```
from google.colab import drive
drive.mount('/content/drive')
```

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

```
import tensorflow as tf
from keras.utils import image_dataset_from_directory
# Directories
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']
```

```
from tensorflow import keras
from keras import layers
data_augmentation = keras.Sequential(
  [
  layers.RandomFlip("horizontal"),
  layers.RandomRotation(0.1),
  layers.RandomZoom(0.2),
  ]
)

#The shape of each batch

for data_batch, labels_batch in train_dataset:
  print('data batch shape:', data_batch.shape)
  print('labels batch shape:', labels_batch.shape)
  break
```

```
data batch shape: (32, 150, 150, 3)
labels batch shape: (32,)
```

```
#Creating the neural network
from tensorflow import keras
from keras import layers
from keras import models
inputs = keras.Input(shape=(IMG_SIZE, IMG_SIZE, 3))
x = data_augmentation(inputs)
x = layers.Rescaling(1./255)(inputs)
x = layers.Conv2D(filters=32, kernel_size=3, activation="relu")(x)
x = layers.MaxPooling2D(pool_size=2)(x)
x = layers.Conv2D(filters=64, kernel_size=3, activation="relu")(x)
x = layers.MaxPooling2D(pool_size=2)(x)
```

```
x = layers.Conv2D(filters=64, kernel_size=3, activation="relu")(x)
x = layers.MaxPooling2D(pool_size=2)(x)
x = layers.Conv2D(filters=128, kernel_size=3, activation="relu")(x)
x = layers.MaxPooling2D(pool_size=2)(x)
x = layers.Conv2D(filters=128, kernel_size=3, activation="relu")(x)
x = layers.MaxPooling2D(pool_size=2)(x)
x = layers.Flatten()(x)
x = layers.Dense(512, activation="relu")(x)
outputs = layers.Dense(10, activation="softmax")(x)
model = keras.Model(inputs=inputs, outputs=outputs)

model.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 150, 150, 3)]     0

 rescaling (Rescaling)       (None, 150, 150, 3)       0

 conv2d (Conv2D)             (None, 148, 148, 32)      896

 max_pooling2d (MaxPooling2  (None, 74, 74, 32)        0
 D)

 conv2d_1 (Conv2D)           (None, 72, 72, 64)        18496

 max_pooling2d_1 (MaxPoolin  (None, 36, 36, 64)        0
 g2D)

 conv2d_2 (Conv2D)           (None, 34, 34, 64)        36928

 max_pooling2d_2 (MaxPoolin  (None, 17, 17, 64)        0
 g2D)

 conv2d_3 (Conv2D)           (None, 15, 15, 128)       73856

 max_pooling2d_3 (MaxPoolin  (None, 7, 7, 128)         0
 g2D)

 conv2d_4 (Conv2D)           (None, 5, 5, 128)         147584

 max_pooling2d_4 (MaxPoolin  (None, 2, 2, 128)         0
 g2D)

 flatten (Flatten)           (None, 512)               0

 dense (Dense)               (None, 512)               262656
```

```
 dense_1 (Dense)             (None, 10)                5130

=================================================================
Total params: 545546 (2.08 MB)
Trainable params: 545546 (2.08 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

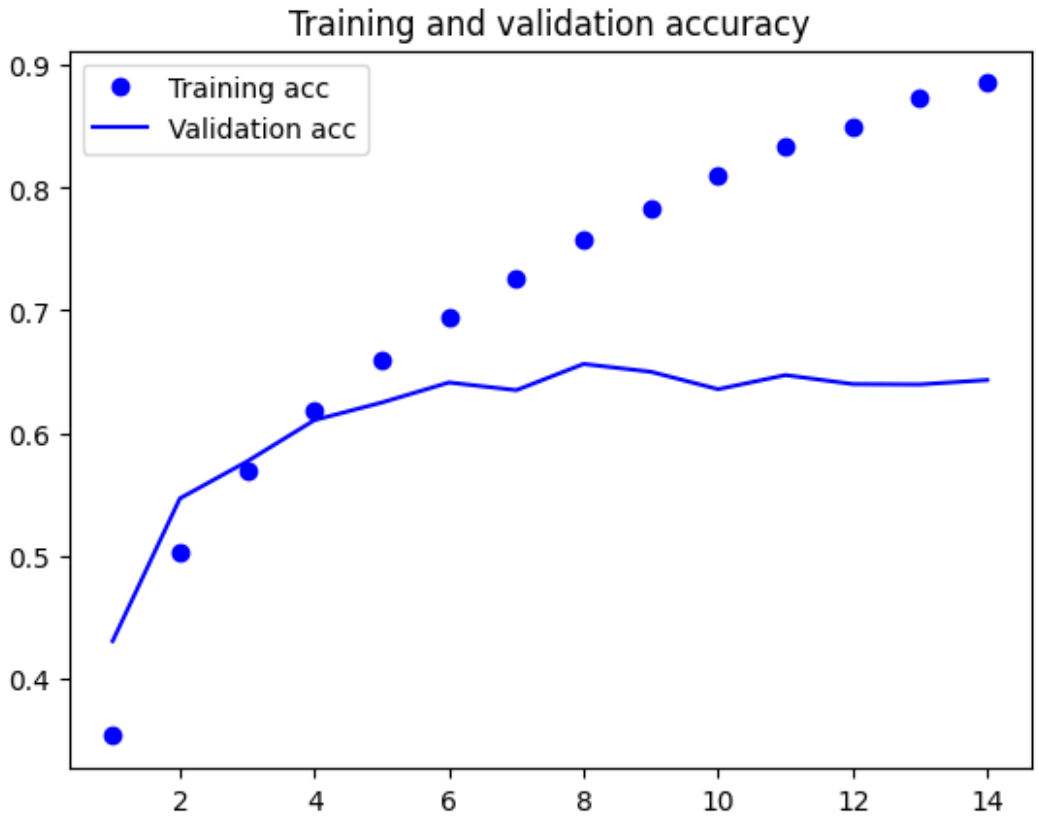
```
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping
checkpoint_callback =
ModelCheckpoint(filepath='/content/drive/MyDrive/ProjetoIA/models/
modelS_2_data_augmentation_best.h5',
                                        monitor='val_loss',
                                        save_best_only=True,
                                        save_weights_only=True,
                                        verbose=1)

