

```

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 toda
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 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 neurônios com funcao de ativacao relu. Atrib
x=tf.keras.layers.Dense(128,activation='relu')(x)

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

#Adiciona após x uma camada densa com 128 neurônios 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.Dense(128,activation='relu')(x)

#Adiciona layers.Dropout(0.5)(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 (BatchNorm (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 (BatchNormaliz (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]
conv2_block1_2_conv (Conv2D) (None, None, None, 6 36864 conv2_block1_2_pad[0
[0]
conv2_block1_2_bn (BatchNormaliz (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_block2_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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_block3_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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]
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]
[0][0]
conv3_block1_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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_block2_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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][0]
conv3_block3_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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][0]
conv3_block4_preact_bn (BatchNorm (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 (BatchNormaliz (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 (BatchNormaliz (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]
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 conv3_block2_out[0]
[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 (BatchNormaliz (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 (BatchNormaliz (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_block2_preact_bn (BatchNorm (None, None, None, 1 4096 conv4_block1_out[0]
[
```

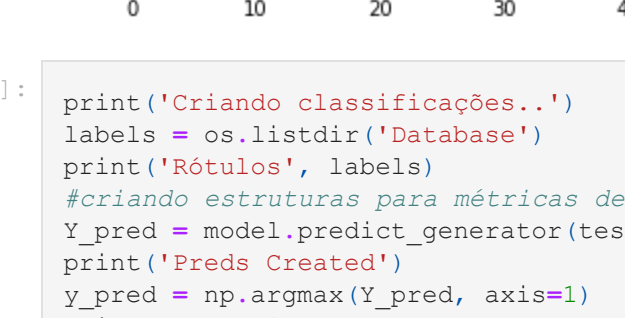


```
22/22 [=====] - 59s 3s/step - loss: 1.8738 - accuracy: 0.1968
22/22 [=====] - 60s 3s/step - loss: 1.7208 - accuracy: 0.3122
Epoch 3/50
