

DEEP LEARNING PROJECT INFNET

DESAFIO

Utilize a base Animals-10- originalmente do Kaggle (5000 imagens de 10 animais diferentes), mas disponibilizada em uma versão menor aqui;

- Utilizando um modelo pré-treinado ResNet-50 (presente no Tensorflow/Keras), e realize as extrações de características, fazendo a projeção das imagens no espaço característico (penúltima camada da ResNet-50);
- Realize a clusterização dos vetores obtidos usando o algoritmo K-médias (K=10);
- Mostre exemplos de imagens dos 10 clusters obtidos;
- Os resultados foram satisfatórios? Justifique utilizando seus conhecimentos sobre avaliação de clusters;

importando as libs necessárias

```
In [ ]: import numpy as np
import tensorflow as tf
from tensorflow.keras.applications.resnet50 import ResNet50, preprocess_input
from tensorflow.keras.preprocessing.image import load_img, img_to_array
from sklearn.cluster import KMeans
import os
import matplotlib.pyplot as plt
from tqdm import tqdm
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.preprocessing import LabelEncoder
```

```
In [ ]: pip freeze requirements.txt
```

```
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beautifulsoup4==4.12.2
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google-api-python-client==2.82.0
google-auth==2.16.2
google-auth-httplib2==0.1.0
google-auth-oauthlib==0.4.6
google-pasta==0.2.0
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```

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Keras-Preprocessing==1.1.2
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numpy==1.23.5
nvidia-pyindex==1.0.9
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pywin32==305.1
pyzmq @ file:///C:/ci/pyzmq_1657616000714/work
```

```

regex==2023.3.23
requests==2.28.2
requests-oauthlib==1.3.1
rsa==4.9
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84/work
scikit-learn==1.2.2
scipy==1.10.1
seaborn==0.12.2
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SQLAlchemy-Utils==0.40.0
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tenacity==8.2.2
tensorboard==2.9.1
tensorboard-data-server==0.6.1
tensorboard-plugin-wit==1.8.1
tensorflow==2.9.3
tensorflow-estimator==2.9.0
tensorflow-intel==2.12.0
tensorflow-io-gcs-filesystem==0.31.0
termcolor==2.3.0
threadpoolctl==3.1.0
tiny.css==1.2.1
toolz @ file:///C:/b/abs_cfvk6rc40d/croot/toolz_1667464080130/work
tornado @ file:///C:/ci/tornado_1662476985533/work
tqdm @ file:///C:/b/abs_f76j9hg7pv/croot/tqdm_1679561871187/work
traitlets @ file:///C:/b/abs_e5m_xjj194/croot/traitlets_1671143896266/work
typing_extensions==4.5.0
uritemplate==4.1.1
urllib3 @ file:///C:/b/abs_3ce53vrdcr/croot/urllib3_1680254693505/work
vaderSentiment==3.3.2
wcwidth @ file:///Users/ktietz/demo/mc3/conda-bld/wcwidth_1629357192024/work
webencodings==0.5.1
Werkzeug==2.3.4
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wrapt==1.14.1
xgboost==1.7.5
xlrd==2.0.1
zstandard==0.19.0
Note: you may need to restart the kernel to use updated packages.

WARNING: Ignoring invalid distribution -ensorflow (e:\miniconda3\envs\bootcamp\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf (e:\miniconda3\envs\bootcamp\lib\site-packages)

```

Criando uma reproduibilidade no modelo, com isso poderemos variar as seeds e assim ter uma precisão mais assertiva de uma reprodução.

```
In [ ]: seed = 52
def set_seed(seed):
    np.random.seed(seed)
    tf.random.set_seed(seed)
set_seed(seed)
```

Carregando o modelo da resnet50 - como manda o enunciado.

```
In [ ]: model = ResNet50(weights='imagenet', include_top=False)
model.summary()
```

Model: "resnet50"

