparableConv2 (None, None, None, 7 536536 block6_sepconv3_act
-----
block6_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block6_sepconv3[0][0]
-----
add_4 (Add) (None, None, None, 7 0 block6_sepconv3_bn[0]
-----
batch_normalization_4 (BatchNor (None, None, None, 7 2912 add_4[0][0]
-----
block7_sepconv1_act (Activation (None, None, None, 7 0 add_4[0][0]
-----
block7_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block7_sepconv1_act
-----
block7_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block7_sepconv1[0][0]
-----
block7_sepconv2_act (Activation (None, None, None, 7 0 block7_sepconv1_bn[0]
-----
block7_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block7_sepconv2_act
-----
block7_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block7_sepconv2[0][0]
-----
block7_sepconv3_act (Activation (None, None, None, 7 0 block7_sepconv2_bn[0]
-----
block7_sepconv3 (SeparableConv2 (None, None, None, 7 536536 block7_sepconv3_act
-----
block7_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block7_sepconv3[0][0]
-----
add_5 (Add) (None, None, None, 7 0 block7_sepconv3_bn[0]
-----
batch_normalization_5 (BatchNor (None, None, None, 7 2912 add_5[0][0]
-----
block8_sepconv1_act (Activation (None, None, None, 7 0 add_5[0][0]
-----
block8_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block8_sepconv1_act
-----
block8_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block8_sepconv1[0][0]
-----
block8_sepconv2_act (Activation (None, None, None, 7 0 block8_sepconv1_bn[0]
-----
block8_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block8_sepconv2_act
-----
block8_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block8_sepconv2[0][0]
-----
block8_sepconv3_act (Activation (None, None, None, 7 0 block8_sepconv2_bn[0]
-----
block8_sepconv3 (SeparableConv2 (None, None, None, 7 536536 block8_sepconv3_act
-----
block8_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block8_sepconv3[0][0]
-----
add_6 (Add) (None, None, None, 7 0 block8_sepconv3_bn[0]
-----
batch_normalization_6 (BatchNor (None, None, None, 7 2912 add_6[0][0]
-----
block9_sepconv1_act (Activation (None, None, None, 7 0 add_6[0][0]
-----
block9_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block9_sepconv1_act
-----
block9_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block9_sepconv1[0][0]
-----
block9_sepconv2_act (Activation (None, None, None, 7 0 block9_sepconv1_bn[0]
-----
block9_sepconv2 (SeparableConv2 (None, None, None, 7 536536 block9_sepconv2_act
-----
block9_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block9_sepconv2[0][0]
-----
block9_sepconv3_act (Activation (None, None, None, 7 0 block9_sepconv2_bn[0]
-----
block9_sepconv3 (SeparableConv2 (None, None, None, 7 536536 block9_sepconv3_act
-----
block9_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block9_sepconv3[0][0]
-----
add_7 (Add) (None, None, None, 7 0 block9_sepconv3_bn[0]
-----
batch_normalization_7 (BatchNor (None, None, None, 7 2912 add_7[0][0]
-----
block10_sepconv1_act (Activation (None, None, None, 7 0 add_7[0][0]
-----
block10_sepconv1 (SeparableConv2 (None, None, None, 7 536536 block10_sepconv1_act
-----
block10_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block10_sepconv1[0]
-----
block10_sepconv2_act (Activatio (None, None, None, 7 0 block10_sepconv1_bn
-----
block10_sepconv2 (SeparableConv (None, None, None, 7 536536 block10_sepconv2_act
-----
block10_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block10_sepconv2[0]
-----
block10_sepconv3_act (Activatio (None, None, None, 7 0 block10_sepconv2_bn
-----
block10_sepconv3 (SeparableConv (None, None, None, 7 536536 block10_sepconv3_act
-----
block10_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block10_sepconv3[0]
-----
add_8 (Add) (None, None, None, 7 0 block10_sepconv3_bn
-----
batch_normalization_8 (BatchNor (None, None, None, 7 2912 add_8[0][0]
-----
block11_sepconv1_act (Activatio (None, None, None, 7 0 add_8[0][0]
-----
block11_sepconv1 (SeparableConv (None, None, None, 7 536536 block11_sepconv1_act
-----
block11_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block11_sepconv1[0]
-----
block11_sepconv2_act (Activatio (None, None, None, 7 0 block11_sepconv1_bn
-----
block11_sepconv2 (SeparableConv (None, None, None, 7 536536 block11_sepconv2_act
-----
block11_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block11_sepconv2[0]
-----
block11_sepconv3_act (Activatio (None, None, None, 7 0 block11_sepconv2_bn
-----
block11_sepconv3 (SeparableConv (None, None, None, 7 536536 block11_sepconv3_act
-----
block11_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block11_sepconv3[0]
-----
add_9 (Add) (None, None, None, 7 0 block11_sepconv3_bn
-----
batch_normalization_9 (BatchNor (None, None, None, 7 2912 add_9[0][0]
-----
block12_sepconv1_act (Activatio (None, None, None, 7 0 add_9[0][0]
-----
block12_sepconv1 (SeparableConv (None, None, None, 7 536536 block12_sepconv1_act
-----
block12_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block12_sepconv1[0]
-----
block12_sepconv2_act (Activatio (None, None, None, 7 0 block12_sepconv1_bn
-----
block12_sepconv2 (SeparableConv (None, None, None, 7 536536 block12_sepconv2_act
-----
block12_sepconv2_bn (BatchNormal (None, None, None, 7 2912 block12_sepconv2[0]
-----
block12_sepconv3_act (Activatio (None, None, None, 7 0 block12_sepconv2_bn
-----
block12_sepconv3 (SeparableConv (None, None, None, 7 536536 block12_sepconv3_act
-----
block12_sepconv3_bn (BatchNormal (None, None, None, 7 2912 block12_sepconv3[0]
-----
add_10 (Add) (None, None, None, 7 0 block12_sepconv3_bn
-----
batch_normalization_10 (BatchNor (None, None, None, 7 2912 add_10[0][0]
-----
block13_sepconv1_act (Activatio (None, None, None, 7 0 add_10[0][0]
-----
block13_sepconv1 (SeparableConv (None, None, None, 7 536536 block13_sepconv1_act
-----
block13_sepconv1_bn (BatchNormal (None, None, None, 7 2912 block13_sepconv1[0]
-----
block13_sepconv2_act (Activatio (None, None, None, 7 0 block13_sepconv1_bn
-----
block13_sepconv2 (SeparableConv (None, None, None, 7 752024 block13_sepconv2_act
-----
block13_sepconv2_bn (BatchNormal (None, None, None, 7 4096 block13_sepconv2[0]
-----
conv2d_3 (Conv2D) (None, None, None, 1 745472 add_10[0][0]
-----
block13_pool (MaxPooling2D) (None, None, None, 1 0 block13_sepconv2_bn
-----
batch_normalization_3 (BatchNor (None, None, None, 1 4096 conv2d_3[0][0]
-----
add_11 (Add) (None, None, None, 1 0 block13_pool[0][0]
-----
batch_normalization_3 (None, None, None, 1 0 batch_normalization_3
-----
block14_sepconv1 (SeparableConv (None, None, None, 1 1582080 add_11[0][0]
-----
block14_sepconv1_bn (BatchNormal (None, None, None, 1 6144 block14_sepconv1[0]
-----
block14_sepconv1_act (Activatio (None, None, None, 1 0 block14_sepconv1_bn
-----
block14_sepconv2 (SeparableConv (None, None, None, 2 3159552 block14_sepconv1_act
-----
block14_sepconv2_bn (BatchNormal (None, None, None, 2 8192 block14_sepconv2[0]
-----
block14_sepconv2_act (Activatio (None, None, None, 2 0 block14_sepconv2_bn
-----
global_max_pooling2d (GlobalMax (None, 2048) 0 block14_sepconv2_act
-----
dense (Dense) (None, 128) 262272 global_max_pooling2d
-----
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, 3) 99 dropout[0][0]
-----
=====
Total params: 21,134,187
val_loss: 0.0169 - val_accuracy: 0.9688
Trainable params: 21,079,658
Non-trainable params: 54,528

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

In [7]: #Iniciando objeto que apanhaz todas as imagens de treino, processando as imagens co
train_data_gen = tf.keras.preprocessing.image.ImageDataGenerator(preprocessing_functi

#Iniciando objeto que apanhaz todas as imagens de teste, processando as imagens com
test_data_gen = tf.keras.preprocessing.image.ImageDataGenerator(preprocessing_functio

In [8]: #CARREGANDO PRÓPRIO DATASET PARA USO
# target_size=(224, 224)

#definindo gerador de imagens de treino
train_generator = train_data_gen.flow_from_directory('shapes_split/train',
                                                    target_size=(128, 128), # tamanho d
                                                    batch_size=batch,
                                                    class_mode='categorical',
                                                    shuffle=True)

#definindo gerador de imagens de teste
test_generator = test_data_gen.flow_from_directory('shapes_split/test', # tamanho da
                                                    target_size=(128, 128), # tamanho d
                                                    batch_size=batch,
                                                    class_mode='categorical',
                                                    shuffle=True)

Found 240 images belonging to 3 classes.
Found 60 images belonging to 3 classes.

In [9]: lr = tf.keras.optimizers.Adam(learning_rate=0.001) #estabelecendo taxa de otimização
model.compile(optimizer=lr, loss='categorical_crossentropy', metrics=['accuracy'])

In [10]: #definicao 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=epoch,
                             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 ')

7/7 ===== - - - - - 39s 3s/step - loss: 0.9384 - accuracy: 0.5146 -
val_loss: 0.2531 - val_accuracy: 0.9688
Epoch 26/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.3212 - accuracy: 0.8714 -
val_loss: 0.0150 - val_accuracy: 1.0000
Epoch 27/100
7/7 ===== - - - - - 15s 2s/step - loss: 0.1524 - accuracy: 0.9262 -
val_loss: 0.0071 - val_accuracy: 1.0000
Epoch 28/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 29/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 30/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 31/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 32/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 33/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 34/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 35/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 36/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 37/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 38/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 39/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 40/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 41/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 42/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 43/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 44/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 45/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 46/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 47/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 48/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 49/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 50/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 51/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 52/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 53/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 54/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 55/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 56/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 57/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 58/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 59/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 60/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 61/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 62/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 63/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 64/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 65/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 66/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 67/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 68/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 69/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 70/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 71/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 72/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 73/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 74/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 75/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 76/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 77/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 78/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 79/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 80/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 81/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 82/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 83/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 84/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 85/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 86/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 87/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 88/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 89/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 90/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 91/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 92/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 93/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 94/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 95/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 96/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 97/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 98/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 99/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
Epoch 100/100
7/7 ===== - - - - - 14s 2s/step - loss: 0.1022 - accuracy: 0.9490 -
val_loss: 0.0176 - val_accuracy: 1.0000
```

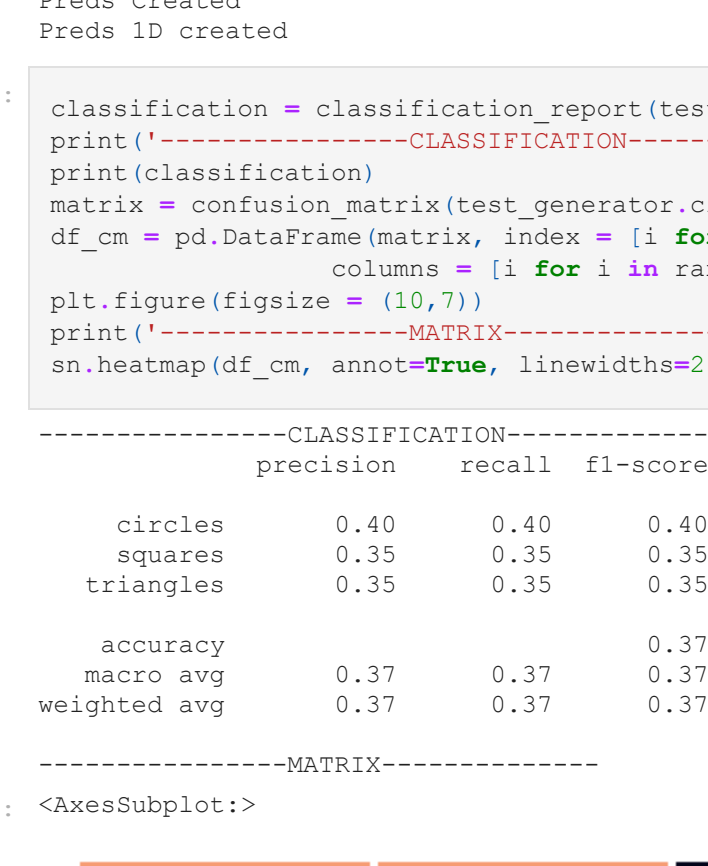


```
Epoch 82/100
7/7 ===== - 8s 1s/step - loss: 0.0204 - accuracy: 0.9943 -
val_loss: 0.0024 - val_accuracy: 1.0000
Epoch 83/100
7/7 ===== - 8s 1s/step - loss: 0.0146 - accuracy: 0.9895 -
val_loss: 7.0379e-04 - val_accuracy: 1.0000
Epoch 84/100
7/7 ===== - 8s 1s/step - loss: 0.0105 - accuracy: 1.0000 -
val_loss: 0.0017 - val_accuracy: 1.0000
Epoch 85/100
7/7 ===== - 8s 1s/step - loss: 0.0016 - accuracy: 0.9988 -
val_loss: 6.2608e-04 - val_accuracy: 1.0000
Epoch 86/100
7/7 ===== - 8s 1s/step - loss: 0.0048 - accuracy: 0.9945 -
val_loss: 5.8927e-04 - val_accuracy: 1.0000
Epoch 87/100
7/7 ===== - 9s 1s/step - loss: 0.0143 - accuracy: 0.9915 -
val_loss: 2.6077e-08 - val_accuracy: 1.0000
Epoch 88/100
7/7 ===== - 8s 1s/step - loss: 0.0134 - accuracy: 1.0000 -
val_loss: 2.6077e-08 - val_accuracy: 1.0000
Epoch 89/100
7/7 ===== - 8s 1s/step - loss: 0.0109 - accuracy: 0.9942 -
val_loss: 0.0025 - val_accuracy: 1.0000
Epoch 90/100
7/7 ===== - 8s 1s/step - loss: 0.0076 - accuracy: 1.0000 -
val_loss: 0.0014 - val_accuracy: 1.0000
Epoch 91/100
7/7 ===== - 8s 1s/step - loss: 4.8331e-05 - accuracy: 1.0000
0 - val_loss: 0.0023 - val_accuracy: 1.0000
Epoch 92/100
7/7 ===== - 8s 1s/step - loss: 1.9452e-04 - accuracy: 1.0000
0 - val_loss: 0.0012 - val_accuracy: 1.0000
Epoch 93/100
7/7 ===== - 8s 1s/step - loss: 0.0055 - accuracy: 0.9981 -
val_loss: 7.9441e-04 - val_accuracy: 1.0000
Epoch 94/100
7/7 ===== - 9s 1s/step - loss: 0.0149 - accuracy: 0.9972 -
val_loss: 7.7057e-04 - val_accuracy: 1.0000
Epoch 95/100
7/7 ===== - 10s 2s/step - loss: 5.3947e-04 - accuracy: 1.00
00 - val_loss: 8.2953e-04 - val_accuracy: 1.0000
Epoch 96/100
7/7 ===== - 11s 2s/step - loss: 0.0208 - accuracy: 1.0000 -
val_loss: 5.9872e-04 - val_accuracy: 1.0000
Epoch 97/100
7/7 ===== - 8s 1s/step - loss: 0.0109 - accuracy: 0.9981 -
val_loss: 3.3266e-04 - val_accuracy: 1.0000
Epoch 98/100
7/7 ===== - 9s 1s/step - loss: 0.0027 - accuracy: 1.0000 -
val_loss: 2.2325e-05 - val_accuracy: 1.0000
Epoch 99/100
7/7 ===== - 9s 1s/step - loss: 0.0198 - accuracy: 0.9826 -
val_loss: 8.9022e-06 - val_accuracy: 1.0000
```

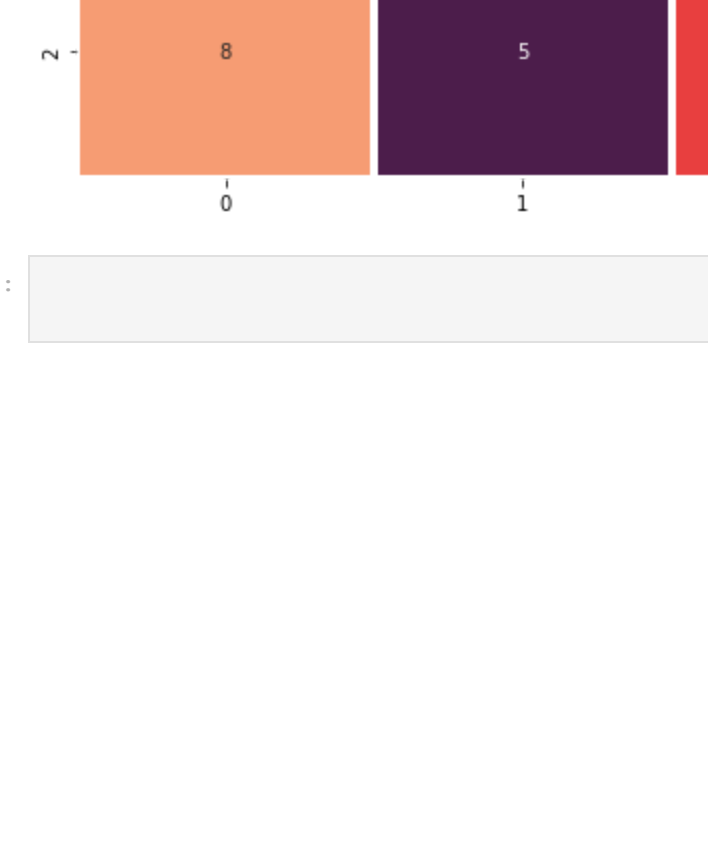
```
In [12]: #Avaliando o modelo
loss_train, train_acc = model.evaluate_generator(train_generator, steps=step_size_train)
loss_test, test_acc = model.evaluate_generator(test_generator, steps=step_size_test)
print('Train: %.3f, Test: %.3f' % (train_acc, test_acc))

c:\users\vinicius\appdata\local\programs\python\python39\lib\site-packages\tensorflow
\python\keras\engine\training.py:1973: UserWarning: 'Model.evaluate_generator' is depre
cated and will be removed in a future version. Please use 'Model.evaluate', which sup
ports generators.
warnings.warn('Model.evaluate_generator' is deprecated and '
Train: 1.000, Test: 1.000
```

```
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
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(os.path.join('chapas_split/test'))
print('Rotulos', labels)
#criando estruturas 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...
Rotulos ['circles', 'squares', 'triangles']
c:\users\vinicius\appdata\local\programs\python\python39\lib\site-packages\tensorflow
\python\keras\engine\training.py:1973: UserWarning: 'Model.predict_generator' is depre
cated and will be removed in a future version. Please use 'Model.predict', which suppo
rts generators.
warnings.warn('Model.predict_generator' is deprecated and '
Preds Created
Preds ID created
```

```
In [16]: classification = ClassificationReport(test_generator.classes, y_pred, target_names=la
print('-----CLASSIFICATION-----')
print(classification)
matrix = confusion_matrix(test_generator.classes, y_pred)
df_cm = pd.DataFrame(matrix, index = [i for i in range(3)],
                      columns = [i for i in range(3)])
plt.figure(figsize = (10,7))
print('-----MATRIX-----')
sn.heatmap(df_cm, annot=True, linewidth=2.5)
```

	precision	recall	f1-score	support
circles	0.40	0.40	0.40	20
squares	0.35	0.35	0.35	20
triangles	0.35	0.35	0.35	20
accuracy			0.37	60
macro avg	0.37	0.37	0.37	60
weighted avg	0.37	0.37	0.37	60

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



```
In [ ]:
```