```
#Used to mount google drive to colab so that files can be accessed
from google drive
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
#Importing necessary libraries for this part of the project
from keras.utils import image_dataset_from_directory
import tensorflow as tf
# Directories
#specifying the directories where the datasets of train, validation
and test are stored
train_dirs = [
    '/content/drive/MyDrive/ProjetoIA/dataset/train1',
    '/content/drive/MyDrive/ProjetoIA/dataset/train2',
    '/content/drive/MyDrive/ProjetoIA/dataset/train4',
    '/content/drive/MyDrive/ProjetoIA/dataset/train5'
]
validation_dir = '/content/drive/MyDrive/ProjetoIA/dataset/train3'
test_dir = '/content/drive/MyDrive/ProjetoIA/dataset/test'

# Parameters
IMG_SIZE = 150
BATCH_SIZE = 32

# Function to load datasets from multiple directories and concatenate
them
def load_and_concatenate_datasets(directories, img_size, batch_size):
    datasets = []
    for directory in directories:
        dataset = image_dataset_from_directory(
            directory,
            image_size=(img_size, img_size),
            batch_size=batch_size
        )
        datasets.append(dataset)
    return datasets

# Load train datasets and concatenate
train_datasets = load_and_concatenate_datasets(train_dirs, IMG_SIZE,
BATCH_SIZE)
train_dataset = tf.data.Dataset.sample_from_datasets(train_datasets)

# Load validation and test datasets
validation_dataset = image_dataset_from_directory(
    validation_dir,
    image_size=(IMG_SIZE, IMG_SIZE),
    batch_size=BATCH_SIZE
)
```

```
test_dataset = image_dataset_from_directory(
    test_dir,
    image_size=(IMG_SIZE, IMG_SIZE),
    batch_size=BATCH_SIZE
)

# Extract class names from one of the datasets
example_dataset = image_dataset_from_directory(
    train_dirs[0],
    image_size=(IMG_SIZE, IMG_SIZE),
    batch_size=BATCH_SIZE
)
class_names = example_dataset.class_names
print(class_names)
```

```
Found 10400 files belonging to 10 classes.
Found 9600 files belonging to 10 classes.
Found 10000 files belonging to 10 classes.
Found 10000 files belonging to 10 classes.
Found 10000 files belonging to 10 classes.
Found 10000 files belonging to 1 classes.
Found 10400 files belonging to 10 classes.
['000_airplane', '001_automobile', '002_bird', '003_cat', '004_deer',
'005_dog', '006_frog', '007_horse', '008_ship', '009_truck']
```

```
#Let us first load the VGG16 model
from tensorflow.keras.applications.vgg16 import VGG16
conv_base = VGG16(weights='imagenet', include_top=False,
input_shape=(150, 150, 3))
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-
applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5
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```

```
from tensorflow import keras
import numpy as np
def get_features_and_labels(dataset):
  all_features = []
  all_labels = []
  for images, labels in dataset:
    preprocessed_images =
keras.applications.vgg16.preprocess_input(images)
    features = conv_base.predict(preprocessed_images)
    all_features.append(features)
    all_labels.append(labels)
  return np.concatenate(all_features), np.concatenate(all_labels)# tem
q se juntar a lista pra caber na rede
```

```
#This is the function that we useto compute the output of the
#feature extraction section for each of the datasets

# extract features and labels for each dataset
train_features, train_labels = get_features_and_labels(train_dataset)
val_features, val_labels = get_features_and_labels(validation_dataset)
test_features, test_labels = get_features_and_labels(test_dataset)
```

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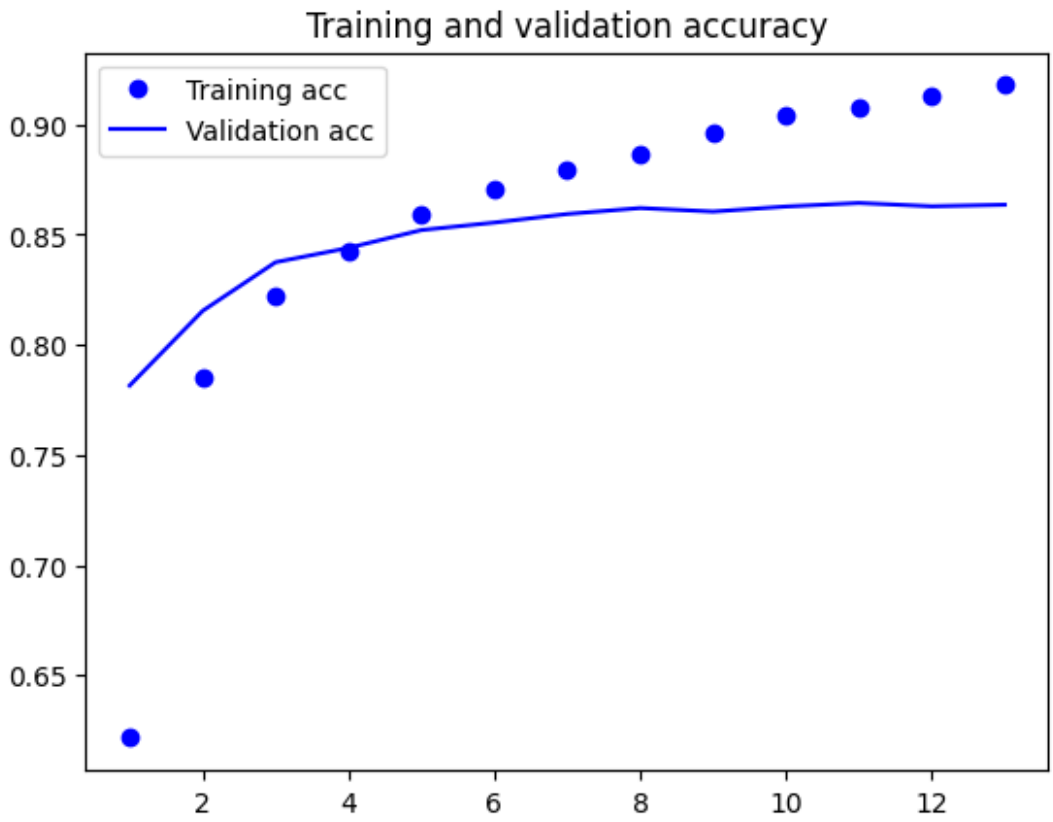
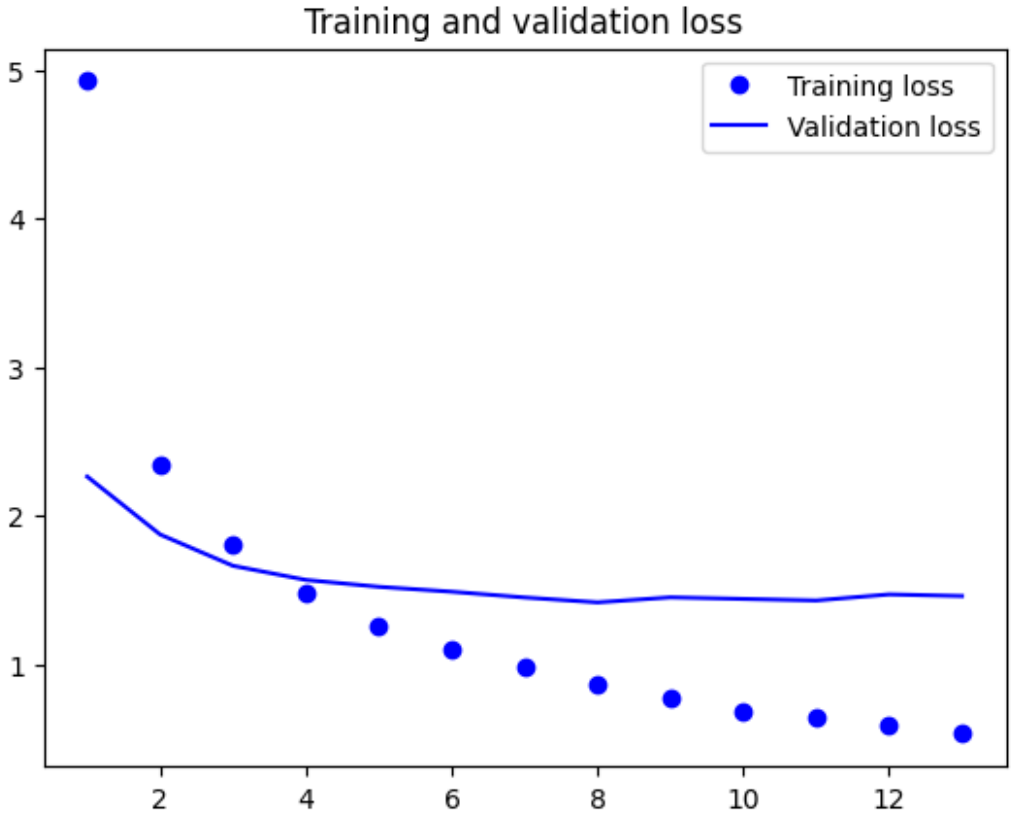
```
#Now, we build a dense network
#that will play the role of the
#classification section
#Because models behave just like layers, we can use them as any other
#layers to build a new model.

from tensorflow import keras
from keras import layers
inputs = keras.Input(shape=(4, 4, 512))#cada imagem gera um cubo,
formato de entrada do vgg16
x = layers.Flatten()(inputs)
x = layers.Dense(256)(x)
x = layers.Dropout(0.2)(x)#desliga 20% por entrada
outputs = layers.Dense(10, activation="softmax")(x)
model = keras.Model(inputs, outputs)

# Adding ModelCheckpoint callback
# and EarlyStopping callback of 5 epochs to avoid overfitting
checkpoint_cb = tf.keras.callbacks.ModelCheckpoint(

'/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best
.h5',
    save_best_only=True,
    monitor='val_loss',
    mode='min',
    verbose=1
)
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss',
                            patience=5,
                            verbose=1)
```

```
# Compile and train the model

model.compile(
 loss='sparse_categorical_crossentropy',
 optimizer=keras.optimizers.RMSprop(learning_rate=1e-5),
 metrics=['accuracy'])
history = model.fit(
  train_features, train_labels,
  epochs=25,
  validation_data=(val_features, val_labels),
  callbacks=[checkpoint_cb, early_stop])

Epoch 1/25
1249/1250 [============================>.] - ETA: 0s - loss: 4.9272 -
accuracy: 0.6214
Epoch 1: val_loss improved from inf to 2.26409, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 6s 4ms/step - loss:
4.9259 - accuracy: 0.6215 - val_loss: 2.2641 - val_accuracy: 0.7815
Epoch 2/25
1238/1250 [============================>.] - ETA: 0s - loss: 2.3438 -
accuracy: 0.7845
Epoch 2: val_loss improved from 2.26409 to 1.87422, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
2.3415 - accuracy: 0.7849 - val_loss: 1.8742 - val_accuracy: 0.8154
Epoch 3/25
1234/1250 [============================>.] - ETA: 0s - loss: 1.8065 -
accuracy: 0.8217
Epoch 3: val_loss improved from 1.87422 to 1.66329, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.8048 - accuracy: 0.8220 - val_loss: 1.6633 - val_accuracy: 0.8375
Epoch 4/25
1250/1250 [==============================] - ETA: 0s - loss: 1.4841 -
accuracy: 0.8429
Epoch 4: val_loss improved from 1.66329 to 1.56821, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.4841 - accuracy: 0.8429 - val_loss: 1.5682 - val_accuracy: 0.8440
Epoch 5/25
1241/1250 [============================>.] - ETA: 0s - loss: 1.2531 -
accuracy: 0.8588
Epoch 5: val_loss improved from 1.56821 to 1.52190, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
```

```
1250/1250 [==============================] - 4s 3ms/step - loss:
1.2524 - accuracy: 0.8590 - val_loss: 1.5219 - val_accuracy: 0.8521
Epoch 6/25
1238/1250 [============================>.] - ETA: 0s - loss: 1.1042 -
accuracy: 0.8709
Epoch 6: val_loss improved from 1.52190 to 1.48889, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.1046 - accuracy: 0.8709 - val_loss: 1.4889 - val_accuracy: 0.8555
Epoch 7/25
1250/1250 [==============================] - ETA: 0s - loss: 0.9783 -
accuracy: 0.8798
Epoch 7: val_loss improved from 1.48889 to 1.45005, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.9783 - accuracy: 0.8798 - val_loss: 1.4500 - val_accuracy: 0.8594
Epoch 8/25
1237/1250 [============================>.] - ETA: 0s - loss: 0.8678 -
accuracy: 0.8866
Epoch 8: val_loss improved from 1.45005 to 1.41707, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_without_DA_best.
h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.8660 - accuracy: 0.8866 - val_loss: 1.4171 - val_accuracy: 0.8621
Epoch 9/25
1234/1250 [============================>.] - ETA: 0s - loss: 0.7675 -
accuracy: 0.8958
Epoch 9: val_loss did not improve from 1.41707
1250/1250 [==============================] - 4s 3ms/step - loss:
0.7691 - accuracy: 0.8960 - val_loss: 1.4509 - val_accuracy: 0.8605
Epoch 10/25
1234/1250 [============================>.] - ETA: 0s - loss: 0.6829 -
accuracy: 0.9046
Epoch 10: val_loss did not improve from 1.41707
1250/1250 [==============================] - 4s 3ms/step - loss:
0.6859 - accuracy: 0.9046 - val_loss: 1.4403 - val_accuracy: 0.8628
Epoch 11/25
1233/1250 [============================>.] - ETA: 0s - loss: 0.6490 -
accuracy: 0.9078
Epoch 11: val_loss did not improve from 1.41707
1250/1250 [==============================] - 4s 3ms/step - loss:
0.6485 - accuracy: 0.9079 - val_loss: 1.4299 - val_accuracy: 0.8644
Epoch 12/25
1231/1250 [============================>.] - ETA: 0s - loss: 0.5836 -
accuracy: 0.9131
Epoch 12: val_loss did not improve from 1.41707
1250/1250 [==============================] - 4s 3ms/step - loss:
```

```
0.5847 - accuracy: 0.9133 - val_loss: 1.4708 - val_accuracy: 0.8629
Epoch 13/25
1242/1250 [============================>.] - ETA: 0s - loss: 0.5319 -
accuracy: 0.9178
Epoch 13: val_loss did not improve from 1.41707
1250/1250 [==============================] - 4s 3ms/step - loss:
0.5320 - accuracy: 0.9179 - val_loss: 1.4598 - val_accuracy: 0.8636
Epoch 13: early stopping

#Displaying curves of loss and accuracy

import matplotlib.pyplot as plt
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(acc) + 1)
plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.legend()
plt.figure()
plt.plot(epochs, loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()
plt.show()
```


Training and validation accuracy
Training acc
Validation acc
0.90
0.85
0.80
0.75
0.70
0.65
2
4
6
8
10
12


Training and validation loss
Training loss
Validation loss
5
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12

```
from keras import models
inputs = keras.Input(shape=(150, 150, 3))
x = keras.applications.vgg16.preprocess_input(inputs)
x = conv_base(x)
outputs = model(x)
full_model = keras.Model(inputs, outputs)

full_model.compile(
 loss='sparse_categorical_crossentropy',
 optimizer=keras.optimizers.RMSprop(learning_rate=1e-5),
 metrics=['accuracy'])

#• Now, we save the model
full_model.save('/content/drive/MyDrive/ProjetoIA/models/CNN_TL_FE_wit
hout_data_augmentation.h5')

#We can later load it and test it:
from tensorflow import keras
loaded_model =
keras.models.load_model('/content/drive/MyDrive/ProjetoIA/models/model
oT_TL_FE_without_DA_best.h5')
# case been loaded change bellow full_model->loaded_model

WARNING:tensorflow:No training configuration found in the save file,
so the model was *not* compiled. Compile it manually.

# case been loaded change bellow full_model->loaded_model
val_loss, val_acc = full_model.evaluate(validation_dataset)
print('val_acc:', val_acc)

313/313 [==============================] - 14s 44ms/step - loss:
1.4598 - accuracy: 0.8636
val_acc: 0.8636000156402588
```

Foram avaliados 313 batches no conjunto de validação Perda calculada no conjunto de validação 1.4598 Previsão do conjunto de validação com 86.36% das previsões foram corretas.