Layer (type)	Output Shape	Param #	Connected to
<hr/>			
input_1 (InputLayer)	[None, None, None, 3]	0	[]
conv1_pad (ZeroPadding2D) [0]'	(None, None, None, 0 3)	0	['input_1[0]
conv1_conv (Conv2D) [0]'	(None, None, None, 64)	9472	['conv1_pad[0]
conv1_bn (BatchNormalization) [0]'	(None, None, None, 64)	256	['conv1_conv[0]
conv1_relu (Activation) [0]'	(None, None, None, 64)	0	['conv1_bn[0]
pool1_pad (ZeroPadding2D) [0]'	(None, None, None, 64)	0	['conv1_relu[0]
pool1_pool (MaxPooling2D) [0]'	(None, None, None, 0)	0	['pool1_pad[0]

Layer (type)	Output Shape	Param #	Connected to
<hr/>			
input_1 (InputLayer)	[None, None, None, 3]	0	[]
conv1_pad (ZeroPadding2D) [0]'	(None, None, None, 0 3)	0	['input_1[0]
conv1_conv (Conv2D) [0]'	(None, None, None, 64)	9472	['conv1_pad[0]
conv1_bn (BatchNormalization) [0]'	(None, None, None, 64)	256	['conv1_conv[0]
conv1_relu (Activation) [0]'	(None, None, None, 64)	0	['conv1_bn[0]
pool1_pad (ZeroPadding2D) [0]'	(None, None, None, 64)	0	['conv1_relu[0]
pool1_pool (MaxPooling2D)	(None, None, None, 0)	0	['pool1_pad[0]

```
[0]']
64)

conv2_block1_1_conv (Conv2D) (None, None, None, 4160 ['pool1_pool[0]
[0]')
64)

conv2_block1_1_bn (BatchNormal _conv[0][0]' (None, None, None, 256 ['conv2_block1_1
_ization)
64)

conv2_block1_1_relu (Activatio _bn[0][0]' (None, None, None, 0 ['conv2_block1_1
n)
64)

conv2_block1_2_conv (Conv2D) (None, None, None, 36928 ['conv2_block1_1
_relu[0][0]')
64)

conv2_block1_2_bn (BatchNormal _conv[0][0]' (None, None, None, 256 ['conv2_block1_2
_ization)
64)

conv2_block1_2_relu (Activatio _bn[0][0]' (None, None, None, 0 ['conv2_block1_2
n)
64)

conv2_block1_0_conv (Conv2D) (None, None, None, 16640 ['pool1_pool[0]
[0]')
256)

conv2_block1_3_conv (Conv2D) (None, None, None, 16640 ['conv2_block1_2
_relu[0][0]')
256)

conv2_block1_0_bn (BatchNormal _conv[0][0]' (None, None, None, 1024 ['conv2_block1_0
_ization)
256)

conv2_block1_3_bn (BatchNormal _conv[0][0]' (None, None, None, 1024 ['conv2_block1_3
_ization)
256)

conv2_block1_add (Add) (None, None, None, 0 ['conv2_block1_0
_bn[0][0]', 256)
'conv2_block1_3
_bn[0][0]']

conv2_block1_out (Activation) (None, None, None, 0 ['conv2_block1_a
dd[0][0]')
256)

conv2_block2_1_conv (Conv2D) (None, None, None, 16448 ['conv2_block1_o
ut[0][0]')
64)

conv2_block2_1_bn (BatchNormal _conv[0][0]' (None, None, None, 256 ['conv2_block2_1
_ization)
64)
```

conv2_block2_1_relu (Activation)	(None, None, None, 0 _bn[0][0]')	n)	64)		['conv2_block2_1
conv2_block2_2_conv (Conv2D)	(None, None, None, 36928 _relu[0][0]')		64)		['conv2_block2_1
conv2_block2_2_bn (BatchNormal	(None, None, None, 256 _conv[0][0]')	ization)	64)		['conv2_block2_2
conv2_block2_2_relu (Activatio	(None, None, None, 0 _bn[0][0]')	n)	64)		['conv2_block2_2
conv2_block2_3_conv (Conv2D)	(None, None, None, 16640 _relu[0][0]')		256)		['conv2_block2_2
conv2_block2_3_bn (BatchNormal	(None, None, None, 1024 _conv[0][0]')	ization)	256)		['conv2_block2_3
conv2_block2_add (Add)	(None, None, None, 0 ut[0][0]',		256)		['conv2_block1_o
_bn[0][0]']					'conv2_block2_3
conv2_block2_out (Activation)	(None, None, None, 0 dd[0][0]')		256)		['conv2_block2_a
conv2_block3_1_conv (Conv2D)	(None, None, None, 16448 ut[0][0]')		64)		['conv2_block2_o
conv2_block3_1_bn (BatchNormal	(None, None, None, 256 _conv[0][0]')	ization)	64)		['conv2_block3_1
conv2_block3_1_relu (Activatio	(None, None, None, 0 _bn[0][0]')	n)	64)		['conv2_block3_1
conv2_block3_2_conv (Conv2D)	(None, None, None, 36928 _relu[0][0]')		64)		['conv2_block3_1
conv2_block3_2_bn (BatchNormal	(None, None, None, 256 _conv[0][0]')	ization)	64)		['conv2_block3_2
conv2_block3_2_relu (Activatio	(None, None, None, 0 _bn[0][0]')	n)	64)		['conv2_block3_2
conv2_block3_3_conv (Conv2D)	(None, None, None, 16640 _relu[0][0]')		256)		['conv2_block3_2

conv2_block3_3_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 256)	1024	['conv2_block3_3 _bn[0][0]']
conv2_block3_add (Add) ut[0][0]', _bn[0][0]'	(None, None, None, 256)	0	['conv2_block2_o 'conv2_block3_3 _bn[0][0]']
conv2_block3_out (Activation) dd[0][0]'	(None, None, None, 256)	0	['conv2_block3_a dd[0][0]']
conv3_block1_1_conv (Conv2D) ut[0][0]'	(None, None, None, 128)	32896	['conv2_block3_o ut[0][0]']
conv3_block1_1_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 128)	512	['conv3_block1_1 _bn[0][0]']
conv3_block1_1_relu (Activatio _bn[0][0]'] n)	(None, None, None, 128)	0	['conv3_block1_1 _bn[0][0]']
conv3_block1_2_conv (Conv2D) _relu[0][0]'	(None, None, None, 128)	147584	['conv3_block1_1 _relu[0][0]']
conv3_block1_2_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 128)	512	['conv3_block1_2 _conv[0][0]']
conv3_block1_2_relu (Activatio _bn[0][0]'] n)	(None, None, None, 128)	0	['conv3_block1_2 _bn[0][0]']
conv3_block1_0_conv (Conv2D) ut[0][0]'	(None, None, None, 512)	131584	['conv2_block3_o ut[0][0]']
conv3_block1_3_conv (Conv2D) _relu[0][0]'	(None, None, None, 512)	66048	['conv3_block1_2 _relu[0][0]']
conv3_block1_0_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 512)	2048	['conv3_block1_0 _conv[0][0]']
conv3_block1_3_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 512)	2048	['conv3_block1_3 _conv[0][0]']
conv3_block1_add (Add) _bn[0][0]', _bn[0][0]'	(None, None, None, 512)	0	['conv3_block1_0 'conv3_block1_3 _bn[0][0]']
conv3_block1_out (Activation)	(None, None, None, 0)	0	['conv3_block1_a dd[0][0]']