early_stopping_callback = EarlyStopping(monitor='val_loss',
                                          patience=6,
                                          verbose=1)

import tensorflow as tf
from keras.optimizers import Adam

model.compile(optimizer=Adam(learning_rate=0.001),
              loss='sparse_categorical_crossentropy',
              metrics=['accuracy'])

#Training the model
#history guarda todos os parametros gerados durante o treino
history = model.fit(
  train_dataset,
  epochs=50,
  validation_data=validation_dataset,
  callbacks=[checkpoint_callback, early_stopping_callback]
  )# n usa para melhorar so para mostrar ao utilizador
```

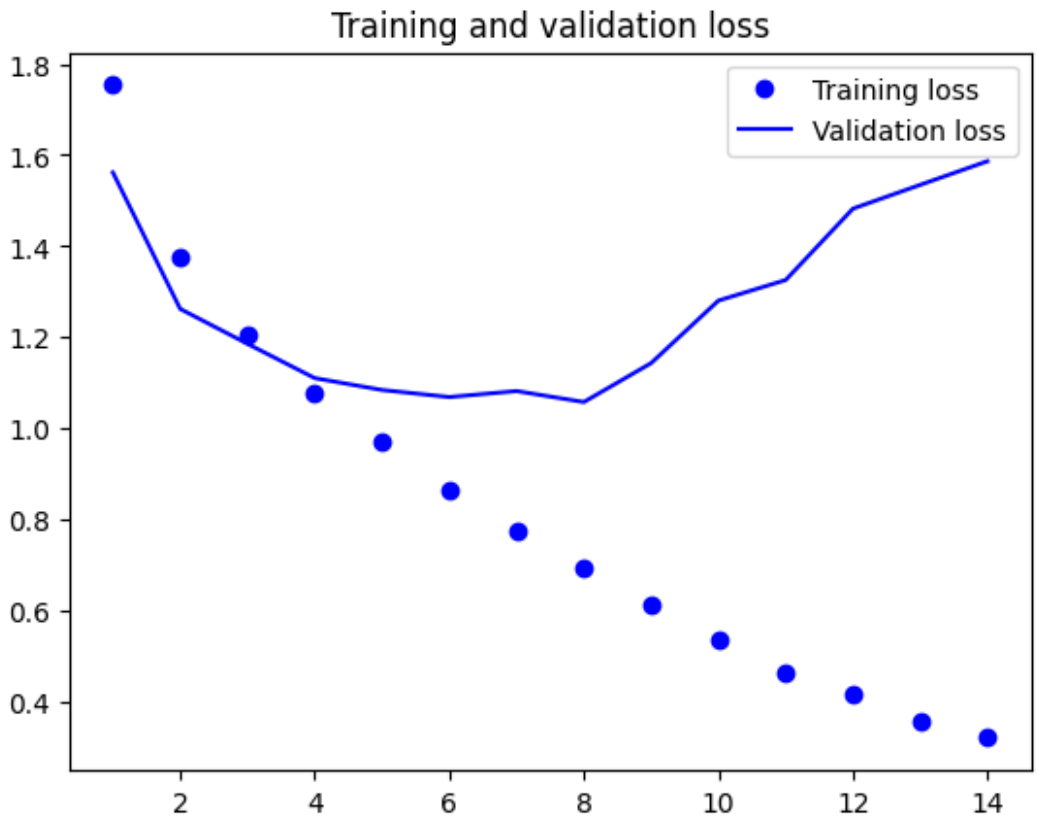
```
Epoch 1/50
   1251/Unknown - 2542s 2s/step - loss: 1.7536 - accuracy: 0.3528
Epoch 1: val_loss improved from inf to 1.56187, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 3442s 3s/step - loss:
1.7536 - accuracy: 0.3528 - val_loss: 1.5619 - val_accuracy: 0.4302
Epoch 2/50
1248/1251 [============================>.] - ETA: 0s - loss: 1.3761 -
accuracy: 0.5023
Epoch 2: val_loss improved from 1.56187 to 1.26241, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
```

```
1251/1251 [==============================] - 66s 53ms/step - loss:
1.3759 - accuracy: 0.5023 - val_loss: 1.2624 - val_accuracy: 0.5466
Epoch 3/50
1248/1251 [============================>.] - ETA: 0s - loss: 1.2073 -
accuracy: 0.5689
Epoch 3: val_loss improved from 1.26241 to 1.18575, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 66s 53ms/step - loss:
1.2070 - accuracy: 0.5689 - val_loss: 1.1857 - val_accuracy: 0.5768
