```
#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.
# Data augmentation

from tensorflow import keras
from keras import layers
data_augmentation = keras.Sequential(
    [
        layers.RandomFlip("horizontal"),
        layers.RandomRotation(0.1),
        layers.RandomZoom(0.2),
    ]
)
from tensorflow import keras
from keras import layers
inputs = keras.Input(shape=(4, 4, 512))#cada imagem gera um cubo
x = data_augmentation(inputs)
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_with_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
1237/1250 [============================>.] - ETA: 0s - loss: 5.0448 -
accuracy: 0.6199
Epoch 1: val_loss improved from inf to 2.27647, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5

/usr/local/lib/python3.10/dist-packages/keras/src/engine/
training.py:3103: UserWarning: You are saving your model as an HDF5
file via `model.save()`. This file format is considered legacy. We
recommend using instead the native Keras format, e.g.
`model.save('my_model.keras')`.
  saving_api.save_model(

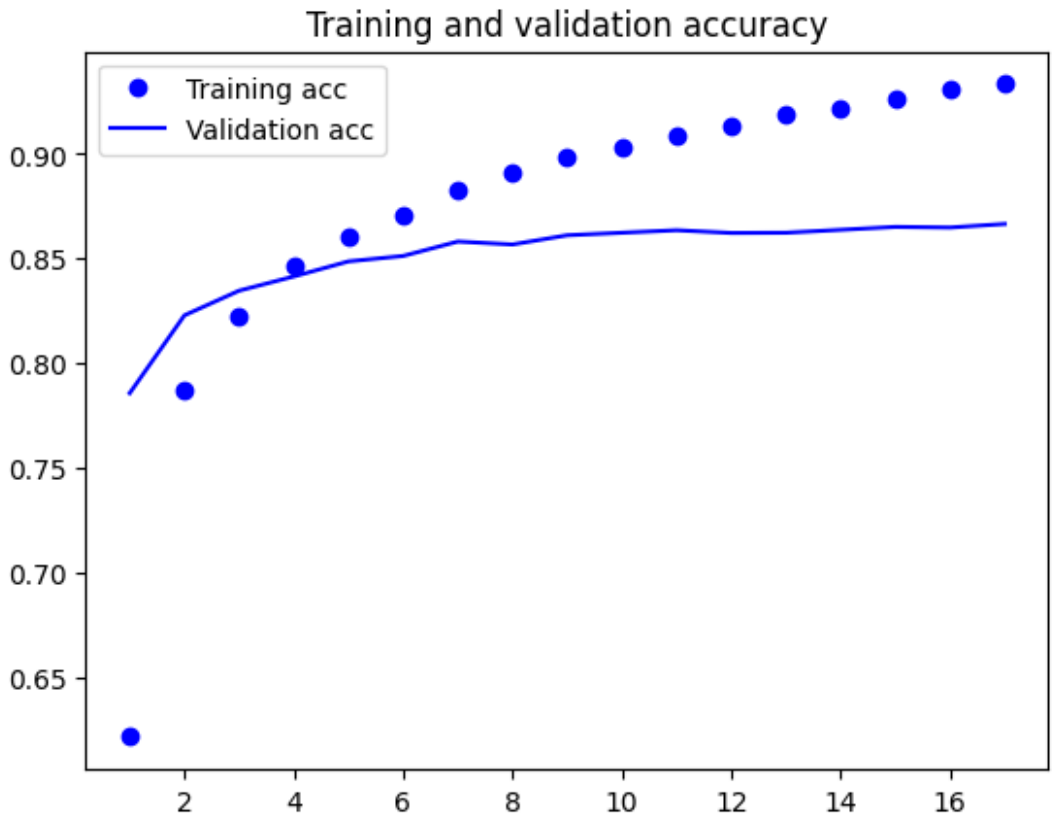
 1250/1250 [==============================] - 6s 4ms/step - loss:
5.0229 - accuracy: 0.6213 - val_loss: 2.2765 - val_accuracy: 0.7856
Epoch 2/25
1239/1250 [============================>.] - ETA: 0s - loss: 2.3468 -
accuracy: 0.7865
Epoch 2: val_loss improved from 2.27647 to 1.83456, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
2.3436 - accuracy: 0.7869 - val_loss: 1.8346 - val_accuracy: 0.8228
Epoch 3/25
1245/1250 [============================>.] - ETA: 0s - loss: 1.8272 -
accuracy: 0.8222
Epoch 3: val_loss improved from 1.83456 to 1.65734, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
```

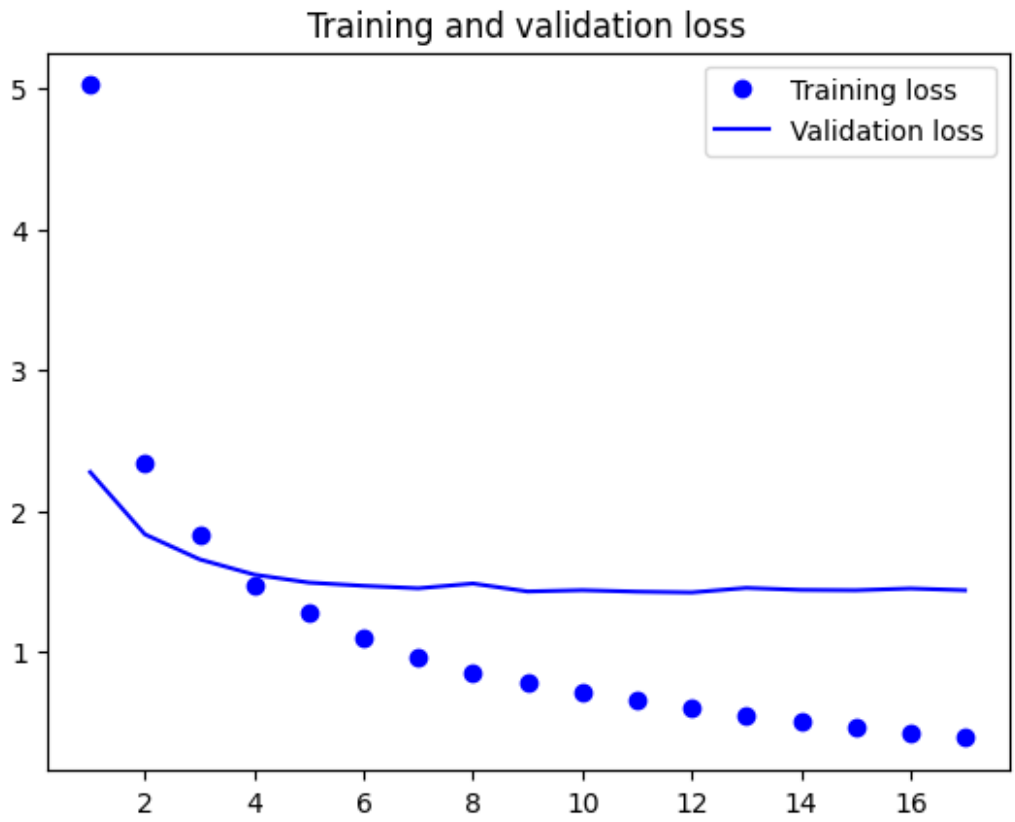
```
1250/1250 [==============================] - 4s 3ms/step - loss:
1.8277 - accuracy: 0.8223 - val_loss: 1.6573 - val_accuracy: 0.8346
Epoch 4/25
1235/1250 [============================>.] - ETA: 0s - loss: 1.4756 -
accuracy: 0.8466
Epoch 4: val_loss improved from 1.65734 to 1.54854, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.4775 - accuracy: 0.8465 - val_loss: 1.5485 - val_accuracy: 0.8414
Epoch 5/25
1238/1250 [============================>.] - ETA: 0s - loss: 1.2710 -
accuracy: 0.8602
Epoch 5: val_loss improved from 1.54854 to 1.49222, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.2723 - accuracy: 0.8600 - val_loss: 1.4922 - val_accuracy: 0.8486
Epoch 6/25
1236/1250 [============================>.] - ETA: 0s - loss: 1.1009 -
accuracy: 0.8704
Epoch 6: val_loss improved from 1.49222 to 1.46926, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
1.0987 - accuracy: 0.8704 - val_loss: 1.4693 - val_accuracy: 0.8512
Epoch 7/25
1231/1250 [============================>.] - ETA: 0s - loss: 0.9666 -
accuracy: 0.8829
Epoch 7: val_loss improved from 1.46926 to 1.45167, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.9677 - accuracy: 0.8826 - val_loss: 1.4517 - val_accuracy: 0.8581
Epoch 8/25
1234/1250 [============================>.] - ETA: 0s - loss: 0.8522 -
accuracy: 0.8915
Epoch 8: val_loss did not improve from 1.45167
1250/1250 [==============================] - 4s 3ms/step - loss:
0.8532 - accuracy: 0.8914 - val_loss: 1.4854 - val_accuracy: 0.8567
Epoch 9/25
1244/1250 [============================>.] - ETA: 0s - loss: 0.7797 -
accuracy: 0.8984
Epoch 9: val_loss improved from 1.45167 to 1.42907, saving model to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.7798 - accuracy: 0.8985 - val_loss: 1.4291 - val_accuracy: 0.8611
Epoch 10/25
1245/1250 [============================>.] - ETA: 0s - loss: 0.7104 -
accuracy: 0.9031
Epoch 10: val_loss did not improve from 1.42907
1250/1250 [==============================] - 4s 3ms/step - loss:
0.7111 - accuracy: 0.9030 - val_loss: 1.4382 - val_accuracy: 0.8623
```

```
Epoch 11/25
1232/1250 [============================>.] - ETA: 0s - loss: 0.6637 -
accuracy: 0.9092
Epoch 11: val_loss improved from 1.42907 to 1.42771, saving model
to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.6654 - accuracy: 0.9091 - val_loss: 1.4277 - val_accuracy: 0.8635
Epoch 12/25
1240/1250 [============================>.] - ETA: 0s - loss: 0.6078 -
accuracy: 0.9136
Epoch 12: val_loss improved from 1.42771 to 1.42224, saving model
to
/content/drive/MyDrive/ProjetoIA/models/modeloT_TL_FE_with_DA_best.h5
1250/1250 [==============================] - 4s 3ms/step - loss:
0.6080 - accuracy: 0.9133 - val_loss: 1.4222 - val_accuracy: 0.8622
Epoch 13/25
1246/1250 [============================>.] - ETA: 0s - loss: 0.5509 -
accuracy: 0.9188
Epoch 13: val_loss did not improve from 1.42224
1250/1250 [==============================] - 4s 3ms/step - loss:
0.5517 - accuracy: 0.9189 - val_loss: 1.4543 - val_accuracy: 0.8623
Epoch 14/25
1236/1250 [============================>.] - ETA: 0s - loss: 0.5036 -
accuracy: 0.9219
Epoch 14: val_loss did not improve from 1.42224
1250/1250 [==============================] - 4s 3ms/step - loss:
0.5048 - accuracy: 0.9215 - val_loss: 1.4401 - val_accuracy: 0.8637
Epoch 15/25
1235/1250 [============================>.] - ETA: 0s - loss: 0.4620 -
accuracy: 0.9263
Epoch 15: val_loss did not improve from 1.42224
1250/1250 [==============================] - 4s 3ms/step - loss:
0.4631 - accuracy: 0.9263 - val_loss: 1.4375 - val_accuracy: 0.8651
Epoch 16/25
1243/1250 [============================>.] - ETA: 0s - loss: 0.4278 -
accuracy: 0.9307
Epoch 16: val_loss did not improve from 1.42224
1250/1250 [==============================] - 4s 3ms/step - loss:
0.4274 - accuracy: 0.9306 - val_loss: 1.4504 - val_accuracy: 0.8648
Epoch 17/25
1234/1250 [============================>.] - ETA: 0s - loss: 0.3915 -
accuracy: 0.9332
Epoch 17: val_loss did not improve from 1.42224
1250/1250 [==============================] - 4s 3ms/step - loss:
0.3901 - accuracy: 0.9333 - val_loss: 1.4379 - val_accuracy: 0.8665
Epoch 17: 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()
```






```
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_modeloT_TL_FE_with_DA.h5')

#We can later load it and test it:
from tensorflow import keras
loaded_model =
keras.models.load_model('/content/drive/MyDrive/ProjetoIA/models/CNN_modeloT_TL_FE_with_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:
1.4379 - accuracy: 0.8665
val_acc: 0.8665000200271606
```

Foram avaliados 313 batches no conjunto de validação Perda calculada no conjunto de validação 1.4379 Previsão do conjunto de validação com 86.65% das previsões foram corretas.