22/22 [=====] - 59s 3s/step - loss: 1.6729 - accuracy: 0.3505
22/22 [=====] - 60s 3s/step - loss: 1.5920 - accuracy: 0.3612
22/22 [=====] - 59s 3s/step - loss: 1.5115 - accuracy: 0.3969
22/22 [=====] - 60s 3s/step - loss: 1.5406 - accuracy: 0.3747
Epoch 8/50
22/22 [=====] - 59s 3s/step - loss: 1.4546 - accuracy: 0.4070
22/22 [=====] - 59s 3s/step - loss: 1.4271 - accuracy: 0.4277
Epoch 10/50
22/22 [=====] - 59s 3s/step - loss: 1.4071 - accuracy: 0.4592
22/22 [=====] - 60s 3s/step - loss: 1.3337 - accuracy: 0.4800
Epoch 11/50
22/22 [=====] - 59s 3s/step - loss: 1.3038 - accuracy: 0.4993
22/22 [=====] - 60s 3s/step - loss: 1.2381 - accuracy: 0.5120
Epoch 13/50
22/22 [=====] - 59s 3s/step - loss: 1.2317 - accuracy: 0.5120
22/22 [=====] - 60s 3s/step - loss: 1.2017 - accuracy: 0.5274
Epoch 14/50
22/22 [=====] - 59s 3s/step - loss: 1.1447 - accuracy: 0.5386
22/22 [=====] - 60s 3s/step - loss: 1.1655 - accuracy: 0.5500
Epoch 15/50
22/22 [=====] - 59s 3s/step - loss: 1.1121 - accuracy: 0.5600
22/22 [=====] - 60s 3s/step - loss: 1.0493 - accuracy: 0.5993
Epoch 16/50
22/22 [=====] - 59s 3s/step - loss: 1.0995 - accuracy: 0.5556
22/22 [=====] - 60s 3s/step - loss: 1.0702 - accuracy: 0.5923
Epoch 17/50
22/22 [=====] - 62s 3s/step - loss: 1.0671 - accuracy: 0.6151
22/22 [=====] - 61s 3s/step - loss: 1.0723 - accuracy: 0.5756
Epoch 18/50
22/22 [=====] - 60s 3s/step - loss: 1.0173 - accuracy: 0.5680
22/22 [=====] - 59s 3s/step - loss: 0.9938 - accuracy: 0.5930
Epoch 19/50
22/22 [=====] - 60s 3s/step - loss: 1.0458 - accuracy: 0.5990
22/22 [=====] - 60s 3s/step - loss: 0.9964 - accuracy: 0.6338
Epoch 20/50
22/22 [=====] - 61s 3s/step - loss: 0.9603 - accuracy: 0.6494
22/22 [=====] - 61s 3s/step - loss: 0.9469 - accuracy: 0.6650
Epoch 21/50
22/22 [=====] - 62s 3s/step - loss: 0.9461 - accuracy: 0.6608
22/22 [=====] - 63s 3s/step - loss: 0.9037 - accuracy: 0.6673
Epoch 22/50
22/22 [=====] - 62s 3s/step - loss: 0.9013 - accuracy: 0.6530
22/22 [=====] - 60s 3s/step - loss: 0.8838 - accuracy: 0.6296
Epoch 23/50
22/22 [=====] - 60s 3s/step - loss: 0.8770 - accuracy: 0.6491
22/22 [=====] - 60s 3s/step - loss: 0.8015 - accuracy: 0.6982
Epoch 24/50
22/22 [=====] - 59s 3s/step - loss: 0.7981 - accuracy: 0.7163
22/22 [=====] - 60s 3s/step - loss: 0.8196 - accuracy: 0.7001
Epoch 25/50
