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 = 50 # quantidade de vezes a ser executado o algoritmo, uma epoch é quanto tod
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 inception_v3

x=base_model.output
```

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


#adiciona apos x uma camada AveragePooling2D e atribui ela ao x novamente (logo x
x=tf.keras.layers.GlobalAveragePooling2D()(x)

#adiciona apos x uma camada densa com 32 neuronios com funcao de ativacao relu. Atrib
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 128 neuronios com funcao de ativacao relu. Atri
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(7,activation='softmax')(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

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, 6 256         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
[0][0]

conv2_block1_out (Add)          (None, None, None, 2 0           conv2_block1_0_conv
[0][0]
                                                                 conv2_block1_3_conv
[0][0]

conv2_block2_preact_bn (BatchNo (None, None, None, 2 1024        conv2_block1_out[0]
[0]

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]

conv2_block2_1_bn (BatchNormali (None, None, None, 6 256         conv2_block2_1_conv
[0][0]

conv2_block2_1_relu (Activation (None, None, None, 6 0           conv2_block2_1_bn[0]
[0]

conv2_block2_2_pad (ZeroPadding (None, None, None, 6 0           conv2_block2_1_relu
[0][0]

conv2_block2_2_conv (Conv2D)    (None, None, None, 6 36864       conv2_block2_2_pad[0]
[0]

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
[0][0]

conv2_block2_out (Add)          (None, None, None, 2 0           conv2_block1_out[0]
[0]
                                                                 conv2_block2_3_conv
[0][0]

conv2_block3_preact_bn (BatchNo (None, None, None, 2 1024        conv2_block2_out[0]
[0]

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]

conv2_block3_1_bn (BatchNormali (None, None, None, 6 256         conv2_block3_1_conv
[0][0]

conv2_block3_1_relu (Activation (None, None, None, 6 0           conv2_block3_1_bn[0]
[0]

conv2_block3_2_pad (ZeroPadding (None, None, None, 6 0           conv2_block3_1_relu
[0][0]

conv2_block3_2_conv (Conv2D)    (None, None, None, 6 36864       conv2_block3_2_pad[0]
[0]

conv2_block3_2_bn (BatchNormali (None, None, None, 6 256         conv2_block3_2_conv
[0][0]

conv2_block3_2_relu (Activation (None, None, None, 6 0           conv2_block3_2_bn[0]
[0]

max_pooling2d (MaxPooling2D)    (None, None, None, 2 0           conv2_block2_out[0]
[0]

conv2_block3_3_conv (Conv2D)    (None, None, None, 2 16640       conv2_block3_2_relu
[0][0]

conv2_block3_out (Add)          (None, None, None, 2 0           max_pooling2d[0][0]
                                                                 conv2_block3_3_conv
[0][0]

conv3_block1_preact_bn (BatchNo (None, None, None, 2 1024        conv2_block3_out[0]
[0]

conv3_block1_preact_relu (Activ (None, None, None, 2 0           conv3_block1_preact_b
n[0][0]

conv3_block1_1_conv (Conv2D)    (None, None, None, 1 32768       conv3_block1_preact_r
elu[0][0]

conv3_block1_1_bn (BatchNormali (None, None, None, 1 512         conv3_block1_1_conv
[0][0]

conv3_block1_1_relu (Activation (None, None, None, 1 0           conv3_block1_1_bn[0]
[0]

conv3_block1_2_pad (ZeroPadding (None, None, None, 1 0           conv3_block1_1_relu
[0][0]

conv3_block1_2_conv (Conv2D)    (None, None, None, 1 147456      conv3_block1_2_pad[0]
[0]

conv3_block1_2_bn (BatchNormali (None, None, None, 1 512         conv3_block1_2_conv
[0][0]

conv3_block1_2_relu (Activation (None, None, None, 1 0           conv3_block1_2_bn[0]
[0]

conv3_block1_0_conv (Conv2D)    (None, None, None, 5 131584      conv3_block1_preact_r
elu[0][0]

conv3_block1_3_conv (Conv2D)    (None, None, None, 5 66048       conv3_block1_2_relu
[0][0]

conv3_block1_out (Add)          (None, None, None, 5 0           conv3_block1_0_conv
[0][0]
                                                                 conv3_block1_3_conv
[0][0]

conv3_block2_preact_bn (BatchNo (None, None, None, 5 2048        conv3_block1_out[0]
[0]

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
elu[0][0]

conv3_block2_1_bn (BatchNormali (None, None, None, 1 512         conv3_block2_1_conv
[0][0]

conv3_block2_1_relu (Activation (None, None, None, 1 0           conv3_block2_1_bn[0]
[0]

conv3_block2_2_pad (ZeroPadding (None, None, None, 1 0           conv3_block2_1_relu
[0][0]

conv3_block2_2_conv (Conv2D)    (None, None, None, 1 147456      conv3_block2_2_pad[0]
[0]

conv3_block2_2_bn (BatchNormali (None, None, None, 1 512         conv3_block2_2_conv
[0][0]

conv3_block2_2_relu (Activation (None, None, None, 1 0           conv3_block2_2_bn[0]
[0]

conv3_block2_3_conv (Conv2D)    (None, None, None, 5 66048       conv3_block2_2_relu
[0][0]

conv3_block2_out (Add)          (None, None, None, 5 0           conv3_block1_out[0]
[0]
                                                                 conv3_block2_3_conv
[0][0]

conv3_block3_preact_bn (BatchNo (None, None, None, 5 2048        conv3_block2_out[0]
[0]

conv3_block3_preact_relu (Activ (None, None, None, 5 0           conv3_block3_preact_b
n[0][0]

conv3_block3_1_conv (Conv2D)    (None, None, None, 1 65536       conv3_block3_preact_r
elu[0][0]

conv3_block3_1_bn (BatchNormali (None, None, None, 1 512         conv3_block3_1_conv
[0][0]

conv3_block3_1_relu (Activation (None, None, None, 1 0           conv3_block3_1_bn[0]
[0]

conv3_block3_2_pad (ZeroPadding (None, None, None, 1 0           conv3_block3_1_relu
[0][0]

conv3_block3_2_conv (Conv2D)    (None, None, None, 1 147456      conv3_block3_2_pad[0]
[0]

conv3_block3_2_bn (BatchNormali (None, None, None, 1 512         conv3_block3_2_conv
[0][0]

conv3_block3_2_relu (Activation (None, None, None, 1 0           conv3_block3_2_bn[0]
[0]

conv3_block3_3_conv (Conv2D)    (None, None, None, 5 66048       conv3_block3_2_relu
[0][0]

conv3_block3_out (Add)          (None, None, None, 5 0           conv3_block2_out[0]
[0]
                                                                 conv3_block3_3_conv
[0][0]

conv3_block4_preact_bn (BatchNo (None, None, None, 5 2048        conv3_block3_out[0]
[0]

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
[0][0]

conv3_block4_1_relu (Activation (None, None, None, 1 0           conv3_block4_1_bn[0]
[0]

conv3_block4_2_pad (ZeroPadding (None, None, None, 1 0           conv3_block4_1_relu
[0][0]

conv3_block4_2_conv (Conv2D)    (None, None, None, 1 147456      conv3_block4_2_pad[0]
[0]

conv3_block4_2_bn (BatchNormali (None, None, None, 1 512         conv3_block4_2_conv
[0][0]

conv3_block4_2_relu (Activation (None, None, None, 1 0           conv3_block4_2_bn[0]
[0]

max_pooling2d_1 (MaxPooling2D)  (None, None, None, 5 0           conv3_block3_out[0]
[0]

conv3_block4_3_conv (Conv2D)    (None, None, None, 5 66048       conv3_block4_2_relu
[0][0]

conv3_block4_out (Add)          (None, None, None, 5 0           max_pooling2d_1[0][0]
                                                                 conv3_block4_3_conv
[0][0]

conv4_block1_preact_bn (BatchNo (None, None, None, 5 2048        conv3_block4_out[0]
[0]

conv4_block1_preact_relu (Activ (None, None, None, 5 0           conv4_block1_preact_b
n[0][0]

conv4_block1_1_conv (Conv2D)    (None, None, None, 2 131072      conv4_block1_preact_r
elu[0][0]

conv4_block1_1_bn (BatchNormali (None, None, None, 2 1024        conv4_block1_1_conv
[0][0]

conv4_block1_1_relu (Activation (None, None, None, 2 0           conv4_block1_1_bn[0]
[0]

conv4_block1_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block1_1_relu
[0][0]

conv4_block1_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block1_2_pad[0]
[0]

conv4_block1_2_bn (BatchNormali (None, None, None, 2 1024        conv4_block1_2_conv
[0][0]

conv4_block1_2_relu (Activation (None, None, None, 2 0           conv4_block1_2_bn[0]
[0]

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
[0][0]

conv4_block1_out (Add)          (None, None, None, 1 0           conv4_block1_0_conv
[0][0]
                                                                 conv4_block1_3_conv
[0][0]

conv4_block2_preact_bn (BatchNo (None, None, None, 1 4096        conv4_block1_out[0]
[0]

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
[0][0]

conv4_block2_1_relu (Activation (None, None, None, 2 0           conv4_block2_1_bn[0]
[0]

conv4_block2_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block2_1_relu
[0][0]

conv4_block2_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block2_2_pad[0]
[0]

conv4_block2_2_bn (BatchNormali (None, None, None, 2 1024        conv4_block2_2_conv
[0][0]

conv4_block2_2_relu (Activation (None, None, None, 2 0           conv4_block2_2_bn[0]
[0]

conv4_block2_3_conv (Conv2D)    (None, None, None, 1 263168      conv4_block2_2_relu
[0][0]

conv4_block2_out (Add)          (None, None, None, 1 0           conv4_block1_out[0]
[0]
                                                                 conv4_block2_3_conv
[0][0]

conv4_block3_preact_bn (BatchNo (None, None, None, 1 4096        conv4_block2_out[0]
[0]

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
[0][0]

conv4_block3_1_relu (Activation (None, None, None, 2 0           conv4_block3_1_bn[0]
[0]

conv4_block3_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block3_1_relu
[0][0]

conv4_block3_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block3_2_pad[0]
[0]

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]
[0]

conv4_block3_3_conv (Conv2D)    (None, None, None, 1 263168      conv4_block3_2_relu
[0][0]

conv4_block3_out (Add)          (None, None, None, 1 0           conv4_block2_out[0]
[0]
                                                                 conv4_block3_3_conv
[0][0]

conv4_block4_preact_bn (BatchNo (None, None, None, 1 4096        conv4_block3_out[0]
[0]

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
[0][0]

conv4_block4_1_relu (Activation (None, None, None, 2 0           conv4_block4_1_bn[0]
[0]

conv4_block4_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block4_1_relu
[0][0]

conv4_block4_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block4_2_pad[0]
[0]

conv4_block4_2_bn (BatchNormali (None, None, None, 2 1024        conv4_block4_2_conv
[0][0]

conv4_block4_2_relu (Activation (None, None, None, 2 0           conv4_block4_2_bn[0]
[0]

conv4_block4_3_conv (Conv2D)    (None, None, None, 1 263168      conv4_block4_2_relu
[0][0]

conv4_block4_out (Add)          (None, None, None, 1 0           conv4_block3_out[0]
[0]
                                                                 conv4_block4_3_conv
[0][0]

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
[0][0]

conv4_block5_1_relu (Activation (None, None, None, 2 0           conv4_block5_1_bn[0]
[0]

conv4_block5_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block5_1_relu
[0][0]

conv4_block5_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block5_2_pad[0]
[0]

conv4_block5_2_bn (BatchNormali (None, None, None, 2 1024        conv4_block5_2_conv
[0][0]

conv4_block5_2_relu (Activation (None, None, None, 2 0           conv4_block5_2_bn[0]
[0]

conv4_block5_3_conv (Conv2D)    (None, None, None, 1 263168      conv4_block5_2_relu
[0][0]

conv4_block5_out (Add)          (None, None, None, 1 0           conv4_block4_out[0]
[0]
                                                                 conv4_block5_3_conv
[0][0]

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
[0][0]

conv4_block6_1_relu (Activation (None, None, None, 2 0           conv4_block6_1_bn[0]
[0]

conv4_block6_2_pad (ZeroPadding (None, None, None, 2 0           conv4_block6_1_relu
[0][0]

conv4_block6_2_conv (Conv2D)    (None, None, None, 2 589824      conv4_block6_2_pad[0]
[0]

conv4_block6_2_bn (BatchNormali (None, None, None, 2 1024        conv4_block6_2_conv
[0][0]

conv4_block6_2_relu (Activation (None, None, None, 2 0           conv4_block6_2_bn[0]
[0]

max_pooling2d_2 (MaxPooling2D)  (None, None, None, 1 0           conv4_block5_out[0]
[0]

conv4_block6_3_conv (Conv2D)    (None, None, None, 1 263168      conv4_block6_2_relu
[0][0]

conv4_block6_out (Add)          (None, None, None, 1 0           max_pooling2d_2[0][0]
                                                                 conv4_block6_3_conv
[0][0]

conv5_block1_preact_bn (BatchNo (None, None, None, 1 4096        conv4_block6_out[0]
[0]

conv5_block1_preact_relu (Activ (None, None, None, 1 0           conv5_block1_preact_b
n[0][0]

conv5_block1_1_conv (Conv2D)    (None, None, None, 5 524288      conv5_block1_preact_r
elu[0][0]

conv5_block1_1_bn (BatchNormali (None, None, None, 5 2048        conv5_block1_1_conv
[0][0]

conv5_block1_1_relu (Activation (None, None, None, 5 0           conv5_block1_1_bn[0]
[0]

conv5_block1_2_pad (ZeroPadding (None, None, None, 5 0           conv5_block1_1_relu
[0][0]

conv5_block1_2_conv (Conv2D)    (None, None, None, 5 2359296     conv5_block1_2_pad[0]
[0]

conv5_block1_2_bn (BatchNormali (None, None, None, 5 2048        conv5_block1_2_conv
[0][0]

conv5_block1_2_relu (Activation (None, None, None, 5 0           conv5_block1_2_bn[0]
[0]

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
[0][0]

conv5_block1_out (Add)          (None, None, None, 2 0           conv5_block1_0_conv
[0][0]
                                                                 conv5_block1_3_conv
[0][0]

conv5_block2_preact_bn (BatchNo (None, None, None, 2 8192        conv5_block1_out[0]
[0]

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
[0][0]

conv5_block2_1_relu (Activation (None, None, None, 5 0           conv5_block2_1_bn[0]
[0]

conv5_block2_2_pad (ZeroPadding (None, None, None, 5 0           conv5_block2_1_relu
[0][0]

conv5_block2_2_conv (Conv2D)    (None, None, None, 5 2359296     conv5_block2_2_pad[0]
[0]

conv5_block2_2_bn (BatchNormali (None, None, None, 5 2048        conv5_block2_2_conv
[0][0]

conv5_block2_2_relu (Activation (None, None, None, 5 0           conv5_block2_2_bn[0]
[0]

conv5_block2_3_conv (Conv2D)    (None, None, None, 2 1050624     conv5_block2_2_relu
[0][0]

conv5_block2_out (Add)          (None, None, None, 2 0           conv5_block1_out[0]
[0]
                                                                 conv5_block2_3_conv
[0][0]

conv5_block3_preact_bn (BatchNo (None, None, None, 2 8192        conv5_block2_out[0]
[0]

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
elu[0][0]

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]
[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, 2048)         0           post_relu[0][0]

dense (Dense)                   (None, 128)          262272      global_average_poolin
g2d[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 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_functio

#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

#definindo gerador de imagens de treino
train_generator = train_data_gen.flow_from_directory('data_tt/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_tt/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)#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 1/50
22/22 [==============================] - 69s 3s/step - loss: 2.1608 - accuracy: 0.1377
- val_loss: 1.8455 - val_accuracy: 0.2750
Epoch 2/50
```

```
22/22 [==============================] - 64s 3s/step - loss: 1.8664 - accuracy: 0.2286
- val_loss: 1.7817 - val_accuracy: 0.3500
Epoch 3/50
22/22 [==============================] - 64s 3s/step - loss: 1.7972 - accuracy: 0.2451
- val_loss: 1.7109 - val_accuracy: 0.4062
Epoch 4/50
22/22 [==============================] - 65s 3s/step - loss: 1.7298 - accuracy: 0.3192
- val_loss: 1.6363 - val_accuracy: 0.4187
Epoch 5/50
22/22 [==============================] - 64s 3s/step - loss: 1.6870 - accuracy: 0.3005
- val_loss: 1.5718 - val_accuracy: 0.4563
Epoch 6/50
22/22 [==============================] - 64s 3s/step - loss: 1.5987 - accuracy: 0.3686
- val_loss: 1.4957 - val_accuracy: 0.4812
Epoch 7/50
22/22 [==============================] - 64s 3s/step - loss: 1.5550 - accuracy: 0.4260
- val_loss: 1.4436 - val_accuracy: 0.4812
Epoch 8/50
22/22 [==============================] - 64s 3s/step - loss: 1.4749 - accuracy: 0.4238
- val_loss: 1.3884 - val_accuracy: 0.4688
Epoch 9/50
22/22 [==============================] - 64s 3s/step - loss: 1.4267 - accuracy: 0.4578
- val_loss: 1.3610 - val_accuracy: 0.4375
Epoch 10/50
22/22 [==============================] - 64s 3s/step - loss: 1.4120 - accuracy: 0.4248
- val_loss: 1.2748 - val_accuracy: 0.4938
Epoch 11/50
22/22 [==============================] - 64s 3s/step - loss: 1.3365 - accuracy: 0.4327
- val_loss: 1.2875 - val_accuracy: 0.4812
Epoch 12/50
22/22 [==============================] - 65s 3s/step - loss: 1.3177 - accuracy: 0.4976
- val_loss: 1.2483 - val_accuracy: 0.5125
Epoch 13/50
22/22 [==============================] - 64s 3s/step - loss: 1.2981 - accuracy: 0.4945
- val_loss: 1.2503 - val_accuracy: 0.4750
Epoch 14/50
22/22 [==============================] - 64s 3s/step - loss: 1.2734 - accuracy: 0.5172
- val_loss: 1.2379 - val_accuracy: 0.4812
Epoch 15/50
22/22 [==============================] - 65s 3s/step - loss: 1.2286 - accuracy: 0.5148
- val_loss: 1.2078 - val_accuracy: 0.4938
Epoch 16/50
22/22 [==============================] - 64s 3s/step - loss: 1.2026 - accuracy: 0.5378
- val_loss: 1.1594 - val_accuracy: 0.5312
Epoch 17/50
22/22 [==============================] - 64s 3s/step - loss: 1.1639 - accuracy: 0.5571
- val_loss: 1.1609 - val_accuracy: 0.5000
Epoch 18/50
22/22 [==============================] - 64s 3s/step - loss: 1.1143 - accuracy: 0.5673
- val_loss: 1.1720 - val_accuracy: 0.4750
Epoch 19/50
22/22 [==============================] - 64s 3s/step - loss: 1.1391 - accuracy: 0.5611
- val_loss: 1.1174 - val_accuracy: 0.5437
Epoch 20/50
22/22 [==============================] - 64s 3s/step - loss: 1.0814 - accuracy: 0.5866
- val_loss: 1.1256 - val_accuracy: 0.5312
Epoch 21/50
22/22 [==============================] - 64s 3s/step - loss: 1.0777 - accuracy: 0.5655
- val_loss: 1.0848 - val_accuracy: 0.5375
Epoch 22/50
22/22 [==============================] - 64s 3s/step - loss: 1.0631 - accuracy: 0.5657
- val_loss: 1.0963 - val_accuracy: 0.5312
Epoch 23/50
22/22 [==============================] - 64s 3s/step - loss: 1.0706 - accuracy: 0.5854
- val_loss: 1.1500 - val_accuracy: 0.4688
Epoch 24/50
22/22 [==============================] - 64s 3s/step - loss: 0.9976 - accuracy: 0.5957
- val_loss: 1.1238 - val_accuracy: 0.4938
Epoch 25/50
22/22 [==============================] - 65s 3s/step - loss: 1.0167 - accuracy: 0.6083
- val_loss: 1.1108 - val_accuracy: 0.5063
Epoch 26/50
22/22 [==============================] - 64s 3s/step - loss: 1.0550 - accuracy: 0.5856
- val_loss: 1.1115 - val_accuracy: 0.4812
Epoch 27/50
22/22 [==============================] - 64s 3s/step - loss: 0.9788 - accuracy: 0.6249
- val_loss: 1.1023 - val_accuracy: 0.5125
Epoch 28/50
22/22 [==============================] - 64s 3s/step - loss: 0.9604 - accuracy: 0.6743
- val_loss: 1.1095 - val_accuracy: 0.4938
Epoch 29/50
22/22 [==============================] - 64s 3s/step - loss: 0.9550 - accuracy: 0.6508
- val_loss: 1.0575 - val_accuracy: 0.5312
Epoch 30/50
22/22 [==============================] - 64s 3s/step - loss: 0.9346 - accuracy: 0.6501
- val_loss: 1.0948 - val_accuracy: 0.5063
Epoch 31/50
22/22 [==============================] - 64s 3s/step - loss: 0.8813 - accuracy: 0.6581
- val_loss: 1.0714 - val_accuracy: 0.5063
Epoch 32/50
22/22 [==============================] - 65s 3s/step - loss: 0.9061 - accuracy: 0.6502
- val_loss: 1.0715 - val_accuracy: 0.5188
Epoch 33/50
22/22 [==============================] - 64s 3s/step - loss: 0.8693 - accuracy: 0.7029
- val_loss: 1.0785 - val_accuracy: 0.4938
Epoch 34/50
22/22 [==============================] - 64s 3s/step - loss: 0.9142 - accuracy: 0.6427
- val_loss: 1.0829 - val_accuracy: 0.5375
Epoch 35/50
22/22 [==============================] - 65s 3s/step - loss: 0.8059 - accuracy: 0.7176
- val_loss: 1.0673 - val_accuracy: 0.5188
Epoch 36/50
22/22 [==============================] - 64s 3s/step - loss: 0.8321 - accuracy: 0.7075
- val_loss: 1.0900 - val_accuracy: 0.5000
Epoch 37/50
22/22 [==============================] - 65s 3s/step - loss: 0.8078 - accuracy: 0.6847
- val_loss: 1.1095 - val_accuracy: 0.4812
Epoch 38/50
22/22 [==============================] - 64s 3s/step - loss: 0.8364 - accuracy: 0.6964
- val_loss: 1.0983 - val_accuracy: 0.5125
Epoch 39/50
22/22 [==============================] - 64s 3s/step - loss: 0.7856 - accuracy: 0.7176
- val_loss: 0.9978 - val_accuracy: 0.5562
Epoch 40/50
22/22 [==============================] - 67s 3s/step - loss: 0.7750 - accuracy: 0.7034
- val_loss: 1.0510 - val_accuracy: 0.5188
Epoch 41/50
22/22 [==============================] - 64s 3s/step - loss: 0.7930 - accuracy: 0.7230
- val_loss: 1.0487 - val_accuracy: 0.5375
Epoch 42/50
22/22 [==============================] - 64s 3s/step - loss: 0.8138 - accuracy: 0.6905
- val_loss: 1.0622 - val_accuracy: 0.5125
Epoch 43/50
22/22 [==============================] - 64s 3s/step - loss: 0.7480 - accuracy: 0.7056
- val_loss: 1.0167 - val_accuracy: 0.5375
Epoch 44/50
22/22 [==============================] - 64s 3s/step - loss: 0.7356 - accuracy: 0.7565
- val_loss: 1.0180 - val_accuracy: 0.5500
Epoch 45/50
22/22 [==============================] - 64s 3s/step - loss: 0.7475 - accuracy: 0.6960
- val_loss: 1.0545 - val_accuracy: 0.5250
Epoch 46/50
22/22 [==============================] - 65s 3s/step - loss: 0.7180 - accuracy: 0.7604
- val_loss: 1.0689 - val_accuracy: 0.5188
Epoch 47/50
22/22 [==============================] - 64s 3s/step - loss: 0.7154 - accuracy: 0.7612
- val_loss: 1.0182 - val_accuracy: 0.5562
Epoch 48/50
22/22 [==============================] - 64s 3s/step - loss: 0.6897 - accuracy: 0.7507
- val_loss: 1.0942 - val_accuracy: 0.5375
Epoch 49/50
22/22 [==============================] - 65s 3s/step - loss: 0.6812 - accuracy: 0.7694
- val_loss: 1.0798 - val_accuracy: 0.5500
Epoch 50/50
22/22 [==============================] - 64s 3s/step - loss: 0.6440 - accuracy: 0.7868
- val_loss: 1.0155 - val_accuracy: 0.5562
```

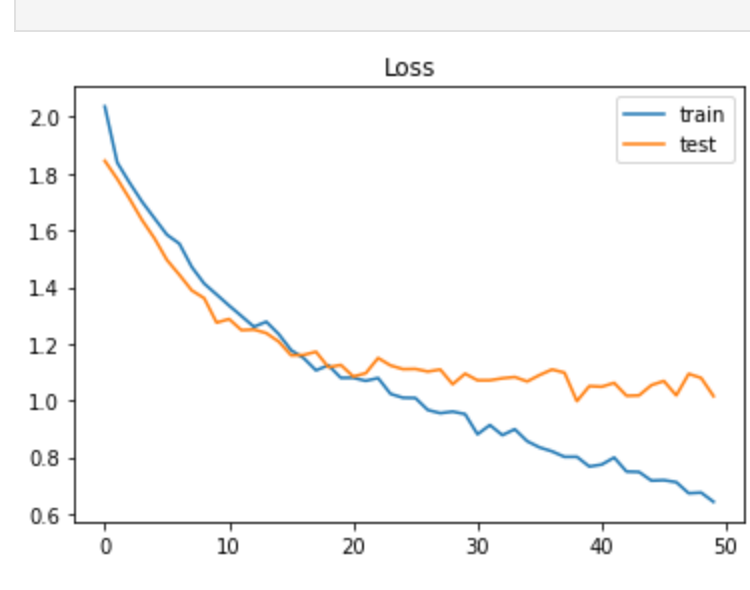
In [12]:

```python
#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: 0.899, Test: 0.531
```

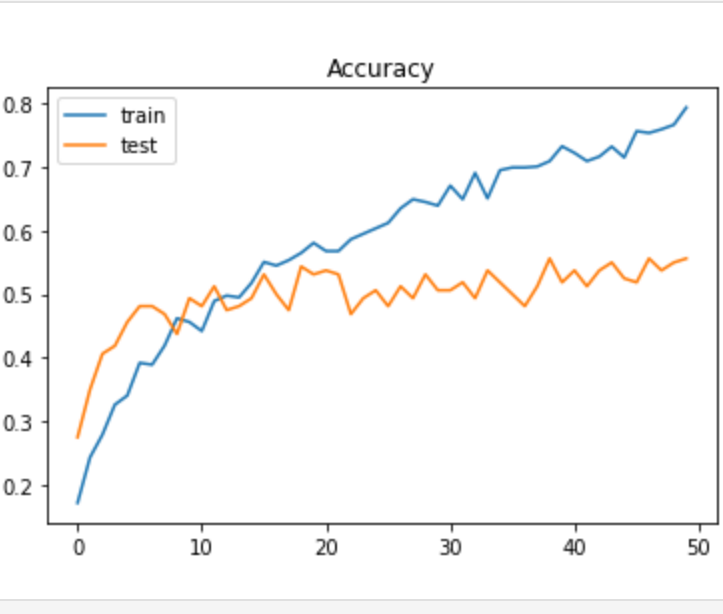
In [13]:

```python
#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]:

```python
# Criando graficos para visualização dos resultados
print()
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]:

```python
print('Criando classificações..')
labels = os.listdir('Database')
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 ['carcinoma_in_situ', 'light_dysplastic', 'moderate_dysplastic', 'normal_colum
nar', 'normal_intermediate', 'normal_superficiel', '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 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]:

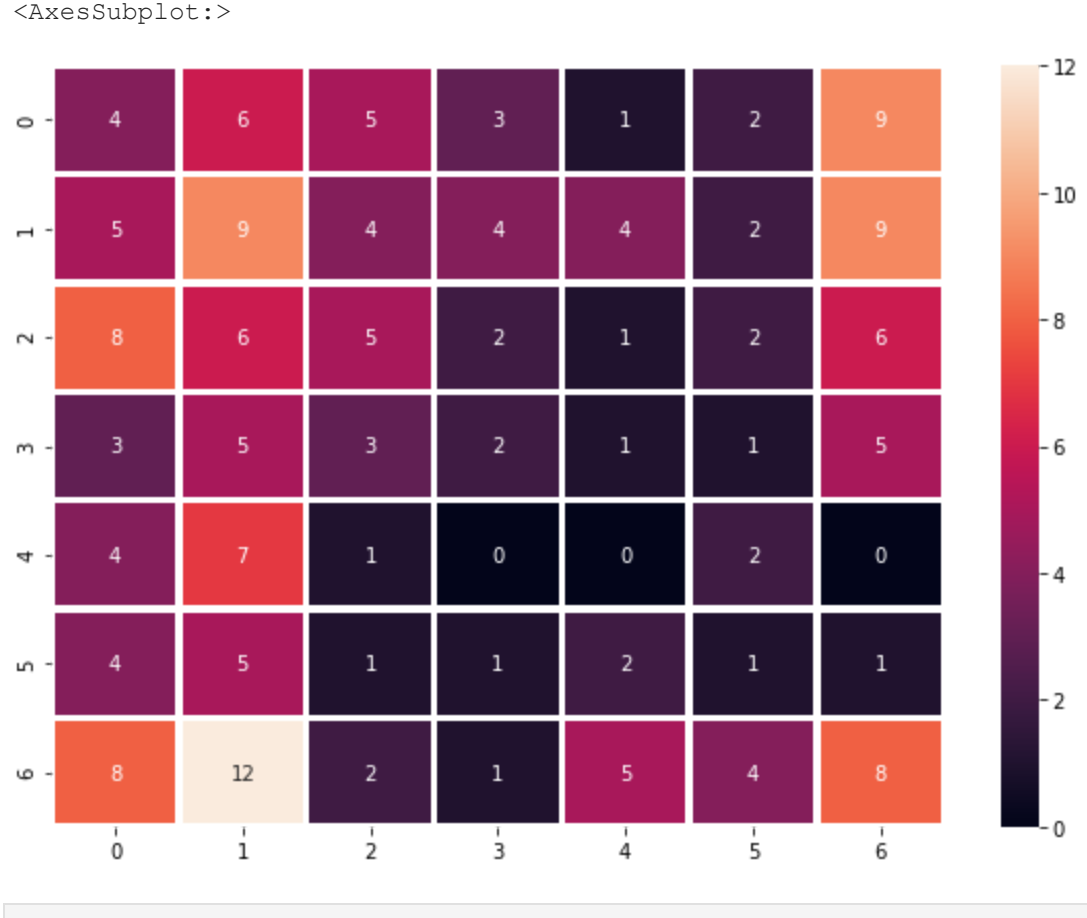
```python
classification = classification_report(test_generator.classes, y_pred, target_names=la
print('----------------CLASSIFICATION--------------')
print(classification)
matrix = confusion_matrix(test_generator.classes, y_pred)
df_cm = pd.DataFrame(matrix, index = [i for i in range(7)],
         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

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

  carcinoma_in_situ       0.11      0.13      0.12        30
   light_dysplastic       0.18      0.24      0.21        37
moderate_dysplastic       0.24      0.17      0.20        30
     normal_columnar      0.15      0.10      0.12        20
normal_intermediate       0.00      0.00      0.00        14
  normal_superficiel      0.07      0.07      0.07        15
   severe_dysplastic      0.21      0.20      0.21        40

           accuracy                           0.16       186
          macro avg       0.14      0.13      0.13       186
       weighted avg       0.16      0.16      0.16       186
```

Out[16]: <AxesSubplot:>



In [ ]: