In [17]:
```python
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
```

In [18]:
```python
epochs = 50 # quantidade de vezes a ser executado o algoritmo, uma epoch é quanto tod
batch = 64 # número de amostras que será carregado a cada execução
```

In [19]:
```python
#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 [20]:
```python
#O restante do modelo e suas camadas são discutidos a seguir
#x recebe o final da inception_v3

x=base_model.output
```

In [21]:
```python
#Nova configuração para o modelo

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

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

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

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

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

#adiciona após 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_1"
__________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==========================================================================================
input_2 (InputLayer)            [(None, None, None,  0
__________________________________________________________________________________________
conv1_pad (ZeroPadding2D)       (None, None, None, 3 0           input_2[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_3 (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_3[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_4 (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_4[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_5 (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_5[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_1 (Glo (None, 2048)         0           post_relu[0][0]
__________________________________________________________________________________________
dense_4 (Dense)                 (None, 128)          262272      global_average_poolin
g2d_1[0][0]
__________________________________________________________________________________________
dense_5 (Dense)                 (None, 64)           8256        dense_4[0][0]
__________________________________________________________________________________________
dense_6 (Dense)                 (None, 32)           2080        dense_5[0][0]
__________________________________________________________________________________________
dropout_1 (Dropout)             (None, 32)           0           dense_6[0][0]
__________________________________________________________________________________________
dense_7 (Dense)                 (None, 7)            231         dropout_1[0][0]
==========================================================================================
Total params: 23,837,639
Trainable params: 23,792,199
Non-trainable params: 45,440
```

In [22]:
```python
#congelando os neuronios 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 [23]:
```python
#iniciando objeto que apanhara todas as imagens de treino, processando as imagem 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 [24]:
```python
#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 184 images belonging to 7 classes.
```

In [25]:
```python
lr = tf.keras.optimizers.Adam(learning_rate=0.0001) #estabelecendo taxa de otimizacao

model.compile(optimizer=lr, loss='categorical_crossentropy', metrics=['accuracy'])
```

In [26]:
```python
#definicao dos steps
step_size_train = train_generator.n//train_generator.batch_size
step_size_test = test_generator.n//test_generator.batch_size
```

In [27]:
```python
#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
11/11 [==============================] - 70s 6s/step - loss: 2.0590 - accuracy: 0.2029
- val_loss: 1.8379 - val_accuracy: 0.2891
Epoch 2/50
11/11 [==============================] - 59s 5s/step - loss: 1.8538 - accuracy: 0.2410
- val_loss: 1.7572 - val_accuracy: 0.2812
Epoch 3/50
11/11 [==============================] - 59s 5s/step - loss: 1.7765 - accuracy: 0.2713
- val_loss: 1.6622 - val_accuracy: 0.3516
Epoch 4/50
```