22/22 [=====] - 59s 3s/step - loss: 0.8021 - accuracy: 0.7219
22/22 [=====] - 59s 3s/step - loss: 0.7502 - accuracy: 0.7155
Epoch 26/50
22/22 [=====] - 59s 3s/step - loss: 0.8040 - accuracy: 0.7058
22/22 [=====] - 60s 3s/step - loss: 0.7917 - accuracy: 0.6940
Epoch 27/50
22/22 [=====] - 60s 3s/step - loss: 0.7433 - accuracy: 0.7285
22/22 [=====] - 60s 3s/step - loss: 0.7371 - accuracy: 0.7531
Epoch 28/50
22/22 [=====] - 59s 3s/step - loss: 0.7385 - accuracy: 0.7429
22/22 [=====] - 60s 3s/step - loss: 0.7162 - accuracy: 0.7273
Epoch 29/50
22/22 [=====] - 62s 3s/step - loss: 0.6815 - accuracy: 0.7270
22/22 [=====] - 62s 3s/step - loss: 0.6815 - accuracy: 0.7270
```

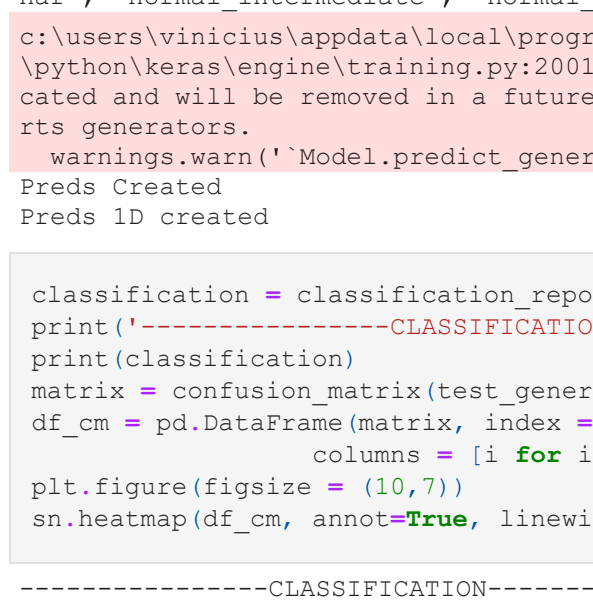
```
In [13]: #Validando o modelo
loss_train, train_acc = model.evaluate_generator(train_generator, steps=step_size_train)
loss_test, test_acc = model.evaluate_generator(test_generator, steps=step_size_test)
print('Train: %.3f, Test: %.3f' % (train_acc, test_acc))

Train: 0.906, Test: 0.542
```

```
In [14]: #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 [15]: # Criando graficos para visualização dos resultados
print()
print('Accuracy')
plt.plot(history.history['accuracy'], label='train')
plt.plot(history.history['val_accuracy'], label='test')
plt.legend()
plt.show()
```

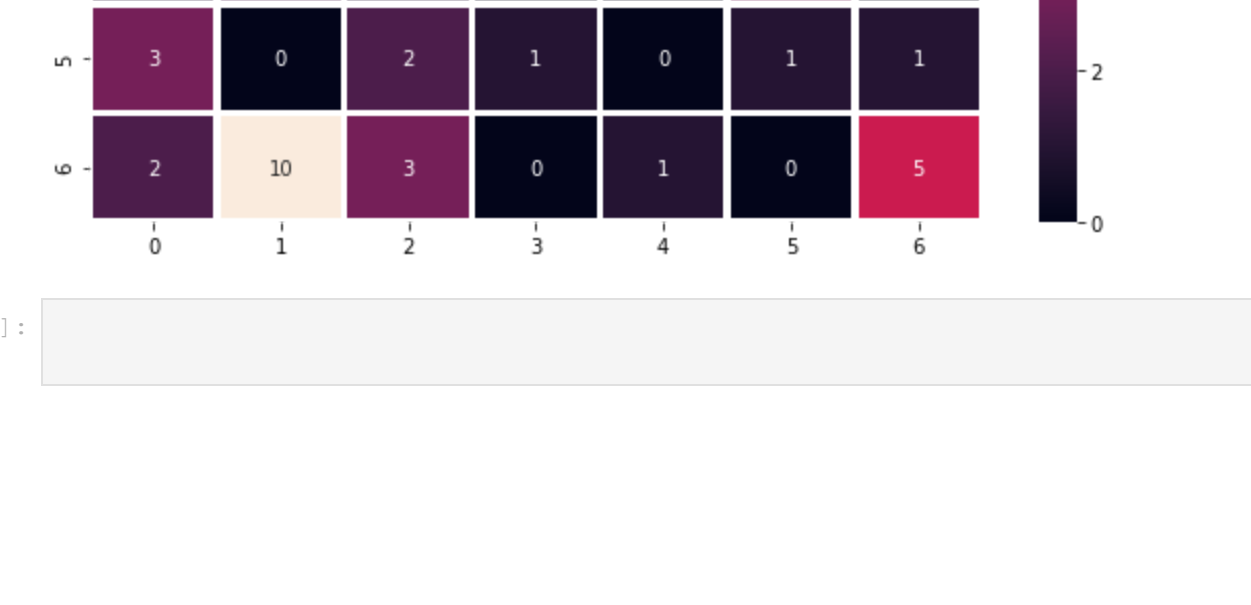


```
In [16]: print('Criando classificações...')
labels = os.listdir('Database')
print('Rótulos:', labels)
#criando estruturas para métricas de avaliação, processo um pouco mais demorado
y_pred = model.predict_generator(test_generator)
print('Preds Created')
y_pred = np.argmax(y_pred, axis=1)
print('Preds 1D created')
```

```
In [18]: print(classification_report(test_generator.classes, y_pred, target_names=Labels))
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))
sm.feature(df_cm, annot=True, linewidths=2.5)
```

	precision	recall	f1-score	support
carcinoma_in_situ	0.09	0.13	0.11	15
light_dysplastic	0.16	0.21	0.18	19
moderate_dysplastic	0.12	0.12	0.12	16
normal_columnar	0.00	0.00	0.00	11
normal_intermediate	0.00	0.00	0.00	7
normal_superficial	0.10	0.12	0.11	8
severe_dysplastic	0.36	0.24	0.29	21
accuracy			0.14	97
macro avg	0.12	0.12	0.12	97
weighted avg	0.15	0.14	0.14	97

```
Out[18]: <AxesSubplot:~>
```



```
In [ ]:
```