Epoch 4/50
1251/1251 [==============================] - ETA: 0s - loss: 1.0784 -
accuracy: 0.6176
Epoch 4: val_loss improved from 1.18575 to 1.11040, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 66s 53ms/step - loss:
1.0784 - accuracy: 0.6176 - val_loss: 1.1104 - val_accuracy: 0.6105
Epoch 5/50
1248/1251 [============================>.] - ETA: 0s - loss: 0.9712 -
accuracy: 0.6588
Epoch 5: val_loss improved from 1.11040 to 1.08437, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 67s 54ms/step - loss:
0.9711 - accuracy: 0.6588 - val_loss: 1.0844 - val_accuracy: 0.6248
Epoch 6/50
1248/1251 [============================>.] - ETA: 0s - loss: 0.8658 -
accuracy: 0.6942
Epoch 6: val_loss improved from 1.08437 to 1.06881, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 66s 53ms/step - loss:
0.8655 - accuracy: 0.6942 - val_loss: 1.0688 - val_accuracy: 0.6412
Epoch 7/50
1250/1251 [============================>.] - ETA: 0s - loss: 0.7762 -
accuracy: 0.7263
Epoch 7: val_loss did not improve from 1.06881
1251/1251 [==============================] - 66s 52ms/step - loss:
0.7760 - accuracy: 0.7264 - val_loss: 1.0820 - val_accuracy: 0.6349
Epoch 8/50
1248/1251 [============================>.] - ETA: 0s - loss: 0.6934 -
accuracy: 0.7573
Epoch 8: val_loss improved from 1.06881 to 1.05781, saving model to
/content/drive/MyDrive/ProjetoIA/models/modelS_2_data_augmentation_bes
t.h5
1251/1251 [==============================] - 66s 52ms/step - loss:
0.6935 - accuracy: 0.7574 - val_loss: 1.0578 - val_accuracy: 0.6563
Epoch 9/50
```

```
1248/1251 [============================>.] - ETA: 0s - loss: 0.6113 -
accuracy: 0.7831
Epoch 9: val_loss did not improve from 1.05781
1251/1251 [==============================] - 67s 53ms/step - loss:
0.6110 - accuracy: 0.7832 - val_loss: 1.1433 - val_accuracy: 0.6499
Epoch 10/50
1251/1251 [==============================] - ETA: 0s - loss: 0.5344 -
accuracy: 0.8106
Epoch 10: val_loss did not improve from 1.05781
1251/1251 [==============================] - 66s 53ms/step - loss:
0.5344 - accuracy: 0.8106 - val_loss: 1.2806 - val_accuracy: 0.6357
Epoch 11/50
1249/1251 [============================>.] - ETA: 0s - loss: 0.4650 -
accuracy: 0.8336
Epoch 11: val_loss did not improve from 1.05781
1251/1251 [==============================] - 66s 52ms/step - loss:
0.4647 - accuracy: 0.8337 - val_loss: 1.3258 - val_accuracy: 0.6472
Epoch 12/50
1248/1251 [============================>.] - ETA: 0s - loss: 0.4167 -
accuracy: 0.8503
Epoch 12: val_loss did not improve from 1.05781
1251/1251 [==============================] - 66s 52ms/step - loss:
0.4167 - accuracy: 0.8503 - val_loss: 1.4825 - val_accuracy: 0.6399
Epoch 13/50
1251/1251 [==============================] - ETA: 0s - loss: 0.3549 -
accuracy: 0.8732
Epoch 13: val_loss did not improve from 1.05781
1251/1251 [==============================] - 66s 52ms/step - loss:
0.3549 - accuracy: 0.8732 - val_loss: 1.5347 - val_accuracy: 0.6396
Epoch 14/50
1251/1251 [==============================] - ETA: 0s - loss: 0.3206 -
accuracy: 0.8854
Epoch 14: val_loss did not improve from 1.05781
1251/1251 [==============================] - 66s 52ms/step - loss:
0.3206 - accuracy: 0.8854 - val_loss: 1.5867 - val_accuracy: 0.6432
Epoch 14: early stopping

#como demora muito tempo vamos dar load de um test model

#Loading and testing the model
from tensorflow import keras
#model = keras.models.load_model('models/modelS_augmentation.h5')

val_loss, val_acc = model.evaluate(validation_dataset)
print('val_acc:', val_acc)

313/313 [==============================] - 13s 40ms/step - loss:
1.5867 - accuracy: 0.6432
val_acc: 0.6431999802589417
```

```python
#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 loss
Training loss
Validation loss
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
2
4
6
8
10
12
14