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dd[0][0]']
      512)

conv3_block2_1_conv (Conv2D)  (None, None, None,   65664      ['conv3_block1_o
ut[0][0]']
      128)

conv3_block2_1_bn (BatchNormal (None, None, None,   512       ['conv3_block2_1
_conv[0][0]']
      128)      128)

conv3_block2_1_relu (Activatio (None, None, None,   0        ['conv3_block2_1
_bn[0][0]']
      128)      128)

conv3_block2_2_conv (Conv2D)  (None, None, None,   147584     ['conv3_block2_1
_relu[0][0]']
      128)

conv3_block2_2_bn (BatchNormal (None, None, None,   512       ['conv3_block2_2
_conv[0][0]']
      128)      128)

conv3_block2_2_relu (Activatio (None, None, None,   0        ['conv3_block2_2
_bn[0][0]']
      128)      128)

conv3_block2_3_conv (Conv2D)  (None, None, None,   66048      ['conv3_block2_2
_relu[0][0]']
      512)

conv3_block2_3_bn (BatchNormal (None, None, None,   2048      ['conv3_block2_3
_conv[0][0]']
      512)      512)

conv3_block2_add (Add)       (None, None, None,   0        ['conv3_block1_o
ut[0][0]',      512)
      _bn[0][0]']

conv3_block2_out (Activation) (None, None, None,   0        ['conv3_block2_a
dd[0][0]']
      512)

conv3_block3_1_conv (Conv2D)  (None, None, None,   65664      ['conv3_block2_o
ut[0][0]']
      128)

conv3_block3_1_bn (BatchNormal (None, None, None,   512       ['conv3_block3_1
_conv[0][0]']
      128)      128)

conv3_block3_1_relu (Activatio (None, None, None,   0        ['conv3_block3_1
_bn[0][0]']
      128)      128)

conv3_block3_2_conv (Conv2D)  (None, None, None,   147584     ['conv3_block3_1
_relu[0][0]']
      128)

```

conv3_block3_2_bn (BatchNormal _conv[0][0]) ization)	(None, None, None, 128)	512	['conv3_block3_2
conv3_block3_2_relu (Activatio _bn[0][0]) n)	(None, None, None, 128)	0	['conv3_block3_2
conv3_block3_3_conv (Conv2D) _relu[0][0])	(None, None, None, 512)	66048	['conv3_block3_2
conv3_block3_3_bn (BatchNormal _conv[0][0]) ization)	(None, None, None, 512)	2048	['conv3_block3_3
conv3_block3_add (Add) ut[0][0], _bn[0][0])	(None, None, None, 512)	0	['conv3_block2_o 'conv3_block3_3
conv3_block3_out (Activation) dd[0][0])	(None, None, None, 512)	0	['conv3_block3_a
conv3_block4_1_conv (Conv2D) ut[0][0])	(None, None, None, 128)	65664	['conv3_block3_o
conv3_block4_1_bn (BatchNormal _conv[0][0]) ization)	(None, None, None, 128)	512	['conv3_block4_1
conv3_block4_1_relu (Activatio _bn[0][0]) n)	(None, None, None, 128)	0	['conv3_block4_1
conv3_block4_2_conv (Conv2D) _relu[0][0])	(None, None, None, 128)	147584	['conv3_block4_1
conv3_block4_2_bn (BatchNormal _conv[0][0]) ization)	(None, None, None, 128)	512	['conv3_block4_2
conv3_block4_2_relu (Activatio _bn[0][0]) n)	(None, None, None, 128)	0	['conv3_block4_2
conv3_block4_3_conv (Conv2D) _relu[0][0])	(None, None, None, 512)	66048	['conv3_block4_2
conv3_block4_3_bn (BatchNormal _conv[0][0]) ization)	(None, None, None, 512)	2048	['conv3_block4_3
conv3_block4_add (Add) ut[0][0], _bn[0][0])	(None, None, None, 512)	0	['conv3_block3_o 'conv3_block4_3

```

    _bn[0][0]']

    conv3_block4_out (Activation)  (None, None, None,      0      ['conv3_block4_a
dd[0][0]']
                                512)

    conv4_block1_1_conv (Conv2D)   (None, None, None,      131328   ['conv3_block4_o
ut[0][0]']
                                256)

    conv4_block1_1_bn (BatchNormal (None, None, None,      1024    ['conv4_block1_1
_conv[0][0]']
                                256)   ization)

    conv4_block1_1_relu (Activatio (None, None, None,      0      ['conv4_block1_1
_bn[0][0]']
                                256)   n)

    conv4_block1_2_conv (Conv2D)   (None, None, None,      590080   ['conv4_block1_1
_relu[0][0]']
                                256)

    conv4_block1_2_bn (BatchNormal (None, None, None,      1024    ['conv4_block1_2
_conv[0][0]']
                                256)   ization)

    conv4_block1_2_relu (Activatio (None, None, None,      0      ['conv4_block1_2
_bn[0][0]']
                                256)   n)

    conv4_block1_0_conv (Conv2D)   (None, None, None,      525312   ['conv3_block4_o
ut[0][0]']
                                1024)

    conv4_block1_3_conv (Conv2D)   (None, None, None,      263168   ['conv4_block1_2
_relu[0][0]']
                                1024)

    conv4_block1_0_bn (BatchNormal (None, None, None,      4096    ['conv4_block1_0
_conv[0][0]']
                                1024)   ization)

    conv4_block1_3_bn (BatchNormal (None, None, None,      4096    ['conv4_block1_3
_conv[0][0]']
                                1024)   ization)

    conv4_block1_add (Add)        (None, None, None,      0      ['conv4_block1_0
_bn[0][0]',           'conv4_block1_3
                                1024)
                                _bn[0][0]']

    conv4_block1_out (Activation) (None, None, None,      0      ['conv4_block1_a
dd[0][0]']
                                1024)

    conv4_block2_1_conv (Conv2D)   (None, None, None,      262400   ['conv4_block1_o
ut[0][0]']
                                256)

    conv4_block2_1_bn (BatchNormal (None, None, None,      1024    ['conv4_block2_1

```

```

_conv[0][0]']
    ization)           256)

    conv4_block2_1_relu (Activatio (None, None, None,   0      ['conv4_block2_1
    _bn[0][0]']
    n)                  256)

    conv4_block2_2_conv (Conv2D)  (None, None, None,   590080   ['conv4_block2_1
    _relu[0][0]']
                                256)

    conv4_block2_2_bn (BatchNormal (None, None, None,   1024   ['conv4_block2_2
    _conv[0][0]']
    ization)           256)

    conv4_block2_2_relu (Activatio (None, None, None,   0      ['conv4_block2_2
    _bn[0][0]']
    n)                  256)

    conv4_block2_3_conv (Conv2D)  (None, None, None,   263168   ['conv4_block2_2
    _relu[0][0]']
                                1024)

    conv4_block2_3_bn (BatchNormal (None, None, None,   4096   ['conv4_block2_3
    _conv[0][0]']
    ization)           1024)

    conv4_block2_add (Add)       (None, None, None,   0      ['conv4_block1_o
    ut[0][0]',          1024)
    _bn[0][0]']

    conv4_block2_out (Activation) (None, None, None,   0      ['conv4_block2_a
    dd[0][0]']
                                1024)

    conv4_block3_1_conv (Conv2D)  (None, None, None,   262400   ['conv4_block2_o
    ut[0][0]']
                                256)

    conv4_block3_1_bn (BatchNormal (None, None, None,   1024   ['conv4_block3_1
    _conv[0][0]']
    ization)           256)

    conv4_block3_1_relu (Activatio (None, None, None,   0      ['conv4_block3_1
    _bn[0][0]']
    n)                  256)

    conv4_block3_2_conv (Conv2D)  (None, None, None,   590080   ['conv4_block3_1
    _relu[0][0]']
                                256)

    conv4_block3_2_bn (BatchNormal (None, None, None,   1024   ['conv4_block3_2
    _conv[0][0]']
    ization)           256)

    conv4_block3_2_relu (Activatio (None, None, None,   0      ['conv4_block3_2
    _bn[0][0]']
    n)                  256)

```

conv4_block3_3_conv (Conv2D) _relu[0][0]'	(None, None, None, 1024)	263168	['conv4_block3_2
conv4_block3_3_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 1024)	4096	['conv4_block3_3
conv4_block3_add (Add) ut[0][0]', _bn[0][0]'	(None, None, None, 1024)	0	['conv4_block2_o 'conv4_block3_3
conv4_block3_out (Activation) dd[0][0]'	(None, None, None, 1024)	0	['conv4_block3_a
conv4_block4_1_conv (Conv2D) ut[0][0]'	(None, None, None, 256)	262400	['conv4_block3_o
conv4_block4_1_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 256)	1024	['conv4_block4_1
conv4_block4_1_relu (Activatio n)	(None, None, None, 256)	0	['conv4_block4_1
conv4_block4_2_conv (Conv2D) _relu[0][0]'	(None, None, None, 256)	590080	['conv4_block4_1
conv4_block4_2_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 256)	1024	['conv4_block4_2
conv4_block4_2_relu (Activatio n)	(None, None, None, 256)	0	['conv4_block4_2
conv4_block4_3_conv (Conv2D) _relu[0][0]'	(None, None, None, 1024)	263168	['conv4_block4_2
conv4_block4_3_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 1024)	4096	['conv4_block4_3
conv4_block4_add (Add) ut[0][0]', _bn[0][0]'	(None, None, None, 1024)	0	['conv4_block3_o 'conv4_block4_3
conv4_block4_out (Activation) dd[0][0]'	(None, None, None, 1024)	0	['conv4_block4_a
conv4_block5_1_conv (Conv2D) ut[0][0]'	(None, None, None, 262400)	262400	['conv4_block4_o

```

        256)

conv4_block5_1_bn (BatchNormal (None, None, None, 1024      ['conv4_block5_1
_conv[0][0]')
    ization)                256)

conv4_block5_1_relu (Activatio (None, None, None, 0      ['conv4_block5_1
_bn[0][0]')
    n)                      256)

conv4_block5_2_conv (Conv2D)  (None, None, None, 590080     ['conv4_block5_1
_relu[0][0]')
                                256)

conv4_block5_2_bn (BatchNormal (None, None, None, 1024      ['conv4_block5_2
_conv[0][0]')
    ization)                256)

conv4_block5_2_relu (Activatio (None, None, None, 0      ['conv4_block5_2
_bn[0][0]')
    n)                      256)

conv4_block5_3_conv (Conv2D)  (None, None, None, 263168     ['conv4_block5_2
_relu[0][0]')
                                1024)

conv4_block5_3_bn (BatchNormal (None, None, None, 4096      ['conv4_block5_3
_conv[0][0]')
    ization)                1024)

conv4_block5_add (Add)       (None, None, None, 0      ['conv4_block4_o
ut[0][0]',           1024)
    _bn[0][0'])

conv4_block5_out (Activation) (None, None, None, 0      ['conv4_block5_a
dd[0][0]')
                                1024)

conv4_block6_1_conv (Conv2D)  (None, None, None, 262400     ['conv4_block5_o
ut[0][0]')
                                256)

conv4_block6_1_bn (BatchNormal (None, None, None, 1024      ['conv4_block6_1
_conv[0][0]')
    ization)                256)

conv4_block6_1_relu (Activatio (None, None, None, 0      ['conv4_block6_1
_bn[0][0]')
    n)                      256)

conv4_block6_2_conv (Conv2D)  (None, None, None, 590080     ['conv4_block6_1
_relu[0][0]')
                                256)

conv4_block6_2_bn (BatchNormal (None, None, None, 1024      ['conv4_block6_2
_conv[0][0]')
    ization)                256)

conv4_block6_2_relu (Activatio (None, None, None, 0      ['conv4_block6_2
_bn[0][0]')
    n)

```

<code>_bn[0][0]' n)</code>	256)		
<code>conv4_block6_3_conv (Conv2D) _relu[0][0]'</code>	(None, None, None, 263168 1024)		['conv4_block6_2
<code>conv4_block6_3_bn (BatchNormal _conv[0][0]'</code>	(None, None, None, 4096 1024)		['conv4_block6_3
<code>conv4_block6_add (Add) ut[0][0]', _bn[0][0]'</code>	(None, None, None, 0 1024)		['conv4_block5_o 'conv4_block6_3
<code>conv4_block6_out (Activation) dd[0][0]'</code>	(None, None, None, 0 1024)		['conv4_block6_a
<code>conv5_block1_1_conv (Conv2D) ut[0][0]'</code>	(None, None, None, 524800 512)		['conv4_block6_o
<code>conv5_block1_1_bn (BatchNormal _conv[0][0]'</code>	(None, None, None, 2048 512)		['conv5_block1_1
<code>conv5_block1_1_relu (Activatio _bn[0][0]'</code>	(None, None, None, 0 512)		['conv5_block1_1
<code>conv5_block1_2_conv (Conv2D) _relu[0][0]'</code>	(None, None, None, 2359808 512)		['conv5_block1_1
<code>conv5_block1_2_bn (BatchNormal _conv[0][0]'</code>	(None, None, None, 2048 512)		['conv5_block1_2
<code>conv5_block1_2_relu (Activatio _bn[0][0]'</code>	(None, None, None, 0 512)		['conv5_block1_2
<code>conv5_block1_0_conv (Conv2D) ut[0][0]'</code>	(None, None, None, 2099200 2048)		['conv4_block6_o
<code>conv5_block1_3_conv (Conv2D) _relu[0][0]'</code>	(None, None, None, 1050624 2048)		['conv5_block1_2
<code>conv5_block1_0_bn (BatchNormal _conv[0][0]'</code>	(None, None, None, 8192 2048)		['conv5_block1_0
<code>conv5_block1_3_bn (BatchNormal _conv[0][0]'</code>	(None, None, None, 8192 2048)		['conv5_block1_3

conv5_block1_add (Add) _bn[0][0]', _bn[0][0]'	(None, None, None, 0 2048)	['conv5_block1_0 'conv5_block1_3
conv5_block1_out (Activation) dd[0][0]'	(None, None, None, 0 2048)	['conv5_block1_a
conv5_block2_1_conv (Conv2D) ut[0][0]'	(None, None, None, 1049088 512)	['conv5_block1_o
conv5_block2_1_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 2048 512)	['conv5_block2_1
conv5_block2_1_relu (Activatio _bn[0][0]' n)	(None, None, None, 0 512)	['conv5_block2_1
conv5_block2_2_conv (Conv2D) _relu[0][0]'	(None, None, None, 2359808 512)	['conv5_block2_1
conv5_block2_2_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 2048 512)	['conv5_block2_2
conv5_block2_2_relu (Activatio _bn[0][0]' n)	(None, None, None, 0 512)	['conv5_block2_2
conv5_block2_3_conv (Conv2D) _relu[0][0]'	(None, None, None, 1050624 2048)	['conv5_block2_2
conv5_block2_3_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 8192 2048)	['conv5_block2_3
conv5_block2_add (Add) ut[0][0]', _bn[0][0]'	(None, None, None, 0 2048)	['conv5_block1_o 'conv5_block2_3
conv5_block2_out (Activation) dd[0][0]'	(None, None, None, 0 2048)	['conv5_block2_a
conv5_block3_1_conv (Conv2D) ut[0][0]'	(None, None, None, 1049088 512)	['conv5_block2_o
conv5_block3_1_bn (BatchNormal _conv[0][0]' ization)	(None, None, None, 2048 512)	['conv5_block3_1
conv5_block3_1_relu (Activatio _bn[0][0]' n)	(None, None, None, 0 512)	['conv5_block3_1

```

n)                               512)

conv5_block3_2_conv (Conv2D)    (None, None, None,     2359808      ['conv5_block3_1
_relu[0][0]']
                                512)

conv5_block3_2_bn (BatchNormal (None, None, None,     2048       ['conv5_block3_2
_conv[0][0]']
                                512)
                                512)

conv5_block3_2_relu (Activatio (None, None, None,     0        ['conv5_block3_2
_bn[0][0]']
                                512)
                                512)

conv5_block3_3_conv (Conv2D)    (None, None, None,     1050624      ['conv5_block3_2
_relu[0][0]']
                                2048)

conv5_block3_3_bn (BatchNormal (None, None, None,     8192       ['conv5_block3_3
_conv[0][0]']
                                2048)
                                2048)

conv5_block3_add (Add)         (None, None, None,     0        ['conv5_block2_o
ut[0][0]',           2048)
                                2048)
                                2048)

conv5_block3_out (Activation) (None, None, None,     0        ['conv5_block3_a
dd[0][0]']
                                2048)
                                2048)

=====
=====

Total params: 23,587,712
Trainable params: 23,534,592
Non-trainable params: 53,120

```

Criando uma função para ler as imagens da pasta

```
In [ ]: def extract_images(path_images, model):
    images_list = []
    for path_img in tqdm(path_images):
        img = load_img(path_img, target_size=(224, 224))
        images = img_to_array(img)
        images = np.expand_dims(images, axis=0)
        images = preprocess_input(images)
        features = model.predict(images, verbose=0)
        images_list.append(features.flatten())
    return np.array(images_list)
```

Caminho das Imagens data é a pasta dos dados, data_ a subpasta

```
In [ ]: data = '../DATA'
data_ = [os.path.join(data, _data_) for _data_ in os.listdir(data)]
```

```
path_images = [os.path.join(_data_, filename) for _data_ in data_ for filename in
```

realizando a extração das imagens usando a resnet 50

```
In [ ]: image = extract_images(path_images, model)
```

100% |██████████| 5000/5000 [05:39<00:00, 14.73it/s]

Realizando a Clusterização utilizando o kmédias e 10 clusters

```
In [ ]: kmeans = KMeans(n_clusters=10, n_init='auto', random_state=seed)
predicted_labels = kmeans.fit_predict(image)
```

De acordo com a boa prática, criar uma função para mostrar as imagens

```
In [ ]: def image_show(path_images, labels, cluster_id):
    cluster_indices = np.where(labels == cluster_id)[0]
    sample_indices = np.random.choice(cluster_indices, 5, replace=False)
    plt.figure(figsize=(14, 5))
    for i, idx in enumerate(sample_indices):
        plt.subplot(1, 5, i+1)
        img = load_img(path_images[idx], target_size=(224, 224))
        plt.imshow(img)
        plt.axis('off')
    plt.show()
```

Exibindo as imagens

```
In [ ]: for cluster_id in range(10):
    print(f"Cluster {cluster_id}:")
    image_show(path_images, predicted_labels, cluster_id)
```

Cluster 0:



Cluster 1:



Cluster 2:



Cluster 3:



Cluster 4:



Cluster 5:



Cluster 6:



Cluster 7:



Cluster 8:



Cluster 9:



Organizando as labels

```
In [ ]: true_labels = [os.path.basename(os.path.dirname(path_img)) for path_img in path_
label_encoder = LabelEncoder()
true_labels_encoded = label_encoder.fit_transform(true_labels)
class_names = np.array(label_encoder.classes_)
```

Matriz de confusão

```
In [ ]: confusion = confusion_matrix(true_labels_encoded, predicted_labels)

In [ ]: order = np.argmax(confusion, axis=0)
confusion = confusion[order]
class_names = class_names[order]
ConfusionMatrixDisplay(confusion, display_labels=class_names).plot()
plt.xticks(rotation=90)
```

Mostrando a Acurácia

```
In [ ]: order = np.argmax(confusion, axis=0)
confusion = confusion[order]
class_names = class_names[order]

ConfusionMatrixDisplay(confusion, display_labels=class_names).plot()
plt.xticks(rotation=90)

accuracy = np.trace(confusion) / np.sum(confusion)
print(f'Accuracy: {accuracy * 100 :.2f}%')
```

Accuracy: 73.16%