```
11/11 [==============================] - 58s 5s/step - loss: 1.6812 - accuracy: 0.3207
- val_loss: 1.6137 - val_accuracy: 0.3594
Epoch 5/50
11/11 [==============================] - 59s 5s/step - loss: 1.6435 - accuracy: 0.3591
- val_loss: 1.5991 - val_accuracy: 0.3750
Epoch 6/50
11/11 [==============================] - 59s 5s/step - loss: 1.5902 - accuracy: 0.3815
- val_loss: 1.5424 - val_accuracy: 0.4141
Epoch 7/50
11/11 [==============================] - 59s 5s/step - loss: 1.5142 - accuracy: 0.3956
- val_loss: 1.4828 - val_accuracy: 0.4062
Epoch 8/50
11/11 [==============================] - 58s 5s/step - loss: 1.5096 - accuracy: 0.4098
- val_loss: 1.4664 - val_accuracy: 0.4531
Epoch 9/50
11/11 [==============================] - 59s 5s/step - loss: 1.4525 - accuracy: 0.4209
- val_loss: 1.4332 - val_accuracy: 0.4688
Epoch 10/50
11/11 [==============================] - 58s 5s/step - loss: 1.4121 - accuracy: 0.4394
- val_loss: 1.3246 - val_accuracy: 0.4688
Epoch 11/50
11/11 [==============================] - 58s 5s/step - loss: 1.4297 - accuracy: 0.4301
- val_loss: 1.3263 - val_accuracy: 0.4688
Epoch 12/50
11/11 [==============================] - 58s 5s/step - loss: 1.3369 - accuracy: 0.4801
- val_loss: 1.2647 - val_accuracy: 0.5078
Epoch 13/50
11/11 [==============================] - 58s 5s/step - loss: 1.3256 - accuracy: 0.4651
- val_loss: 1.2662 - val_accuracy: 0.5000
Epoch 14/50
11/11 [==============================] - 59s 5s/step - loss: 1.2962 - accuracy: 0.4829
- val_loss: 1.1843 - val_accuracy: 0.5703
Epoch 15/50
11/11 [==============================] - 58s 6s/step - loss: 1.2842 - accuracy: 0.5002
- val_loss: 1.2763 - val_accuracy: 0.5156
Epoch 16/50
11/11 [==============================] - 61s 6s/step - loss: 1.3134 - accuracy: 0.4583
- val_loss: 1.2310 - val_accuracy: 0.5469
Epoch 17/50
11/11 [==============================] - 58s 5s/step - loss: 1.2308 - accuracy: 0.5148
- val_loss: 1.1991 - val_accuracy: 0.5000
Epoch 18/50
11/11 [==============================] - 59s 5s/step - loss: 1.2445 - accuracy: 0.4867
- val_loss: 1.2370 - val_accuracy: 0.5078
Epoch 19/50
11/11 [==============================] - 59s 5s/step - loss: 1.2412 - accuracy: 0.4862
- val_loss: 1.2364 - val_accuracy: 0.5078
Epoch 20/50
11/11 [==============================] - 59s 5s/step - loss: 1.2293 - accuracy: 0.4839
- val_loss: 1.2421 - val_accuracy: 0.5078
Epoch 21/50
11/11 [==============================] - 58s 5s/step - loss: 1.2004 - accuracy: 0.5371
- val_loss: 1.2389 - val_accuracy: 0.4844
Epoch 22/50
11/11 [==============================] - 59s 5s/step - loss: 1.2279 - accuracy: 0.4949
- val_loss: 1.2022 - val_accuracy: 0.4766
Epoch 23/50
11/11 [==============================] - 58s 5s/step - loss: 1.1317 - accuracy: 0.5768
- val_loss: 1.1943 - val_accuracy: 0.5469
Epoch 24/50
11/11 [==============================] - 59s 5s/step - loss: 1.1285 - accuracy: 0.5729
- val_loss: 1.1525 - val_accuracy: 0.5156
Epoch 25/50
11/11 [==============================] - 60s 6s/step - loss: 1.1313 - accuracy: 0.5339
- val_loss: 1.1585 - val_accuracy: 0.5312
Epoch 26/50
11/11 [==============================] - 62s 6s/step - loss: 1.1319 - accuracy: 0.5360
- val_loss: 1.1264 - val_accuracy: 0.5312
Epoch 27/50
11/11 [==============================] - 59s 5s/step - loss: 1.0436 - accuracy: 0.5853
- val_loss: 1.0479 - val_accuracy: 0.5781
Epoch 28/50
11/11 [==============================] - 59s 5s/step - loss: 1.1094 - accuracy: 0.5590
- val_loss: 1.1389 - val_accuracy: 0.5625
Epoch 29/50
11/11 [==============================] - 58s 5s/step - loss: 1.0597 - accuracy: 0.5835
- val_loss: 1.1018 - val_accuracy: 0.5156
Epoch 30/50
11/11 [==============================] - 59s 5s/step - loss: 1.0096 - accuracy: 0.6121
- val_loss: 1.1351 - val_accuracy: 0.4922
Epoch 31/50
11/11 [==============================] - 59s 5s/step - loss: 1.0327 - accuracy: 0.6141
- val_loss: 1.1641 - val_accuracy: 0.5391
Epoch 32/50
11/11 [==============================] - 59s 5s/step - loss: 1.0264 - accuracy: 0.5726
- val_loss: 1.0806 - val_accuracy: 0.5625
Epoch 33/50
11/11 [==============================] - 59s 5s/step - loss: 1.0580 - accuracy: 0.5780
- val_loss: 1.1109 - val_accuracy: 0.5547
Epoch 34/50
11/11 [==============================] - 59s 5s/step - loss: 1.0064 - accuracy: 0.6131
- val_loss: 1.1087 - val_accuracy: 0.5156
Epoch 35/50
11/11 [==============================] - 59s 5s/step - loss: 1.0481 - accuracy: 0.5825
- val_loss: 1.0971 - val_accuracy: 0.5156
Epoch 36/50
11/11 [==============================] - 59s 5s/step - loss: 1.0090 - accuracy: 0.6158
- val_loss: 1.1302 - val_accuracy: 0.5156
Epoch 37/50
11/11 [==============================] - 58s 5s/step - loss: 1.0099 - accuracy: 0.5937
- val_loss: 1.1216 - val_accuracy: 0.5234
Epoch 38/50
11/11 [==============================] - 58s 5s/step - loss: 0.9892 - accuracy: 0.5904
- val_loss: 1.0789 - val_accuracy: 0.5234
Epoch 39/50
11/11 [==============================] - 58s 5s/step - loss: 0.8775 - accuracy: 0.6691
- val_loss: 1.0781 - val_accuracy: 0.5234
Epoch 40/50
11/11 [==============================] - 58s 5s/step - loss: 0.9653 - accuracy: 0.6166
- val_loss: 1.0155 - val_accuracy: 0.5625
Epoch 41/50
11/11 [==============================] - 59s 5s/step - loss: 0.9219 - accuracy: 0.6391
- val_loss: 1.0945 - val_accuracy: 0.5312
Epoch 42/50
11/11 [==============================] - 58s 5s/step - loss: 0.8739 - accuracy: 0.6599
- val_loss: 1.0292 - val_accuracy: 0.5859
Epoch 43/50
11/11 [==============================] - 59s 5s/step - loss: 0.9126 - accuracy: 0.6573
- val_loss: 1.0556 - val_accuracy: 0.5469
Epoch 44/50
11/11 [==============================] - 59s 6s/step - loss: 0.9346 - accuracy: 0.6120
- val_loss: 1.1098 - val_accuracy: 0.5391
Epoch 45/50
11/11 [==============================] - 58s 5s/step - loss: 0.9133 - accuracy: 0.6467
- val_loss: 1.0939 - val_accuracy: 0.5469
Epoch 46/50
11/11 [==============================] - 59s 5s/step - loss: 0.9326 - accuracy: 0.6585
- val_loss: 1.0858 - val_accuracy: 0.5391
Epoch 47/50
11/11 [==============================] - 61s 6s/step - loss: 0.9158 - accuracy: 0.6762
- val_loss: 0.9992 - val_accuracy: 0.5547
Epoch 48/50
11/11 [==============================] - 59s 5s/step - loss: 0.8874 - accuracy: 0.6241
- val_loss: 1.0641 - val_accuracy: 0.5391
Epoch 49/50
11/11 [==============================] - 58s 5s/step - loss: 0.8471 - accuracy: 0.6837
- val_loss: 1.0463 - val_accuracy: 0.5547
Epoch 50/50
11/11 [==============================] - 59s 5s/step - loss: 0.8219 - accuracy: 0.7042
- val_loss: 1.0603 - val_accuracy: 0.5156
```

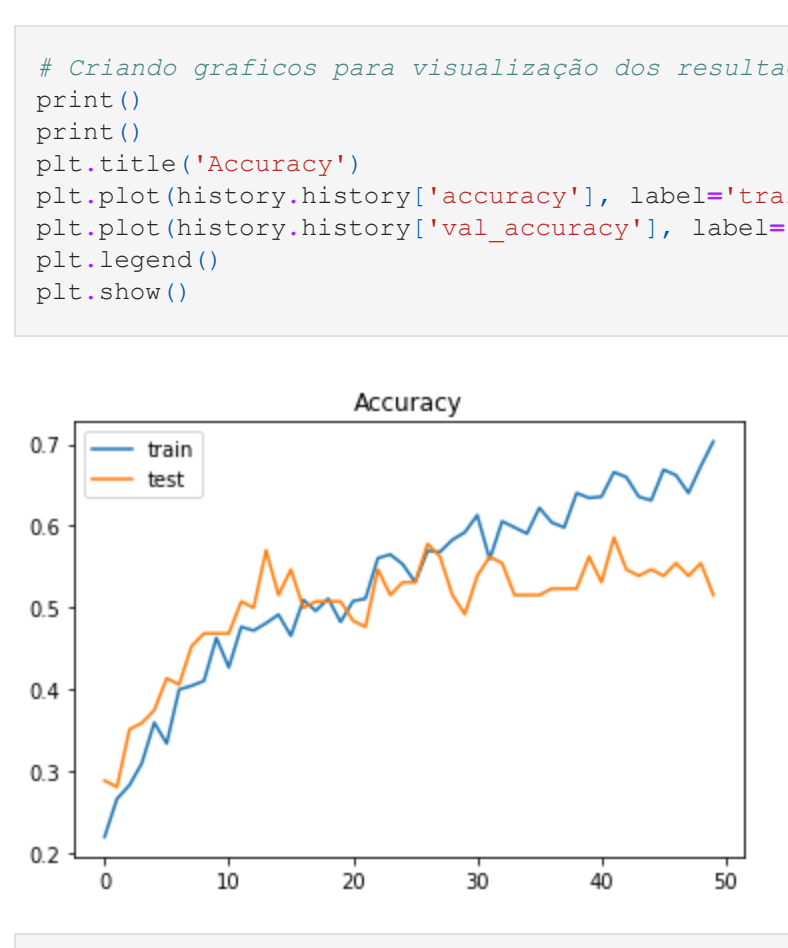
In [28]:

```
#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: 0.620, Test: 0.477
```

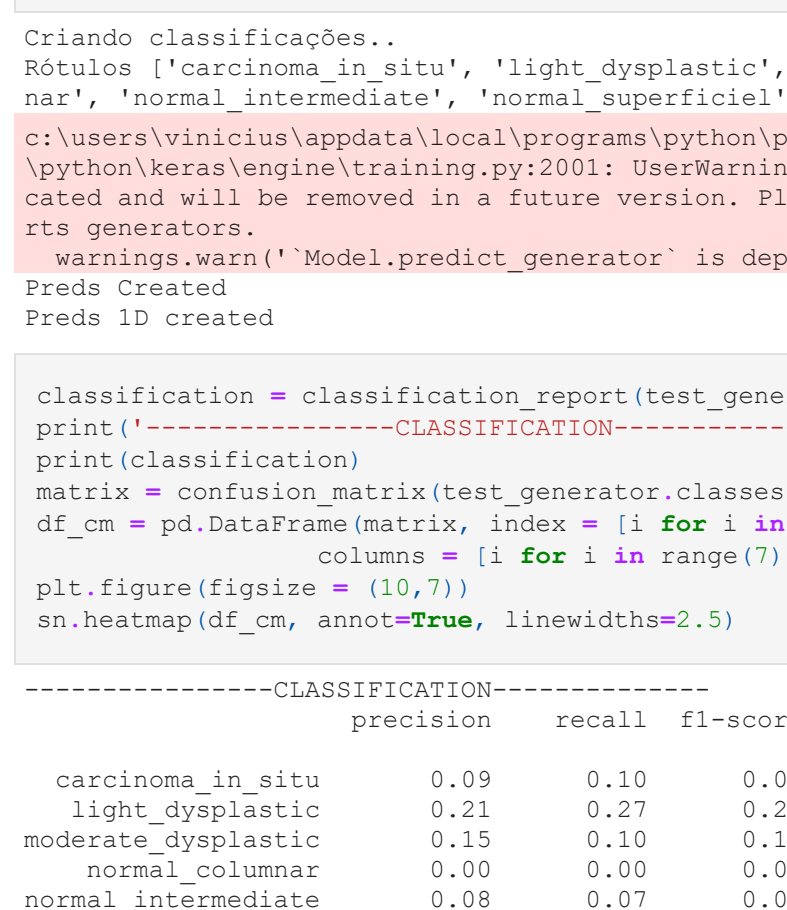
In [29]:

```
#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 [30]:

```
# 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 [31]:

```
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 [32]:

```
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       0.09      0.10      0.09        30
    light_dysplastic       0.21      0.27      0.24        37
 moderate_dysplastic       0.15      0.10      0.12        30
      normal_columnar      0.00      0.00      0.00        20
 normal_intermediate       0.08      0.07      0.07        14
  normal_superficiel       0.00      0.00      0.00        15
   severe_dysplastic       0.20      0.25      0.22        40

            accuracy                           0.15       186
           macro avg       0.10      0.11      0.11       186
        weighted avg       0.13      0.15      0.14       186
```

Out[32]: <AxesSubplot:>

In [ ]: