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

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 sn
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 InceptionResNetV2 com os pesos aprendidos no treino da 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 neuronios com funcao de ativacao relu. Atri
x=tf.keras.layers.Dense(128,activation='relu')(x)

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

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

#adiciona após 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 neuronios (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 (BatchNormaliza (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]
[0]
______________________________________________________________________________
block1_conv2_bn (BatchNormaliza (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]
[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]
[0]
______________________________________________________________________________
block2_sepconv2 (SeparableConv2 (None, None, None, 1 17536       block2_sepconv2_act
[0][0]
______________________________________________________________________________
block2_sepconv2_bn (BatchNormal (None, None, None, 1 512         block2_sepconv2[0][0]
______________________________________________________________________________
conv2d (Conv2D)                 (None, None, None, 1 8192        block1_conv2_act[0]
[0]
______________________________________________________________________________
block2_pool (MaxPooling2D)      (None, None, None, 1 0           block2_sepconv2_bn[0]
[0]
______________________________________________________________________________
batch_normalization (BatchNorma (None, None, None, 1 512         conv2d[0][0]
______________________________________________________________________________
add (Add)                       (None, None, None, 1 0           block2_pool[0][0]
                                                                 batch_normalization
[0][0]
______________________________________________________________________________
block3_sepconv1_act (Activation (None, None, None, 1 0           add[0][0]
______________________________________________________________________________
block3_sepconv1 (SeparableConv2 (None, None, None, 2 33920       block3_sepconv1_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block3_sepconv2 (SeparableConv2 (None, None, None, 2 67840       block3_sepconv2_act
[0][0]
______________________________________________________________________________
block3_sepconv2_bn (BatchNormal (None, None, None, 2 1024        block3_sepconv2[0][0]
______________________________________________________________________________
conv2d_1 (Conv2D)               (None, None, None, 2 32768       add[0][0]
______________________________________________________________________________
block3_pool (MaxPooling2D)      (None, None, None, 2 0           block3_sepconv2_bn[0]
[0]
______________________________________________________________________________
batch_normalization_1 (BatchNor (None, None, None, 2 1024        conv2d_1[0][0]
______________________________________________________________________________
add_1 (Add)                     (None, None, None, 2 0           block3_pool[0][0]
                                                                 batch_normalization_1
[0][0]
______________________________________________________________________________
block4_sepconv1_act (Activation (None, None, None, 2 0           add_1[0][0]
______________________________________________________________________________
block4_sepconv1 (SeparableConv2 (None, None, None, 7 188672      block4_sepconv1_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block4_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block4_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[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
[0][0]
______________________________________________________________________________
block5_sepconv1_act (Activation (None, None, None, 7 0           add_2[0][0]
______________________________________________________________________________
block5_sepconv1 (SeparableConv2 (None, None, None, 7 536536      block5_sepconv1_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block5_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block5_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block5_sepconv3 (SeparableConv2 (None, None, None, 7 536536      block5_sepconv3_act
[0][0]
______________________________________________________________________________
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]
[0]
                                                                 add_2[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
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block6_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block6_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block6_sepconv3 (SeparableConv2 (None, None, None, 7 536536      block6_sepconv3_act
[0][0]
______________________________________________________________________________
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]
[0]
                                                                 add_3[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
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block7_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block7_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block7_sepconv3 (SeparableConv2 (None, None, None, 7 536536      block7_sepconv3_act
[0][0]
______________________________________________________________________________
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]
[0]
                                                                 add_4[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
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block8_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block8_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block8_sepconv3 (SeparableConv2 (None, None, None, 7 536536      block8_sepconv3_act
[0][0]
______________________________________________________________________________
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]
[0]
                                                                 add_5[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
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block9_sepconv2 (SeparableConv2 (None, None, None, 7 536536      block9_sepconv2_act
[0][0]
______________________________________________________________________________
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]
[0]
______________________________________________________________________________
block9_sepconv3 (SeparableConv2 (None, None, None, 7 536536      block9_sepconv3_act
[0][0]
______________________________________________________________________________
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]
[0]
                                                                 add_6[0][0]
______________________________________________________________________________
block10_sepconv1_act (Activatio (None, None, None, 7 0           add_7[0][0]
______________________________________________________________________________
block10_sepconv1 (SeparableConv (None, None, None, 7 536536      block10_sepconv1_act
[0][0]
______________________________________________________________________________
block10_sepconv1_bn (BatchNorma (None, None, None, 7 2912        block10_sepconv1[0]
[0]
______________________________________________________________________________
block10_sepconv2_act (Activatio (None, None, None, 7 0           block10_sepconv1_bn
[0][0]
______________________________________________________________________________
block10_sepconv2 (SeparableConv (None, None, None, 7 536536      block10_sepconv2_act
[0][0]
______________________________________________________________________________
block10_sepconv2_bn (BatchNorma (None, None, None, 7 2912        block10_sepconv2[0]
[0]
______________________________________________________________________________
block10_sepconv3_act (Activatio (None, None, None, 7 0           block10_sepconv2_bn
[0][0]
______________________________________________________________________________
block10_sepconv3 (SeparableConv (None, None, None, 7 536536      block10_sepconv3_act
[0][0]
______________________________________________________________________________
block10_sepconv3_bn (BatchNorma (None, None, None, 7 2912        block10_sepconv3[0]
[0]
______________________________________________________________________________
add_8 (Add)                     (None, None, None, 7 0           block10_sepconv3_bn
[0][0]
                                                                 add_7[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
[0][0]
______________________________________________________________________________
block11_sepconv1_bn (BatchNorma (None, None, None, 7 2912        block11_sepconv1[0]
[0]
______________________________________________________________________________
block11_sepconv2_act (Activatio (None, None, None, 7 0           block11_sepconv1_bn
[0][0]
______________________________________________________________________________
block11_sepconv2 (SeparableConv (None, None, None, 7 536536      block11_sepconv2_act
[0][0]
______________________________________________________________________________
block11_sepconv2_bn (BatchNorma (None, None, None, 7 2912        block11_sepconv2[0]
[0]
______________________________________________________________________________
block11_sepconv3_act (Activatio (None, None, None, 7 0           block11_sepconv2_bn
[0][0]
______________________________________________________________________________
block11_sepconv3 (SeparableConv (None, None, None, 7 536536      block11_sepconv3_act
[0][0]
______________________________________________________________________________
block11_sepconv3_bn (BatchNorma (None, None, None, 7 2912        block11_sepconv3[0]
[0]
______________________________________________________________________________
add_9 (Add)                     (None, None, None, 7 0           block11_sepconv3_bn
[0][0]
                                                                 add_8[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
[0][0]
______________________________________________________________________________
block12_sepconv1_bn (BatchNorma (None, None, None, 7 2912        block12_sepconv1[0]
[0]
______________________________________________________________________________
block12_sepconv2_act (Activatio (None, None, None, 7 0           block12_sepconv1_bn
[0][0]
______________________________________________________________________________
block12_sepconv2 (SeparableConv (None, None, None, 7 536536      block12_sepconv2_act
[0][0]
______________________________________________________________________________
block12_sepconv2_bn (BatchNorma (None, None, None, 7 2912        block12_sepconv2[0]
[0]
______________________________________________________________________________
block12_sepconv3_act (Activatio (None, None, None, 7 0           block12_sepconv2_bn
[0][0]
______________________________________________________________________________
block12_sepconv3 (SeparableConv (None, None, None, 7 536536      block12_sepconv3_act
[0][0]
______________________________________________________________________________
block12_sepconv3_bn (BatchNorma (None, None, None, 7 2912        block12_sepconv3[0]
[0]
______________________________________________________________________________
add_10 (Add)                    (None, None, None, 7 0           block12_sepconv3_bn
[0][0]
                                                                 add_9[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
[0][0]
______________________________________________________________________________
block13_sepconv1_bn (BatchNorma (None, None, None, 7 2912        block13_sepconv1[0]
[0]
______________________________________________________________________________
block13_sepconv2_act (Activatio (None, None, None, 7 0           block13_sepconv1_bn
[0][0]
______________________________________________________________________________
block13_sepconv2 (SeparableConv (None, None, None, 1 752024      block13_sepconv2_act
[0][0]
______________________________________________________________________________
block13_sepconv2_bn (BatchNorma (None, None, None, 1 4096        block13_sepconv2[0]
[0]
______________________________________________________________________________
conv2d_3 (Conv2D)               (None, None, None, 1 745472      add_10[0][0]
______________________________________________________________________________
block13_pool (MaxPooling2D)     (None, None, None, 1 0           block13_sepconv2_bn
[0][0]
______________________________________________________________________________
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
[0][0]
______________________________________________________________________________
block14_sepconv1 (SeparableConv (None, None, None, 1 1582080     add_11[0][0]
______________________________________________________________________________
block14_sepconv1_bn (BatchNorma (None, None, None, 1 6144        block14_sepconv1[0]
[0]
______________________________________________________________________________
block14_sepconv1_act (Activatio (None, None, None, 1 0           block14_sepconv1_bn
[0][0]
______________________________________________________________________________
block14_sepconv2 (SeparableConv (None, None, None, 2 3159552     block14_sepconv1_act
[0][0]
______________________________________________________________________________
block14_sepconv2_bn (BatchNorma (None, None, None, 2 8192        block14_sepconv2[0]
[0]
______________________________________________________________________________
block14_sepconv2_act (Activatio (None, None, None, 2 0           block14_sepconv2_bn
[0][0]
______________________________________________________________________________
global_max_pooling2d (GlobalMax (None, 2048)         0           block14_sepconv2_act
[0][0]
______________________________________________________________________________
dense (Dense)                   (None, 128)          262272      global_max_pooling2d
[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, 3)            99          dropout[0][0]
==============================================================================
Total params: 21,134,187
Trainable params: 21,079,659
Non-trainable params: 54,528
______________________________________________________________________________
```

In [6]:

```
#congelando os neuronios já treinados na ImageNet, queremos retreinar somente a ultim
for l in model.layers:
    if l.name.split('_')[0] != 'dense':
        l.trainable=False
    else:
        l.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_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 da
                                                     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',
                                                   target_size=(128, 128), # tamanho da
                                                   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=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 '
Epoch 1/100
7/7 [==============================] - 13s 1s/step - loss: 1.0135 - accuracy: 0.5244 -
val_loss: 0.1149 - val_accuracy: 1.0000
Epoch 2/100
7/7 [==============================] - 8s 1s/step - loss: 0.2622 - accuracy: 0.8737 -
val_loss: 0.0088 - val_accuracy: 1.0000
Epoch 3/100
7/7 [==============================] - 8s 1s/step - loss: 0.0921 - accuracy: 0.9573 -
val_loss: 0.0112 - val_accuracy: 1.0000
Epoch 4/100
7/7 [==============================] - 9s 1s/step - loss: 0.0869 - accuracy: 0.9545 -
val_loss: 0.0299 - val_accuracy: 1.0000
Epoch 5/100
7/7 [==============================] - 9s 1s/step - loss: 0.0729 - accuracy: 0.9735 -
val_loss: 0.0032 - val_accuracy: 1.0000
Epoch 6/100
7/7 [==============================] - 10s 1s/step - loss: 0.0334 - accuracy: 0.9893 -
val_loss: 9.0280e-04 - val_accuracy: 1.0000
Epoch 7/100
7/7 [==============================] - 9s 1s/step - loss: 0.0434 - accuracy: 0.9707 -
val_loss: 0.0118 - val_accuracy: 1.0000
Epoch 8/100
7/7 [==============================] - 9s 1s/step - loss: 0.0237 - accuracy: 0.9853 -
val_loss: 0.0073 - val_accuracy: 1.0000
Epoch 9/100
7/7 [==============================] - 8s 1s/step - loss: 0.0233 - accuracy: 0.9917 -
val_loss: 0.0074 - val_accuracy: 1.0000
Epoch 10/100
7/7 [==============================] - 8s 1s/step - loss: 0.0336 - accuracy: 0.9853 -
val_loss: 6.9246e-05 - val_accuracy: 1.0000
Epoch 11/100
7/7 [==============================] - 9s 1s/step - loss: 0.0192 - accuracy: 0.9933 -
val_loss: 1.7918e-04 - val_accuracy: 1.0000
Epoch 12/100
7/7 [==============================] - 9s 1s/step - loss: 0.0089 - accuracy: 1.0000 -
val_loss: 4.0776e-04 - val_accuracy: 1.0000
Epoch 13/100
7/7 [==============================] - 8s 1s/step - loss: 0.0175 - accuracy: 1.0000 -
val_loss: 0.0027 - val_accuracy: 1.0000
Epoch 14/100
7/7 [==============================] - 8s 1s/step - loss: 0.0246 - accuracy: 0.9887 -
val_loss: 0.0031 - val_accuracy: 1.0000
Epoch 15/100
7/7 [==============================] - 9s 1s/step - loss: 0.0209 - accuracy: 0.9868 -
val_loss: 0.0070 - val_accuracy: 1.0000
Epoch 16/100
7/7 [==============================] - 9s 1s/step - loss: 0.0220 - accuracy: 0.9893 -
val_loss: 0.0029 - val_accuracy: 1.0000
Epoch 17/100
7/7 [==============================] - 9s 1s/step - loss: 0.0114 - accuracy: 1.0000 -
val_loss: 4.5305e-05 - val_accuracy: 1.0000
Epoch 18/100
7/7 [==============================] - 9s 1s/step - loss: 0.0229 - accuracy: 0.9842 -
val_loss: 0.0032 - val_accuracy: 1.0000
Epoch 19/100
7/7 [==============================] - 9s 1s/step - loss: 0.0160 - accuracy: 0.9901 -
val_loss: 0.0087 - val_accuracy: 1.0000
Epoch 20/100
7/7 [==============================] - 9s 1s/step - loss: 0.0326 - accuracy: 0.9818 -
val_loss: 0.0073 - val_accuracy: 1.0000
Epoch 21/100
7/7 [==============================] - 10s 1s/step - loss: 0.0043 - accuracy: 0.9974 -
val_loss: 0.0059 - val_accuracy: 1.0000
Epoch 22/100
7/7 [==============================] - 11s 2s/step - loss: 0.0050 - accuracy: 1.0000 -
val_loss: 0.0048 - val_accuracy: 1.0000
Epoch 23/100
7/7 [==============================] - 10s 1s/step - loss: 0.0121 - accuracy: 0.9981 -
val_loss: 0.0024 - val_accuracy: 1.0000
Epoch 24/100
7/7 [==============================] - 10s 1s/step - loss: 0.0160 - accuracy: 0.9881 -
val_loss: 0.0019 - val_accuracy: 1.0000
Epoch 25/100
7/7 [==============================] - 9s 1s/step - loss: 0.0096 - accuracy: 1.0000 -
val_loss: 6.5139e-04 - val_accuracy: 1.0000
Epoch 26/100
7/7 [==============================] - 11s 2s/step - loss: 0.0062 - accuracy: 0.9988 -
val_loss: 0.0017 - val_accuracy: 1.0000
Epoch 27/100
7/7 [==============================] - 13s 2s/step - loss: 0.0028 - accuracy: 1.0000 -
val_loss: 0.0020 - val_accuracy: 1.0000
Epoch 28/100
7/7 [==============================] - 13s 2s/step - loss: 0.0039 - accuracy: 1.0000 -
val_loss: 0.0116 - val_accuracy: 1.0000
Epoch 29/100
7/7 [==============================] - 12s 2s/step - loss: 0.0014 - accuracy: 1.0000 -
val_loss: 0.0024 - val_accuracy: 1.0000
Epoch 30/100
7/7 [==============================] - 10s 2s/step - loss: 0.0034 - accuracy: 1.0000 -
val_loss: 1.7546e-06 - val_accuracy: 1.0000
Epoch 31/100
7/7 [==============================] - 10s 1s/step - loss: 0.0126 - accuracy: 0.9930 -
val_loss: 1.1107e-05 - val_accuracy: 1.0000
Epoch 32/100
7/7 [==============================] - 11s 2s/step - loss: 0.0188 - accuracy: 0.9934 -
val_loss: 0.0476 - val_accuracy: 0.9688
Epoch 33/100
7/7 [==============================] - 12s 2s/step - loss: 0.0055 - accuracy: 1.0000 -
val_loss: 0.0215 - val_accuracy: 1.0000
Epoch 34/100
7/7 [==============================] - 11s 1s/step - loss: 0.0092 - accuracy: 0.9961 -
val_loss: 0.0115 - val_accuracy: 1.0000
Epoch 35/100
7/7 [==============================] - 9s 1s/step - loss: 0.0237 - accuracy: 0.9823 -
val_loss: 0.0011 - val_accuracy: 1.0000
Epoch 36/100
7/7 [==============================] - 9s 1s/step - loss: 0.0075 - accuracy: 0.9951 -
val_loss: 3.5165e-04 - val_accuracy: 1.0000
Epoch 37/100
7/7 [==============================] - 9s 1s/step - loss: 0.0023 - accuracy: 1.0000 -
val_loss: 9.9967e-05 - val_accuracy: 1.0000
Epoch 38/100
7/7 [==============================] - 9s 1s/step - loss: 0.0028 - accuracy: 1.0000 -
val_loss: 2.0973e-06 - val_accuracy: 1.0000
Epoch 39/100
7/7 [==============================] - 10s 1s/step - loss: 0.0208 - accuracy: 0.9864 -
val_loss: 0.0010 - val_accuracy: 1.0000
Epoch 40/100
7/7 [==============================] - 10s 1s/step - loss: 3.4100e-04 - accuracy: 1.00
00 - val_loss: 7.0361e-04 - val_accuracy: 1.0000
Epoch 41/100
7/7 [==============================] - 10s 1s/step - loss: 0.0029 - accuracy: 1.0000 -
val_loss: 4.5252e-04 - val_accuracy: 1.0000
Epoch 42/100
7/7 [==============================] - 11s 2s/step - loss: 0.0023 - accuracy: 1.0000 -
val_loss: 6.6142e-04 - val_accuracy: 1.0000
Epoch 43/100
7/7 [==============================] - 10s 1s/step - loss: 0.0038 - accuracy: 1.0000 -
val_loss: 4.2796e-04 - val_accuracy: 1.0000
Epoch 44/100
7/7 [==============================] - 10s 1s/step - loss: 0.0013 - accuracy: 1.0000 -
val_loss: 0.0010 - val_accuracy: 1.0000
Epoch 45/100
7/7 [==============================] - 11s 2s/step - loss: 0.0127 - accuracy: 0.9930 -
val_loss: 3.8738e-04 - val_accuracy: 1.0000
Epoch 46/100
7/7 [==============================] - 10s 1s/step - loss: 0.0191 - accuracy: 0.9892 -
val_loss: 1.7285e-06 - val_accuracy: 1.0000
Epoch 47/100
7/7 [==============================] - 10s 1s/step - loss: 0.0040 - accuracy: 0.9982 -
val_loss: 2.8828e-04 - val_accuracy: 1.0000
Epoch 48/100
7/7 [==============================] - 9s 1s/step - loss: 0.0069 - accuracy: 0.9969 -
val_loss: 6.9673e-04 - val_accuracy: 1.0000
Epoch 49/100
7/7 [==============================] - 9s 1s/step - loss: 0.0013 - accuracy: 1.0000 -
val_loss: 6.5022e-04 - val_accuracy: 1.0000
Epoch 50/100
7/7 [==============================] - 10s 1s/step - loss: 0.0110 - accuracy: 0.9861 -
val_loss: 8.6581e-04 - val_accuracy: 1.0000
Epoch 51/100
7/7 [==============================] - 11s 2s/step - loss: 0.0084 - accuracy: 1.0000 -
val_loss: 4.0605e-07 - val_accuracy: 1.0000
Epoch 52/100
7/7 [==============================] - 14s 2s/step - loss: 0.0031 - accuracy: 1.0000 -
val_loss: 0.0454 - val_accuracy: 0.9688
Epoch 53/100
7/7 [==============================] - 9s 1s/step - loss: 0.0016 - accuracy: 1.0000 -
val_loss: 4.4703e-07 - val_accuracy: 1.0000
Epoch 54/100
7/7 [==============================] - 12s 2s/step - loss: 7.7449e-04 - accuracy: 1.00
00 - val_loss: 0.0029 - val_accuracy: 1.0000
Epoch 55/100
7/7 [==============================] - 14s 2s/step - loss: 0.0058 - accuracy: 0.9981 -
val_loss: 3.2037e-07 - val_accuracy: 1.0000
Epoch 56/100
7/7 [==============================] - 14s 2s/step - loss: 0.0026 - accuracy: 0.9972 -
val_loss: 0.0182 - val_accuracy: 1.0000
Epoch 57/100
7/7 [==============================] - 15s 2s/step - loss: 6.3106e-04 - accuracy: 1.00
00 - val_loss: 0.0021 - val_accuracy: 1.0000
Epoch 58/100
7/7 [==============================] - 15s 2s/step - loss: 0.0037 - accuracy: 0.9969 -
val_loss: 2.2352e-08 - val_accuracy: 1.0000
Epoch 59/100
7/7 [==============================] - 16s 2s/step - loss: 8.4938e-04 - accuracy: 1.00
00 - val_loss: 0.0016 - val_accuracy: 1.0000
Epoch 60/100
7/7 [==============================] - 16s 2s/step - loss: 0.0020 - accuracy: 0.9989 -
val_loss: 0.0041 - val_accuracy: 1.0000
Epoch 61/100
7/7 [==============================] - 14s 2s/step - loss: 0.0101 - accuracy: 0.9915 -
val_loss: 1.7136e-07 - val_accuracy: 1.0000
Epoch 62/100
7/7 [==============================] - 14s 2s/step - loss: 0.0120 - accuracy: 0.9887 -
val_loss: 0.0011 - val_accuracy: 1.0000
Epoch 63/100
7/7 [==============================] - 14s 2s/step - loss: 0.0042 - accuracy: 1.0000 -
val_loss: 0.0011 - val_accuracy: 1.0000
Epoch 64/100
7/7 [==============================] - 14s 2s/step - loss: 3.0118e-04 - accuracy: 1.00
00 - val_loss: 2.6077e-08 - val_accuracy: 1.0000
Epoch 65/100
7/7 [==============================] - 15s 2s/step - loss: 0.0022 - accuracy: 1.0000 -
val_loss: 0.0053 - val_accuracy: 1.0000
Epoch 66/100
7/7 [==============================] - 14s 2s/step - loss: 0.0061 - accuracy: 0.9969 -
val_loss: 9.1350e-04 - val_accuracy: 1.0000
Epoch 67/100
7/7 [==============================] - 14s 2s/step - loss: 0.0051 - accuracy: 1.0000 -
val_loss: 0.0020 - val_accuracy: 1.0000
Epoch 68/100
7/7 [==============================] - 14s 2s/step - loss: 0.0056 - accuracy: 1.0000 -
val_loss: 6.1101e-04 - val_accuracy: 1.0000
Epoch 69/100
7/7 [==============================] - 14s 2s/step - loss: 0.0043 - accuracy: 0.9972 -
val_loss: 5.7562e-04 - val_accuracy: 1.0000
Epoch 70/100
7/7 [==============================] - 15s 2s/step - loss: 0.0073 - accuracy: 0.9965 -
val_loss: 4.0978e-08 - val_accuracy: 1.0000
Epoch 71/100
7/7 [==============================] - 14s 2s/step - loss: 4.1547e-04 - accuracy: 1.00
00 - val_loss: 0.0012 - val_accuracy: 1.0000
Epoch 72/100
7/7 [==============================] - 14s 2s/step - loss: 4.6301e-05 - accuracy: 1.00
00 - val_loss: 0.0015 - val_accuracy: 1.0000
Epoch 73/100
7/7 [==============================] - 15s 2s/step - loss: 3.0625e-04 - accuracy: 1.00
00 - val_loss: 0.0017 - val_accuracy: 1.0000
Epoch 74/100
7/7 [==============================] - 15s 2s/step - loss: 0.0027 - accuracy: 0.9982 -
val_loss: 9.3132e-08 - val_accuracy: 1.0000
Epoch 75/100
7/7 [==============================] - 14s 2s/step - loss: 0.0012 - accuracy: 1.0000 -
val_loss: 0.0011 - val_accuracy: 1.0000
Epoch 76/100
7/7 [==============================] - 14s 2s/step - loss: 0.0138 - accuracy: 0.9961 -
val_loss: 5.5688e-05 - val_accuracy: 1.0000
Epoch 77/100
7/7 [==============================] - 14s 2s/step - loss: 9.1017e-04 - accuracy: 1.00
00 - val_loss: 1.3187e-06 - val_accuracy: 1.0000
Epoch 78/100
7/7 [==============================] - 14s 2s/step - loss: 0.0038 - accuracy: 0.9972 -
val_loss: 1.5414e-04 - val_accuracy: 1.0000
Epoch 79/100
7/7 [==============================] - 15s 2s/step - loss: 0.0085 - accuracy: 1.0000 -
val_loss: 3.3985e-05 - val_accuracy: 1.0000
Epoch 80/100
7/7 [==============================] - 14s 2s/step - loss: 0.0094 - accuracy: 0.9949 -
val_loss: 1.4844e-04 - val_accuracy: 1.0000
Epoch 81/100
7/7 [==============================] - 14s 2s/step - loss: 0.0092 - accuracy: 1.0000 -
val_loss: 5.9605e-08 - val_accuracy: 1.0000
```

```
Epoch 82/100
7/7 [==============================] - 14s 2s/step - loss: 0.0093 - accuracy: 0.9926 -
val_loss: 0.1728 - val_accuracy: 0.9688
Epoch 83/100
7/7 [==============================] - 14s 2s/step - loss: 0.0024 - accuracy: 1.0000 -
val_loss: 0.0508 - val_accuracy: 0.9688
Epoch 84/100
7/7 [==============================] - 14s 2s/step - loss: 0.0022 - accuracy: 1.0000 -
val_loss: 4.5506e-09 - val_accuracy: 1.0000
Epoch 85/100
7/7 [==============================] - 14s 2s/step - loss: 0.0013 - accuracy: 1.0000 -
val_loss: 0.0146 - val_accuracy: 1.0000
Epoch 86/100
7/7 [==============================] - 15s 2s/step - loss: 4.5670e-04 - accuracy: 1.00
00 - val_loss: 5.9604e-07 - val_accuracy: 1.0000
Epoch 87/100
7/7 [==============================] - 15s 2s/step - loss: 6.6926e-04 - accuracy: 1.00
00 - val_loss: 0.0016 - val_accuracy: 1.0000
Epoch 88/100
7/7 [==============================] - 14s 2s/step - loss: 0.0071 - accuracy: 0.9972 -
val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 89/100
7/7 [==============================] - 14s 2s/step - loss: 2.8473e-04 - accuracy: 1.00
00 - val_loss: 3.7253e-09 - val_accuracy: 1.0000
Epoch 90/100
7/7 [==============================] - 15s 2s/step - loss: 0.0012 - accuracy: 1.0000 -
val_loss: 0.0432 - val_accuracy: 0.9688
Epoch 91/100
7/7 [==============================] - 14s 2s/step - loss: 0.0156 - accuracy: 0.9930 -
val_loss: 0.0508 - val_accuracy: 0.9688
Epoch 92/100
7/7 [==============================] - 14s 2s/step - loss: 0.0045 - accuracy: 1.0000 -
val_loss: 0.0508 - val_accuracy: 0.9688
Epoch 93/100
7/7 [==============================] - 14s 2s/step - loss: 0.0025 - accuracy: 0.9981 -
val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 94/100
7/7 [==============================] - 14s 2s/step - loss: 0.0070 - accuracy: 1.0000 -
val_loss: 0.0529 - val_accuracy: 0.9688
Epoch 95/100
7/7 [==============================] - 14s 2s/step - loss: 0.0044 - accuracy: 1.0000 -
val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 96/100
7/7 [==============================] - 14s 2s/step - loss: 0.0079 - accuracy: 0.9962 -
val_loss: 0.0562 - val_accuracy: 0.9688
Epoch 97/100
7/7 [==============================] - 14s 2s/step - loss: 0.0127 - accuracy: 0.9892 -
val_loss: 3.2408e-06 - val_accuracy: 1.0000
Epoch 98/100
7/7 [==============================] - 14s 2s/step - loss: 0.0015 - accuracy: 1.0000 -
val_loss: 3.4473e-04 - val_accuracy: 1.0000
Epoch 99/100
7/7 [==============================] - 14s 2s/step - loss: 0.0073 - accuracy: 1.0000 -
val_loss: 2.8259e-04 - val_accuracy: 1.0000
Epoch 100/100
7/7 [==============================] - 14s 2s/step - loss: 0.0108 - accuracy: 0.9891 -
val_loss: 0.0262 - val_accuracy: 0.9688
```

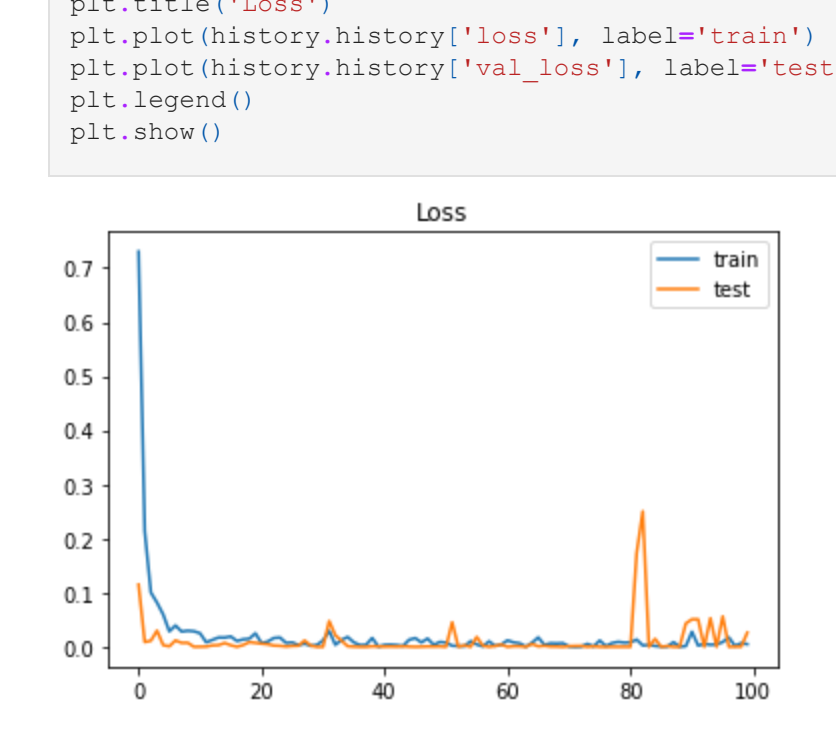
In [12]:

```
#Avaliando o modelo
loss_train, train_acc = model.evaluate_generator(train_generator, steps=step_size_tra
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 depr
ecated 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
```

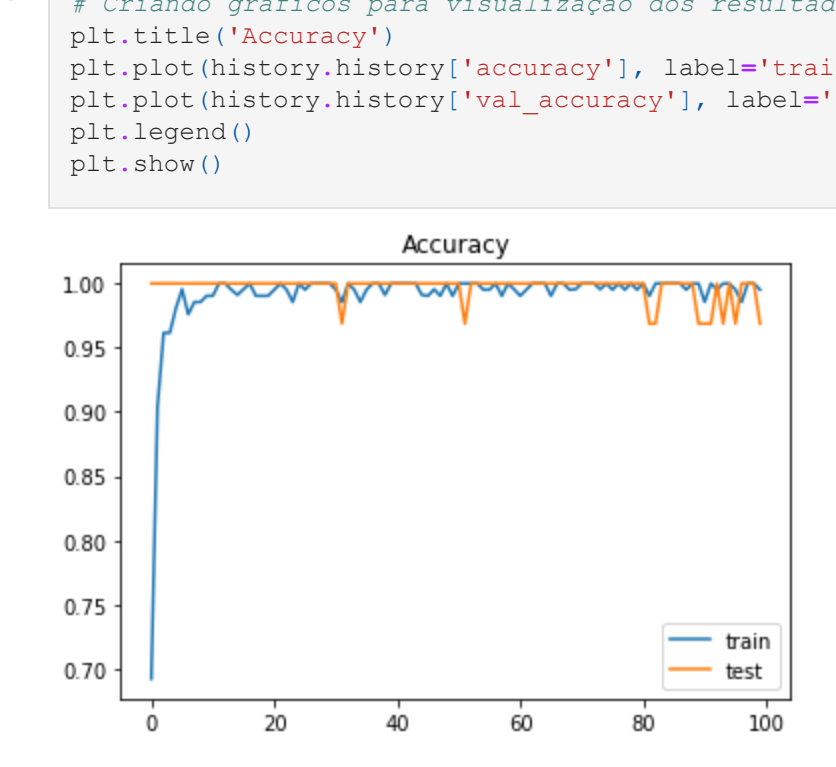
In [13]:

```
#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('shapes_split/test')
print('Rótulos', 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 1D created')
```

```
Criando classificações..
Rótulos ['circles', 'squares', 'triangles']
c:\users\vinicius\appdata\local\programs\python\python39\lib\site-packages\tensorflow
\python\keras\engine\training.py:2001: 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 1D created
```

In [16]:

```
classification = classification_report(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, linewidths=2.5)
```

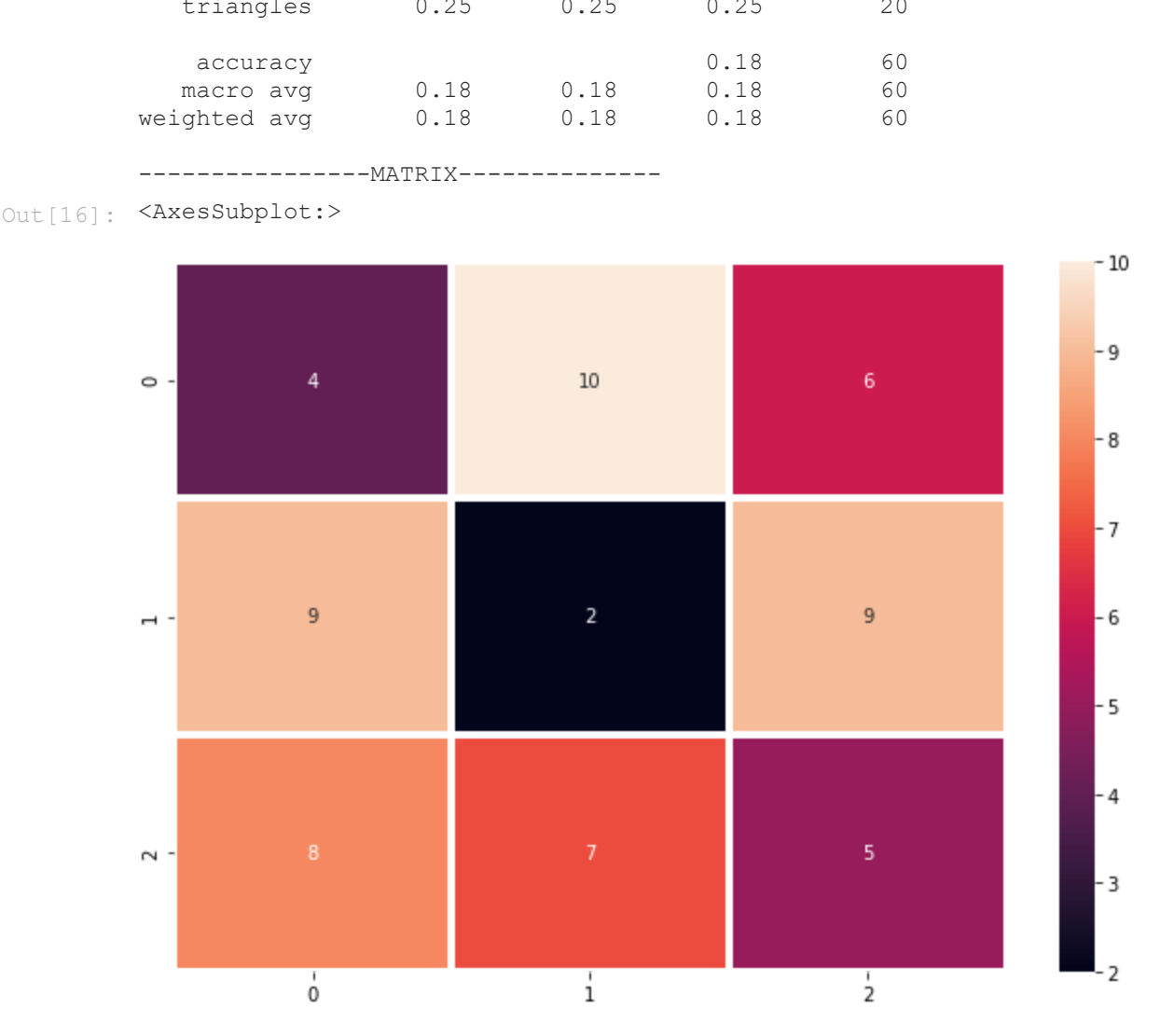
```
----------------CLASSIFICATION--------------
              precision    recall  f1-score   support

     circles       0.19      0.20      0.20        20
     squares       0.11      0.10      0.10        20
   triangles       0.25      0.25      0.25        20

    accuracy                           0.18        60
   macro avg       0.18      0.18      0.18        60
weighted avg       0.18      0.18      0.18        60

-----------------MATRIX-----------------
```

Out[16]: <AxesSubplot:>



In [ ]: