# TFM_LauraRivera_objectivo1_marca

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<img src="http://www.uoc.edu/portal/_resources/common/imatges/marca_UOC/UOC_Masterbrand.jpg", align="left">

Identificación de huellas de calzado a partir de imágenes con redes neuronales convolucionales

MU Ingeniería Computacional y Matemática / Área de Inteligencia Artificial

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## 1 Identificación de huellas de calzado a partir de imágenes con redes neuronales convolucionales

El objetivo de este apartado es, a parte de la creación y entrenamiento de un red neuronal capaz de determinar la marca de calzado de una huella a partir de los datos disponibles. Se realizan diferentes experimentos con diferentes parámetros y procesos para analizar los resultados y poder concluir si éstas pueden dar un resultado satisfactorio.

Con este proyecto se quiere dar respuesta a las siguientes preguntas o hipótesis mediante los experimentos: 1. ¿Qué preprocesado de imágenes funciona mejor? 2. ¿Utilizar más epochs, resulta siempre en mejor resultado? 3. ¿Un mayor tamaño de las imágenes utilizadas, resulta en un mejor resultado? (En otro cuaderno) 4. ¿Cuál es el mínimo de muestras por marcas aceptable para el modelo?

[2]:

```
#librerias necesarias:
import pandas as pd
import numpy as np
from zipfile import ZipFile
import matplotlib.pyplot as plt
from PIL import Image
import os
import random
import skimage
import cv2 as cv
import pickle
from datetime import datetime
```

[3]:

```
#En caso de utilizar google colab:
#from google.colab import drive
```

```
#drive.mount('/content/gdrive')
```

# 2 Lectura y análisis de los conjuntos de datos

## 2.1 Base de datos 2d FootWear con información de marca

Base de datos extraída de: https://iastate.figshare.com/articles/figure/2D_Footwear_outsole_impressions/11624

https://www.sciencedirect.com/science/article/pii/S2352340920304029?via%3Dihub

[4]:

```
def unzipImages(folder='images'):
    with ZipFile('data/2dFootwear/Part1.zip', 'r') as zipObj:
      zipObj.extractall(folder)

    with ZipFile('data/2dFootwear/Part2.zip', 'r') as zipObj:
      zipObj.extractall(folder)
    with ZipFile('data/2dFootwear/Part3.zip', 'r') as zipObj:
      zipObj.extractall(folder)

    with ZipFile('data/2dFootwear/Part4.zip', 'r') as zipObj:
      zipObj.extractall(folder)

    with ZipFile('data/2dFootwear/Part5.zip', 'r') as zipObj:
      zipObj.extractall(folder)
```

[5]:

```
if not os.path.isdir("images"):
    unzipImages("images")
```

### 2.1.1 Análisis de los datos 2d Footwear

Consiste en 1500 imágenes de la huella de 150 pares de zapatos de 28 individuos diferentes. Además, se dispone de 62 marcas de calzado diferentes, y las que más aparecen son Nike, Asics y Adidas. Por último, existen 70 registros de calzado de mujer y 80 de hombre.

[6]:

```
df = pd.read_csv('data/2dFootwear/Data-information.csv', delimiter=';')
df['Brand'] = df['Brand'].str.strip() #eliminar espacios en blanco

X_files = df['ID'].values.tolist()
brands = df['Brand'].values.tolist()

values_brand, counts_brand = np.unique(brands, return_counts=True)
print('Tag example:',X_files[0]) #nomenclatura
print('Nº lines:',len(X_files)) #lineas en el csv
individuals, count_ind = np.unique(df['ID'].str[:3], return_counts=True)
print('Nº different people:',len(individuals)) #diferentes individuos de la␣
 ↪muestra
num_classes = len(values_brand) #se guarda porque será necesario para crear el␣
 ↪modelo
```

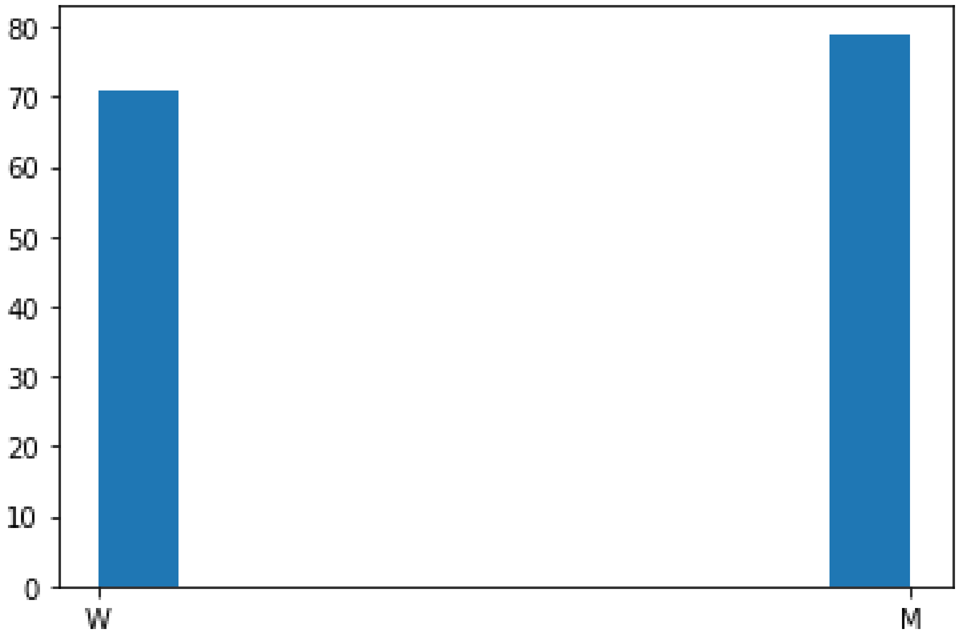
```
print('Nº of different brands: %d' %num_classes) #marcas diferentes
print(values_brand) #Listado de marcas únicas
```

```
Tag example: 001_01
Nº lines: 150
Nº different people: 28
Nº of different brands: 60
['Adidas' 'Airspeed' 'Airwalk' 'Aldo' 'American Eagle' 'Arizona' 'Asics'
 'BAGO' 'BASS' 'Birkenstock' 'Brooks' 'CalvinKlain' 'Champion' 'Clarks'
 'Columbus' 'Converse' 'Cooeli' 'Court classic' 'Dansko' 'Deer Stags'
 'Dockers' 'Ecco' 'Elcanto' 'Fadedglory' 'Feiyue' 'Fila' 'G.H.Bass&Co'
 'Guho' 'HeyBear' 'K-swiss' 'Keen' 'Landya' 'Namuhana' 'Newbalance' 'Nike'
 'Ninewest' 'None' 'OP' 'Ofem' 'Prospecs' 'Puma' 'Robin' 'Saucony'
 'Shoedy' 'Shoopen' 'Simply vera' 'Skechers' 'Soma' 'Sonoma' 'Sorel'
 'Sperry' 'Stone' 'Sugar' 'T2R' 'Teva' 'Truesoft' 'Under Amour' 'Vans'
 'Vibram' 'Yonex']
```

A continuación, el histograma con el número de muestras según género, en este caso hay 70 muestras de mujeres y 80 de hombres.

```
[7]: plt.hist(df['Gender'])
```

```
[7]: (array([71.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0., 79.]),
      array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. ]),
      <BarContainer object of 10 artists>)
```



Por último, se muestran las cinco marcas que más aparecen en el conjunto de datos.

Además se seleccionan esas marcas que aparecen minimo X veces en la muestra (X=5 por defecto), para crear un subconjunto de datos que elimine las marcas con una única muestra y comprobar en los siguientes casos si influye en el resultado.

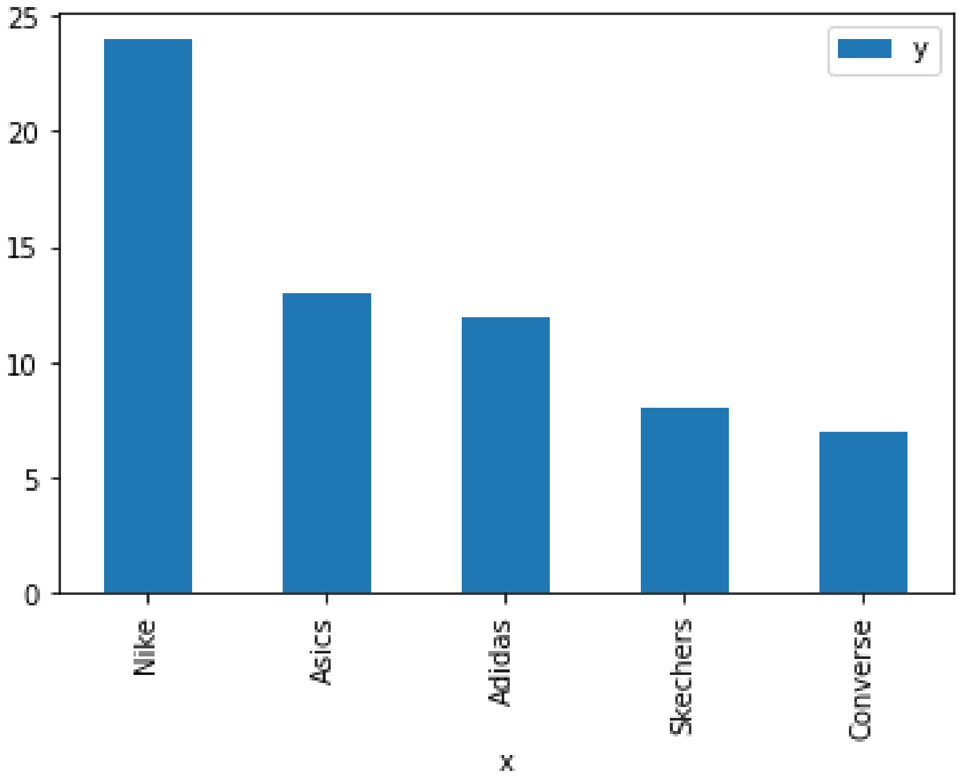
[8]:

```
def filterMinSamples(data, minSamples, deleteNone=True):
    if deleteNone == True:
        data=data[data['x']!="None"] #eliminar marca = "None"

    dataone=data[data['y']<minSamples] #marcas con pocas muestras
    if deleteNone == True:
        data=data[data['y']>=minSamples] #marcas con minimo "minSamples"␣
 ↪muestras
    else:
        data.loc[data['y']<minSamples, 'x'] ="None"
        values_brand, counts_brand = np.unique(data['x'], return_counts=True)
        data = pd.DataFrame({'x':values_brand, 'y':counts_brand})
        #data = data.groupby('x').agg(y=('y','sum'))
    print(data)
    num_classes=len(data)
    print('Brands with at least '+str(minSamples)+' samples: %d' %num_classes)
    print('Brands with only 1 register: %d' %len(dataone))
    return data, dataone

dfbrandall = pd.DataFrame({'x':values_brand, 'y':counts_brand})

dfbrand, dfbrandone = filterMinSamples(dfbrandall, 5)

num_classes=len(dfbrand)
dfbrand = dfbrand.sort_values('y', ascending = False) #ordenar descendientemente

# mostrar las 5 marcas que más aparecen en el conjunto de datos
dfbrand.head(5).plot('x', 'y', kind='bar') #mostrar gráfica
```

```
           x   y
0     Adidas  12
6      Asics  13
15  Converse   7
34      Nike  24
42   Saucony   6
46  Skechers   8
50    Sperry   7
Brands with at least 5 samples: 7
Brands with only 1 register: 52
```

[8]:

```
<AxesSubplot: xlabel='x'>
```



[11]:

```
def crop_jpeg(crop_size, imgPath):
    dir_list = os.listdir("./"+imgPath)
    for f in dir_list:
        im = Image.open("./"+imgPath+"/"+f)
        h,w,c = im.shape
        im3 = im2.crop((crop_size,crop_size,h-(crop_size*2),w-(crop_size*2)))␣
 ↪#Quitar marco medidor

def get_images_full_to_jpeg(imgPath):
  dir_list = os.listdir("./"+imgPath)
  result = []

  for f in dir_list:

    im = Image.open("./"+imgPath+"/"+f)
    im.save("./"+imgPath+"/"+f[0:-4]+'jpeg')

    result.append(f[0:-4]+'jpeg')
    os.remove("./"+imgPath+"/"+f)

  print('Nº files:',len(result))
  return result


def get_images_to_jpeg(imgPath):
  dir_list = os.listdir("./"+imgPath)
  result = []

  for f in dir_list:

    im = Image.open("./"+imgPath+"/"+f)
    im2=im.resize((400,912))
    im3 = im2.crop((40,40,320,872)) #Quitar marco medidor
    im3.save("./"+imgPath+"/"+f[0:-4]+'jpeg')

    result.append(f[0:-4]+'jpeg')
    os.remove("./"+imgPath+"/"+f)

  print('Nº files:',len(result))
  return result

def get_images(imgPath):
  dir_list = os.listdir("./"+imgPath)
  result = []
  for f in dir_list:
    if "jpeg" in f:
        result.append(f)


  print('Nº files:',len(result))
  return result
```

[12]:
```
# Get the list of all files in /images and convert to jpeg
#shoeFiles = get_images_to_jpeg("images") #la primera vez para convertir las␣
 ↪imágenes
shoeFiles = get_images("images")
```

```
Nº files: 1500
```

### 2.1.2 Visualización de imágenes

Se ha creado la función *plot_image* que permite la visualización de las imágenes de cualquiera de las dos bases de datos.

Parámetros:
*imgPath*: carpeta donde estan las imágenes
*fileNames*: array con los nombres de los ficheros a mostrar

[13]:

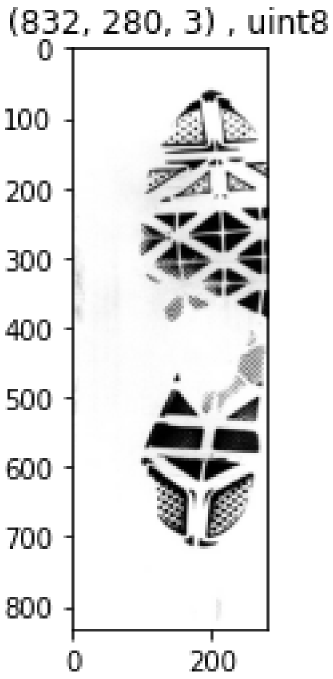
```
import skimage
def plot_image(imgPath, fileNames):
  for i in range(len(fileNames)):
    filename = fileNames[i]
    img = skimage.io.imread(imgPath+filename)

    plt.figure()
    plt.title(str(img.shape)+" , "+str(img.dtype))
    plt.imshow(img)
  print(fileNames)
  plt.show()

def plot_image2(img):

    plt.figure()
    plt.title(str(img.shape)+" , "+str(img.dtype))
    plt.imshow(img)

    plt.show()
def plot_image_grey(img):

    plt.figure()
    plt.title(str(img.shape)+" , "+str(img.dtype))
    plt.imshow(img, cmap='gray')

    plt.show()
```

A continuación, se muestra una imagen aleatória de cada uno de los 3 datasets del proyecto:

[14]:

```
plot_image("images/",random.choices(shoeFiles,k=1))
```

```
['025_02_R_03.jpeg']
```



## 2.2 División de los datos

Para la división de los datos se ha utilizado la funcióon train_test_split dos veces, primero para dividir entre el 80% de train y el 20% de test y después para extraer el equivalente al 10% para la validación.

De esta manera se dispone de 70% train, 20% test y 10% validación.

Antes de dividir los datos de la base de datos 2d Footwear, se ha formateado la tabla ya que actualmente solo muestra la información de marca según el calzado del usuario, pero no contiene el nombre de la imagen, se ha creado la siguiente función para que el conjunto de datos contenga dos columnas (X:fichero, y:marca)

[15]:

```
def filesWithBrand(shoeFiles):
  files = []
  brands = []
  for image in shoeFiles:
    files.append(image) #filename
    person = df[df['ID'].str[:6]==image[:6]]  #persona+contador de calzado
    brands.append(person['Brand'].iloc[0])

  return pd.DataFrame({'X':files, 'y':brands})

def filterBrands(data, one, deleteNone=True):
    #dfbrandone creado antes con las marcas que no cumplen.
    if not one.empty:
        df_shoe_brand=data[~data['y'].isin(one['x'].to_numpy())]
    else: #Nothing to remove
        df_shoe_brand = data

    if deleteNone == True:
        df_shoe_brand=df_shoe_brand[df_shoe_brand['y']!="None"]

    df_shoe_brand['factor_brand'] = pd.Categorical(pd.
 ↪factorize(df_shoe_brand['y'])[0].astype(np.float32))

    return df_shoe_brand

df_shoe_brand_all = filesWithBrand(shoeFiles) #contiene todas las muestras

#eliminar aquellas marcas que no aparecen mínimo en "minSample" muestras
df_shoe_brand = filterBrands(df_shoe_brand_all,dfbrandone)
print(df_shoe_brand)
#número de marcas con 5 o más muestras:
print('Nº of brands: %d' %num_classes)
```

```
                     X         y factor_brand
3     009_08_R_05.jpeg     Asics          0.0
8     010_01_L_01.jpeg  Skechers          1.0
13    025_05_R_01.jpeg     Asics          0.0
15    020_03_R_03.jpeg    Sperry          2.0
17    011_03_L_04.jpeg    Adidas          3.0
…                 …       …          …
1490  020_02_L_01.jpeg  Skechers          1.0
1493  011_01_R_04.jpeg    Adidas          3.0
1494  026_07_L_03.jpeg   Saucony          6.0
1496  018_04_R_02.jpeg    Sperry          2.0
1499  025_03_L_04.jpeg      Nike          4.0

[770 rows x 3 columns]
Nº of brands: 7
```

[16]:

```
def checkBalancedSample(train, test, val):
    checkTest = False
    checkVal = False

    #Comprobar si existen en train
    test_in = test.y.isin(train.y).astype(int)
    val_in=val.y.isin(train.y).astype(int)

    #Comprobar que existen todos (todo 1)
    if all(x==1 for x in test_in):
        checkTest = True
    if all(x==1 for x in val_in):
        checkVal = True
    #Devuelve True si en test y val aparecen marcas que existen en train:
    if checkTest and checkVal:
        return True
    return False
```

[17]:
```
from sklearn.model_selection import train_test_split
def  split_datafiles(df):

  X_train, X_test = train_test_split(df, test_size=0.2 , random_state=random.
 ↪randint(0,32),shuffle=True)

  X_train, X_val = train_test_split(X_train ,test_size=0.14,␣
 ↪random_state=random.randint(0,32),shuffle=True) # 0.14 x 0.7 = 0.1
  return X_train,  X_test ,X_val

#Dividir conjunto de datos:
#shoes_train, shoes_test, shoes_val = split_datafiles(df)
shoes_train, shoes_test, shoes_val = split_datafiles(df_shoe_brand)

while checkBalancedSample(shoes_train, shoes_test, shoes_val) == False:
    shoes_train, shoes_test, shoes_val = split_datafiles(df_shoe_brand)
```

# 3 Clasificadores

En este apartado, primero se utilizan diferentes clasificadores para comparar, posteriormente, su resultado con el de la red neuronal convolucional propuesta.

## 3.1 Extracción de características

La extracción de características es el proceso de recuperar los datos más importantes de los datos sin procesar. La extracción de características es encontrar el conjunto de parámetros que definen la forma de una imagen de manera precisa y única.

Para la extracción de características se utiliza la técnica Bag of Features, que extrae N características de las imágenes utilizando los descriptores SIFT (Scale Invariant Feature Transform).

Existen diferentes algoritmos de extracción de caraterísticas y para este proyecto se escoge utilizar SIFT ya que KAZE y ORB tienen cuenta las rotaciones y en este caso no sería necesario, ya que todas las muestras se toman con la misma metodologia.

Se hace uso de la librería OpenCV, de uso libre y con funcionalidades de visión por computador.

[87]:
```
!pip install opencv-contrib-python==4.4.0.44
```

```
Requirement already satisfied: opencv-contrib-python==4.4.0.44 in
/Library/Frameworks/Python.framework/Versions/3.8/lib/python3.8/site-packages
(4.4.0.44)
Requirement already satisfied: numpy>=1.17.3 in
/Library/Frameworks/Python.framework/Versions/3.8/lib/python3.8/site-packages
(from opencv-contrib-python==4.4.0.44) (1.23.4)

[notice] A new release of pip is
available: 23.0.1 -> 23.1.2
[notice] To update, run:
pip install --upgrade pip
```

[92]:

```python
#extrae y calcula los descriptores SIFT para el conjunto de imágenes enviado
def extractSIFT(input_files):
    all_features_dict = {}
    feature_extractor = cv.SIFT.create()
    for i, fname in enumerate(input_files):
        rgb = cv.cvtColor(cv.imread("images/"+fname), cv2.COLOR_BGR2RGB)
        gray = cv.cvtColor(rgb, cv.COLOR_RGB2GRAY)
        kp, desc = feature_extractor.detectAndCompute(gray, None)
        all_features_dict[fname] = desc
    return all_features_dict
```

[93]:

```python
#Esta función extrae las características de cada categoria (marca)
#input: listado de categorias (marcas), listado de ficheros, marca de cada␣
 ↪fichero
#output: lista ficheros, lista categorias, lista de características
def getFiles(cat_list, X_files, y_values):
  all_files = []
  all_files_labels = {}
  all_features = {}
  cat_indexes= []
  cat_files = []
  cat_features = []

  #values_train contiene el listado de categorias sin repeticiones
  for cat, label in zip(cat_list, range(len(cat_list))):

      #primero buscar los indices en el listado de cada categoria (dentro bucle)
      cat_indexes = [i for i,x in enumerate(y_values) if x == cat]

      #como se saben las posiciones, se cogen esas imagenes de esa categoria:
      cat_files = [X_files.iloc[i] for i in cat_indexes]
      cat_features = extractSIFT(cat_files)
      all_files = all_files + cat_files
      all_features.update(cat_features)
      for i in cat_files:
        all_files_labels[i] = label
  return all_files, all_files_labels, all_features
```

[94]:
```
def getFilesBySubset(subset, tipo):
    #values_brand= np.unique(subset['y']) #listado marcas únicas que aparecen␣
 ↪en subconjunto TRAIN

    if os.path.exists("saved/all_files_nonone2_"+tipo+".pkl"):
        with open('saved/all_files_nonone_'+tipo+'.pkl', 'rb') as fp:
            all_files = pickle.load(fp)
        with open('saved/all_files_nonone_labels_'+tipo+'.pkl', 'rb') as fp:
            all_files_labels = pickle.load(fp)
        with open('saved/all_features_nonone_'+tipo+'.pkl', 'rb') as fp:
            all_features = pickle.load(fp)
        #all_files_train = np.loadtxt('saved/all_files_train.txt')
        #all_files_labels_train = np.loadtxt('saved/all_files_labels_train.txt')
        #all_features_train = np.loadtxt('saved/all_features_train.txt')
    else:
        all_files, all_files_labels,␣
 ↪all_features=getFiles(values_brand,subset['X'],subset['y'])

    return all_files, all_files_labels, all_features
```

[95]:
```
values_brand= np.unique(df_shoe_brand['y']) #listado marcas únicas que aparecen␣
 ↪en subconjunto TRAIN

all_files_train, all_files_labels_train,␣
 ↪all_features_train=getFilesBySubset(shoes_train, "train")
#Este proceso tarda 40 minutos aproximadamente, por eso se guarda en un fichero␣
 ↪para agilizar las pruebas
```

[83]:
```
if not os.path.exists("saved/all_files_nonone_train.pkl"):
    with open('saved/all_files_nonone_train.pkl', 'wb') as fp:
        pickle.dump(all_files_train, fp)
    with open('saved/all_files_labels_nonone_train.pkl', 'wb') as fp:
        pickle.dump(all_files_labels_train, fp)
    with open('saved/all_features_nonone_train.pkl', 'wb') as fp:
        pickle.dump(all_features_train, fp)
```

A continuación un ejemplo de la matriz de características y la impresión de la imagen con los puntos puntos de interés detectados.

[96]:
```
#guarda la primera imagen  con los puntos de interés
img = cv.imread("images/"+all_files_train[0])
gray = cv.cvtColor(img, cv.COLOR_BGR2GRAY)
```

```
features = cv2.SIFT_create()
keypoints = features.detect(gray, None)

img2=cv.drawKeypoints(gray,keypoints,0,(0,0,255), flags=cv2.
 ↪DRAW_MATCHES_FLAGS_DRAW_RICH_KEYPOINTS)
cv.imwrite('results/'+all_files_train[0], img2)
```

[96]:
```
True
```

[97]:
```
#Se crea el Bag of Features con un diccionario de tamaño 75:
dictionarySize =75
if not os.path.exists("saved/bow_dict_nonone.pkl"):

    BOW = cv.BOWKMeansTrainer(dictionarySize)

    for feat in all_features_train:
        BOW.add(all_features_train[feat])
    dictionary = BOW.cluster()
else:
    with open('saved/bow_dict_nonone.pkl', 'rb') as fp:
        dictionary = pickle.load(fp)
print(dictionary.shape)
print(all_features_train[all_files_train[0]].shape) #subdivisión de train:␣
 ↪shoes_train
```

```
(75, 128)
(1024, 128)
```

[98]:
```
import pickle
if not os.path.exists("saved/bow_dict_nonone.pkl"):
    with open('saved/bow_dict_nonone.pkl', 'wb') as fp:
        pickle.dump(dictionary, fp)
        print('BOW dictionary saved successfully to file')

#Como se trata de un proceso que toma bastante tiempo, también se ha decidido␣
 ↪guardar el resultado en un fichero para futuras ejecuciones
```

[99]:
```
def getFeatures(all_files, all_features, all_files_labels):
  X = np.empty((len(all_files),dictionarySize))
  y = np.empty((len(all_files),))
  all_features_BOW = {}

  count = 0
  for filename in all_files:
      desc_query = all_features[filename]
      matches = matcher.match(desc_query,dictionary)
      train_idxs = []
      for j in range(len(matches)):
        train_idxs.append(matches[j].trainIdx)
      hist, bin_edges = histogram(train_idxs, bins=range(dictionarySize+1))
      all_features_BOW[filename] = hist
      X[count,:] = hist
      y[count] = all_files_labels[filename]
      count = count + 1
  return X,y
```

[100]:

```
from numpy import histogram
import numpy as np

#Comentario: A continuación se normaliza el numero de caracteristicas para que␣
 ↪todas tengan la misma cantidad,
#ya que con el proceso anterior (BOW) es muy probable que las imagenes tengan␣
 ↪numero de caracteristicas diferentes.

matcher = cv.BFMatcher(normType=cv.NORM_L2)

X, y = getFeatures(all_files_train, all_features_train, all_files_labels_train)
```

### 3.1.1 Support Vector Machines (SVM)

Tiene como objetivo encontrar el hiperplano que clasifica claramente los puntos. Este hiperplano se calcula maximizando el margen de las instancias de entrenamiento en el espacio de destino.

[101]:

```
from sklearn.model_selection import train_test_split
from sklearn import svm
from sklearn.model_selection import GridSearchCV

X_train, X_test_t, y_train, y_test_t = train_test_split(X, y, test_size=0.3,␣
 ↪random_state=0)

# Set the parameters by cross-validation
kernels =  ["rbf", "linear", "poly", "sigmoid"]
Cs= [1, 2,3,4, 5, 10, 20]


#Se utiliza GridSearchCV para identificar la mejor configuración de entre los␣
 ↪diferentes kernel con diferentes
#valores de C.
clf = GridSearchCV(estimator=svm.SVC(), param_grid=dict(C=Cs,␣
 ↪kernel=kernels),n_jobs=-1)
clf.fit(X_train, y_train)

print('Mejor configuración kernel=%s, c= %s con un score de %s' %(clf.
 ↪best_estimator_.kernel, clf.best_estimator_.C, clf.best_score_))
```

```
Mejor configuración kernel=rbf, c= 20 con un score de 0.9783783783783784
```

[102]:

```
#Ejecuto la configuración con mejor resultado kernel=rbf, c=20:

clf_train = svm.SVC(kernel='rbf', C=20).fit(X_train, y_train)
clf_train.score(X_test_t, y_test_t)
```

[102]:

```
0.9811320754716981
```

### 3.1.2 KNeighborsClassifier

Determina la clase de la información mirando los puntos cercanos. De manera que selecciona la clase (o grupo) que tiene más puntos de la instancia.

[105]:

```
from sklearn.neighbors import KNeighborsClassifier
model = KNeighborsClassifier(n_neighbors=num_classes)
model.fit(X_train, y_train)
model.score(X_test_t, y_test_t)
```

```
/Library/Frameworks/Python.framework/Versions/3.8/lib/python3.8/site-
packages/sklearn/neighbors/_classification.py:189: FutureWarning: Unlike other
reduction functions (e.g. `skew`, `kurtosis`), the default behavior of `mode`
typically preserves the axis it acts along. In SciPy 1.11.0, this behavior will
change: the default value of `keepdims` will become False, the `axis` over which
the statistic is taken will be eliminated, and the value None will no longer be
accepted. Set `keepdims` to True or False to avoid this warning.
  mode, _ = stats.mode(_y[neigh_ind, k], axis=1)
```

[105]:

```
0.8679245283018868
```

### 3.1.3 DecisionTreeClassifier

Las normas de clasificación se extraen construyendo un árbol de decisiones con los datos de entrenamiento. En cada nodo del árbol, se utiliza el atributo con mayor diferencia en entropía para dividir los datos.

[107]:

```
from sklearn.tree import DecisionTreeClassifier
model = DecisionTreeClassifier()
model.fit(X_train, y_train)
model.score(X_test_t, y_test_t)
```

[107]:

```
0.7547169811320755
```

# 4 Objetivo 1: Predicción de la marca de calzado utilizando redes neuronales convolucionales

## 4.1 Red neuronal convolucional propuesta

En este caso los datos ya estan etiquetados, por lo que se puede crear un modelo para que entrene según esa etiqueta.

*Es necesario transformar las etiquetas de marcas a numérico para el correcto funcionamiento del modelo. Paso realizado en los primeros pasos*

[34]:
```
#Se ha creado un generador para añadir la aumentación de las imágenes
import torchvision.io
import torch
from tensorflow.keras.utils import Sequence
import torchvision.transforms as T
from torchvision.transforms import Resize
from skimage.io import imread
from skimage.util import img_as_float,random_noise
from skimage.transform import rotate
from skimage.color import rgb2gray
import numpy as np
import random
import os
from skimage import io
from skimage import transform, util



#función que elimina las filas y columnas en blanco:
def crop_image(gray, pixel_value=220):
    #gray = cv2.imread(filename, cv2.IMREAD_GRAYSCALE)

    crop_rows = gray[~np.all(gray > pixel_value, axis=1), :]
    cropped_image = crop_rows[:, ~np.all(crop_rows > pixel_value, axis=0)]
    return cropped_image

def create_variation(theImage,doFlip,doNoise,doRotate):
  image = img_as_float(theImage)
  if doFlip==True:
    image = np.fliplr(image)
  if doNoise==True:
    image = util.random_noise(image)
  if doRotate==True:
    image = transform.rotate(image, random.randint(-45, 45),mode='symmetric')
  return image

class DataGenerator2dFootwear(Sequence):
    # Constructor. Input parameters are:
    # * fileNames   : List of sample file names
    # * doRandomize : If True, the provided file names are shuffled after each␣
 ↪training epoch
    #                 and each image can be left unchanged, flipped, corrupted␣
 ↪with
```

```
    #                 noise or rotated. 8 possible combinations is chosen␣
↪randomly with equal probability.
    #                 If False, file names are not shuffled and each image is␣
↪provided unchanged.
    # * imgPath     : Path to the images
    # * batchSize   : Number of sample images and ground truth items in each␣
↪batch
    def __init__(self,data, df_shoe_brand,doRandomize=False,imgPath='images',␣
↪doGray=True,doBin=True, doCrop = True,batchSize=10):
        # Store parameters
        self.imgPath=imgPath
        self.fileNames=data.copy()
        self.batchSize=batchSize
        self.doRandomize=doRandomize
        self.df_shoe_brand=df_shoe_brand
        self.doGray=doGray
        self.doBin=doBin
        self.doCrop=doCrop
        # Get number of files (to avoid computing them later)
        self.numImages=len(data)
        # Shuffle them if required
        self.on_epoch_end()

    # Shuffle data if required
    def on_epoch_end(self):
        if self.doRandomize:
            random.shuffle(self.fileNames)

    # Returns the number of total batches
    def __len__(self):
        return int(np.ceil(float(self.numImages)/float(self.batchSize)))


    # Input  : theIndex - Index of the image to load within self.fileNames.
    # Output : theImage - Loaded (and possibly transformed) image. Must be
    #                     of float type with values within [0,1]
    #          theClass - Shoe brand
    def _load_image_(self,theIndex):


        file = self.fileNames[theIndex]


        img = io.imread(self.imgPath+file)
        h,w,c = img.shape #guardar el shape por si se hace crop poder hacer el␣
↪resize
```

```
        if self.doGray:#escala de grises
            img = rgb2gray(img)
            #plot_image_grey(img)
        if self.doBin: #blanco y negro
            test_binary_high,img = cv.threshold(img,0, 255, cv2.THRESH_BINARY)
        if self.doCrop: #quitar columnas/filas blancas
            img = crop_image(img)
            img = cv2.resize(img, (h,w), interpolation = cv2.INTER_AREA)

        theImage = img_as_float(img)

        theImage=theImage /255.0 #normalizar (quito rescaling del modelo)

        #añadir aumentación a las imágenes:
        if self.doRandomize:
          theImage=create_variation(img,random.choice([True, False]),random.
↪choice([True, False]),random.choice([True, False]))
        #else:
         # theImage=create_variation(img,False, False, False)

        #Buscar la imagen en el csv para extraer la Marca:
        person = self.df_shoe_brand[self.df_shoe_brand['X'].str[:6]==file[:6]] ␣
↪#persona+contador de calzado
        theClass = person['factor_brand'].iloc[0]#self.classes[theIndex] #¿debe␣
↪ser numérico o podría ser la etiqueta?
        return theImage,theClass

    # Provides the images,class batch
    # Batch format:
    # - X : The data. Numpy array of shape (bs,nr,nc,3)
    # - y : The ground truth. Numpy array of shape (bs,1)
    # Where nb=batch size, nr=num rows, nc=num cols
    def __getitem__(self,theIndex):
        X=[]
        y=[]
        bStart=max(theIndex*self.batchSize,0)
        bEnd=min((theIndex+1)*self.batchSize,self.numImages)
        for i in range(bStart,bEnd):
            [curImage,curGT]=self._load_image_(i)
            X.append(curImage)
            y.append(curGT)
        return np.array(X),np.array(y)
```

[35]:

```
#Modelo con dropout:
from tensorflow.keras import models
from tensorflow.keras import optimizers
from tensorflow.keras.layers import Conv2D, MaxPooling2D, UpSampling2D, Dense,␣
 ↪Flatten, Softmax, Rescaling, Dropout
import tensorflow as tf

def createModelTest(color, n=num_classes):
    if color == True:
        shape = (280,832,3)
    else:
        shape = (280,832,1)
    model_test = models.Sequential([
      Conv2D(16, 3, padding='same', activation='relu', input_shape=shape),
      MaxPooling2D(),
      Conv2D(32, 3, padding='same', activation='relu'),
      MaxPooling2D(),
      Conv2D(64, 3, padding='same', activation='relu'),
      MaxPooling2D(),
      Flatten(),
      Dense(128, activation='relu'),
      Dropout(0.5),
      Dense(n, activation='softmax'),
      Flatten()
    ])
    return model_test
```

[36]:

```
def createModelTestCustomShape(color,w,h):
    if color == True:
        shape = (w,h,3)
    else:
        shape = (w,h,1)
    model_test = models.Sequential([
      #Rescaling(1./255, input_shape=(280,832,3)),
      Conv2D(16, 3, padding='same', activation='relu', input_shape=shape),
      MaxPooling2D(),
      Conv2D(32, 3, padding='same', activation='relu'),
      MaxPooling2D(),
      Conv2D(64, 3, padding='same', activation='relu'),
      MaxPooling2D(),
      Flatten(),
      Dense(128, activation='relu'),
      Dropout(0.5),
      Dense(num_classes, activation='softmax'),
      Flatten()
      #Dense(num_classes,activation='softmax')
      # ,Flatten()
    ])
    return model_test
```

[37]:

```
def plot_history(history):
# summarize history for accuracy
    plt.plot(history.history['accuracy'])
    plt.plot(history.history['val_accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()
    # summarize history for loss
    plt.plot(history.history['loss'])
    plt.plot(history.history['val_loss'])
    plt.title('model loss')
    plt.ylabel('loss')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()

def plot_history_2(history):
    plt.plot(history.history['accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()
    # summarize history for loss
    plt.plot(history.history['loss'])
    plt.title('model loss')
    plt.ylabel('loss')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()
```

[38]:

```
def showResult(predicted, test, array):
    filename = test['X']
    img = skimage.io.imread("images/"+filename)

    plt.figure()
    plt.title(test['y']+" "+str(test['factor_brand']))
    plt.imshow(img)
    if array == True:
        print(predicted)
        sort_index = np.argsort(-predicted)
        print(sort_index)
    else:
        print(predicted)
```

[39]:

```
#Calular porcentaje que aparecen en las 3 primera posiciones
def getXfirstOk(predicted, test, x):
    sort_index = np.argsort(-predicted)
    if test['factor_brand'] in sort_index[:x]:
        return True
    return False
```

[40]:

```
def checkAccuracyFirstPositions(predicted_y, shoes_test, x):
    total = len(predicted_y)
    ok = 0
    for i in range(total):
        if getXfirstOk(predicted_y[i],shoes_test.iloc[i],x):
            ok = ok+1

    print(ok)
    print(ok/total)
```

[41]:

```
#Devuelve el % de veces que la marca se predijo con un porcentage >= minPercent
#Porcentaje de aceptación.
def checkBrandPercent(predicted_y, shoes_test, minPercent):
    total = len(predicted_y)
    ok = 0
    for i in range(total):
        #print(shoes_test['factor_brand'].iloc[i])
        #print(predicted_y[int(shoes_test['factor_brand'].iloc[i])])
        if predicted_y[0][int(shoes_test['factor_brand'].iloc[i])] >=␣
 ↪minPercent:
            ok = ok+1

    print(ok/total)
```

[42]:

```
from sklearn.metrics import confusion_matrix,␣
 ↪plot_confusion_matrix,ConfusionMatrixDisplay

def printConfMatrix(predicted, test, n ):
    sort_index = np.argsort(-predicted)
    cm = confusion_matrix(test['factor_brand'],[item[0] for item in sort_index])

    cm_display = ConfusionMatrixDisplay(confusion_matrix = cm, display_labels =␣
 ↪range(n))

    cm_display.plot()
    plt.show()
```

[43]:

```
def checkModel(modelTest, testGenerator, shoes_test, num_classes):
    predicted_y = modelTest.predict(testGenerator)
    print("Test evaluation:")
    print(modelTest.evaluate(testGenerator))
    print("% of correct brand in the first 3 positions:")
    checkAccuracyFirstPositions(predicted_y, shoes_test,3)
    print("% of brand predicted with percentage >= 0.25") #independent from␣
 ↪position
    checkBrandPercent(predicted_y, shoes_test,0.25)
    print("% of brand predicted with percentage >= 0.5")
    checkBrandPercent(predicted_y, shoes_test,0.5)
    print("% of brand predicted with percentage >= 0.75")
    checkBrandPercent(predicted_y, shoes_test,0.75)
    print("Matriz de confusión:")
    printConfMatrix(predicted_y,shoes_test, num_classes)
```

[44]:

```
def executeModel(aumentation, gray, binary, crop, epoch):

    modelTest = createModelTest(not gray)

    modelTest.compile(optimizer='adam',
              loss=tf.keras.losses.
 ↪SparseCategoricalCrossentropy(from_logits=False),
              metrics=['accuracy'])

    #Configurar el preprocesado que se hará en las imágenes desntro del␣
 ↪Generator.
    trainGenerator=DataGenerator2dFootwear(shoes_train['X'].
 ↪tolist(),df_shoe_brand,aumentation, "images/", gray, binary, crop)
    testGenerator=DataGenerator2dFootwear(shoes_test['X'].
 ↪tolist(),df_shoe_brand,False, "images/", gray, binary, crop)
    valGenerator=DataGenerator2dFootwear(shoes_val['X'].
 ↪tolist(),df_shoe_brand,False, "images/", gray, binary, crop)
    print(" ")
    print('Training model with aumentation:'+str(aumentation)+', gray:
 ↪'+str(gray)+', binary:'+str(binary)+', crop:'+str(crop)+' and epochs =␣
 ↪'+str(epoch))
    trainHistory = modelTest.fit(trainGenerator,validation_data=valGenerator,␣
 ↪epochs=epoch)

    plot_history(trainHistory)

    checkModel(modelTest, testGenerator, shoes_test, num_classes)

    return modelTest #Devuelve el modelo por si se necesita hacer más pruebas␣
 ↪sin volver a entrenar.
```

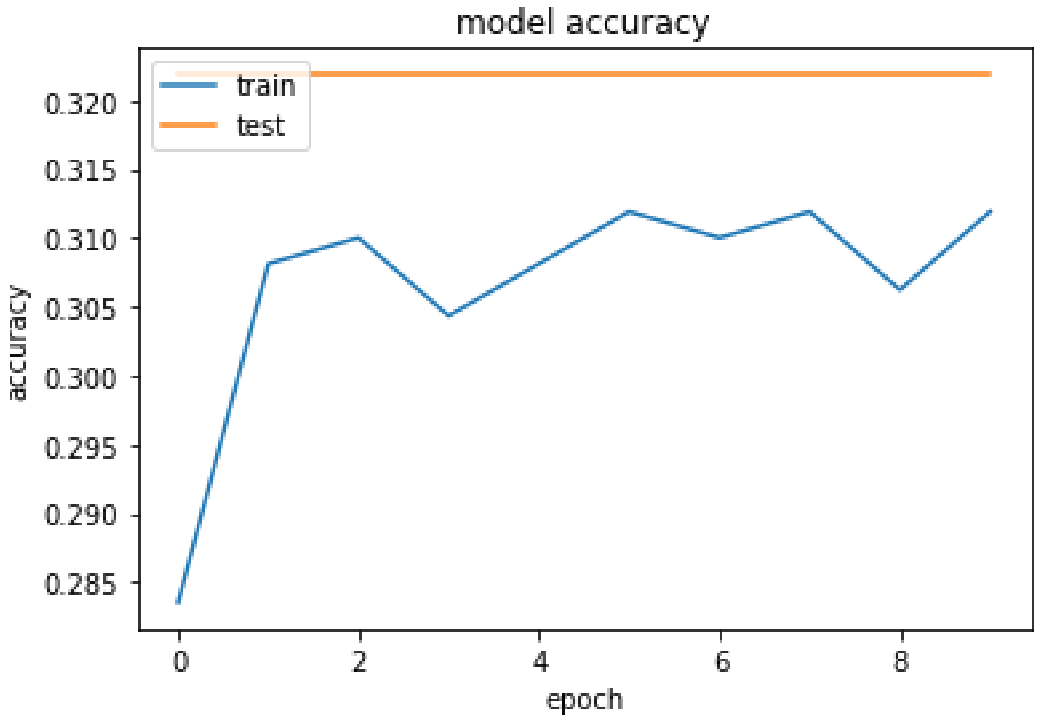
[46]:

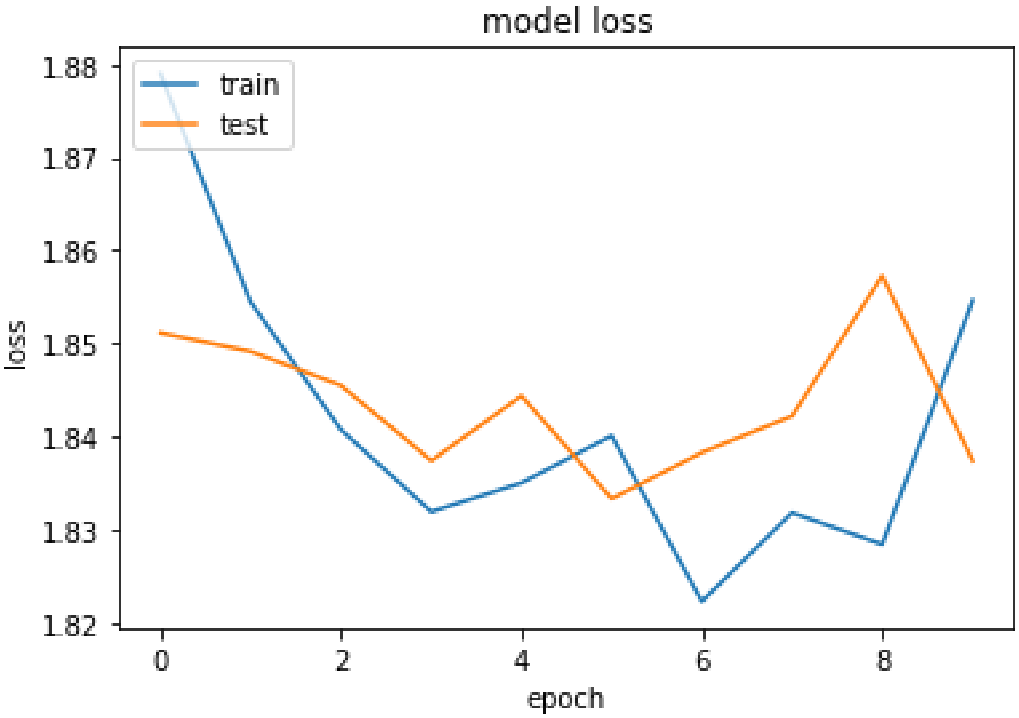
```
import cv2
def executeModelData(aumentation, gray, binary, crop, epoch, train, test, val,␣
 ↪df, n):

    modelTest = createModelTest(not gray, n)

    modelTest.compile(optimizer='adam',
              loss=tf.keras.losses.
 ↪SparseCategoricalCrossentropy(from_logits=False),
              metrics=['accuracy'])

    #Configurar el preprocesado que se hará en las imágenes desntro del␣
 ↪Generator.
    trainGenerator=DataGenerator2dFootwear(train['X'].tolist(),df,aumentation,␣
 ↪"images/", gray, binary, crop)
    testGenerator=DataGenerator2dFootwear(test['X'].tolist(),df,False, "images/
 ↪", gray, binary, crop)
    valGenerator=DataGenerator2dFootwear(val['X'].tolist(),df,False, "images/",␣
 ↪gray, binary, crop)
    print(" ")
    print('Training model with aumentation:'+str(aumentation)+', gray:
 ↪'+str(gray)+', binary:'+str(binary)+', crop:'+str(crop)+' and epochs =␣
 ↪'+str(epoch))
    trainHistory = modelTest.fit(trainGenerator,validation_data=valGenerator,␣
 ↪epochs=epoch)

    plot_history(trainHistory)

    predicted_y = modelTest.predict(testGenerator)
    print("Test evaluation:")
    print(modelTest.evaluate(testGenerator)) #first position
    print("% of correct brand in the first 3 positions:")
    checkAccuracyFirstPositions(predicted_y, test,3)
    print("% of brand predicted with percentage >= 0.25") #independent from␣
 ↪position
    checkBrandPercent(predicted_y, test,0.25)
    print("% of brand predicted with percentage >= 0.5")
    checkBrandPercent(predicted_y, test,0.5)
    print("% of brand predicted with percentage >= 0.75")
    checkBrandPercent(predicted_y, test,0.75)
    if n<=20:
        print("Matriz de confusión:")
        printConfMatrix(predicted_y,test,n)
    return modelTest
```

### 4.1.1 Experimentos con diferentes valores de epoch y diferentes preprocesos en las imágenes

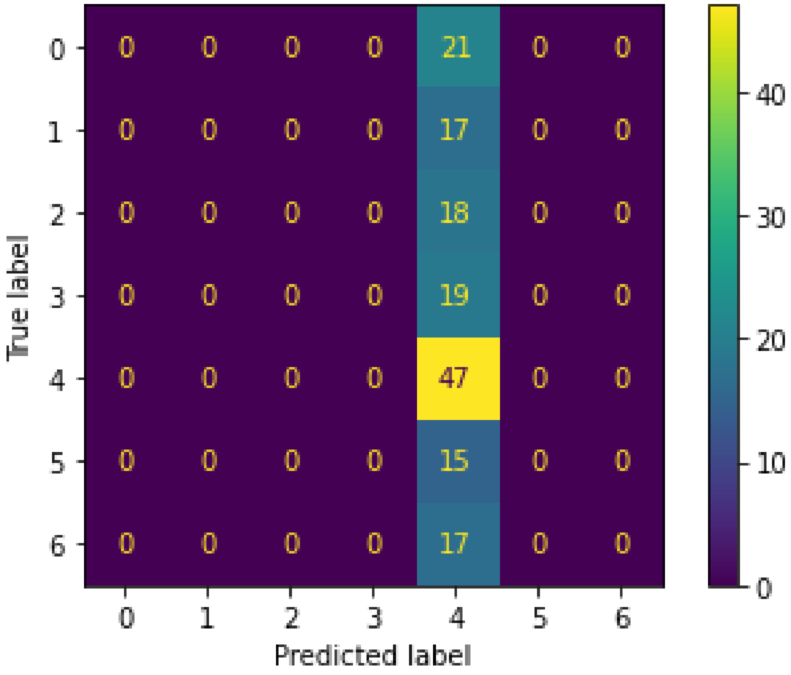
[177]:
```
model_test01=executeModel(False, False, False, False, 10)
```

```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
53/53 [==============================] - 66s 1s/step - loss: 1.8790 - accuracy:
0.2836 - val_loss: 1.8511 - val_accuracy: 0.3218
Epoch 2/10
53/53 [==============================] - 70s 1s/step - loss: 1.8544 - accuracy:
0.3081 - val_loss: 1.8491 - val_accuracy: 0.3218
Epoch 3/10
53/53 [==============================] - 102s 2s/step - loss: 1.8407 - accuracy:
0.3100 - val_loss: 1.8455 - val_accuracy: 0.3218
Epoch 4/10
53/53 [==============================] - 101s 2s/step - loss: 1.8319 - accuracy:
0.3043 - val_loss: 1.8374 - val_accuracy: 0.3218
Epoch 5/10
53/53 [==============================] - 84s 2s/step - loss: 1.8350 - accuracy:
0.3081 - val_loss: 1.8443 - val_accuracy: 0.3218
Epoch 6/10
53/53 [==============================] - 86s 2s/step - loss: 1.8400 - accuracy:
0.3119 - val_loss: 1.8333 - val_accuracy: 0.3218
Epoch 7/10
53/53 [==============================] - 79s 1s/step - loss: 1.8222 - accuracy:
0.3100 - val_loss: 1.8382 - val_accuracy: 0.3218
Epoch 8/10
53/53 [==============================] - 80s 2s/step - loss: 1.8318 - accuracy:
0.3119 - val_loss: 1.8422 - val_accuracy: 0.3218
Epoch 9/10
53/53 [==============================] - 80s 2s/step - loss: 1.8284 - accuracy:
0.3062 - val_loss: 1.8572 - val_accuracy: 0.3218
Epoch 10/10
53/53 [==============================] - 84s 2s/step - loss: 1.8546 - accuracy:
0.3119 - val_loss: 1.8374 - val_accuracy: 0.3218
```


model accuracy
train
test
0.320
0.315
0.310
0.305
0.300
0.295
0.290
0.285
accuracy
0
2
4
6
8
epoch


model loss
train
test
1.88
1.87
1.86
1.85
1.84
1.83
1.82
loss
0
2
4
6
8
epoch

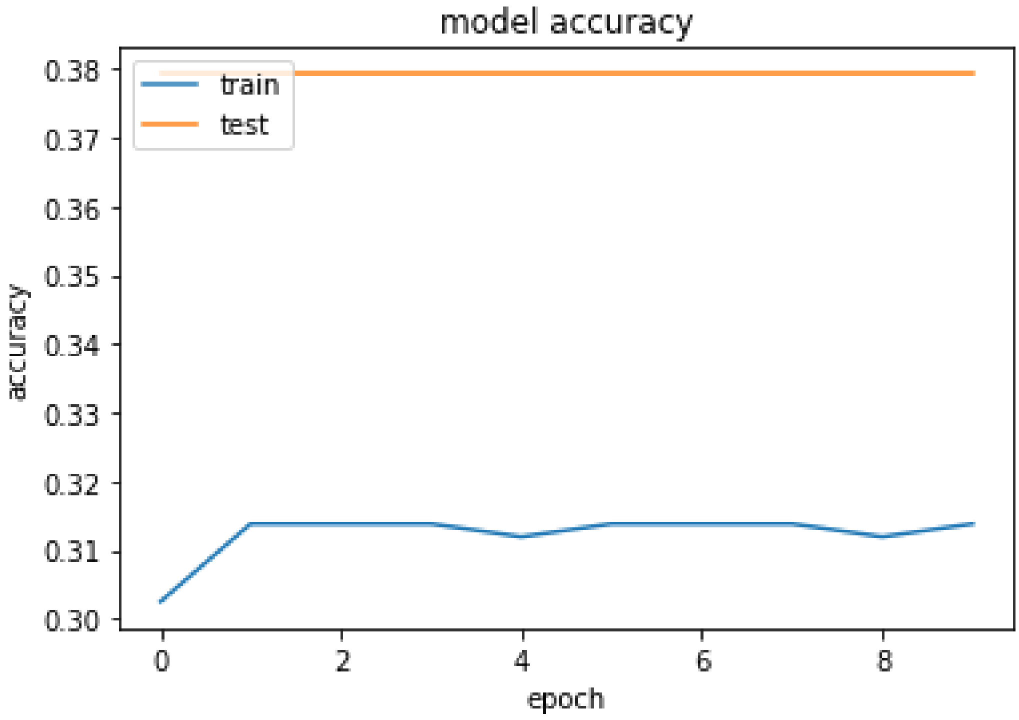
```
16/16 [==============================] - 6s 375ms/step
Test evaluation:
16/16 [==============================] - 6s 389ms/step - loss: 1.8854 -
accuracy: 0.3052
[1.8854320049285889, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

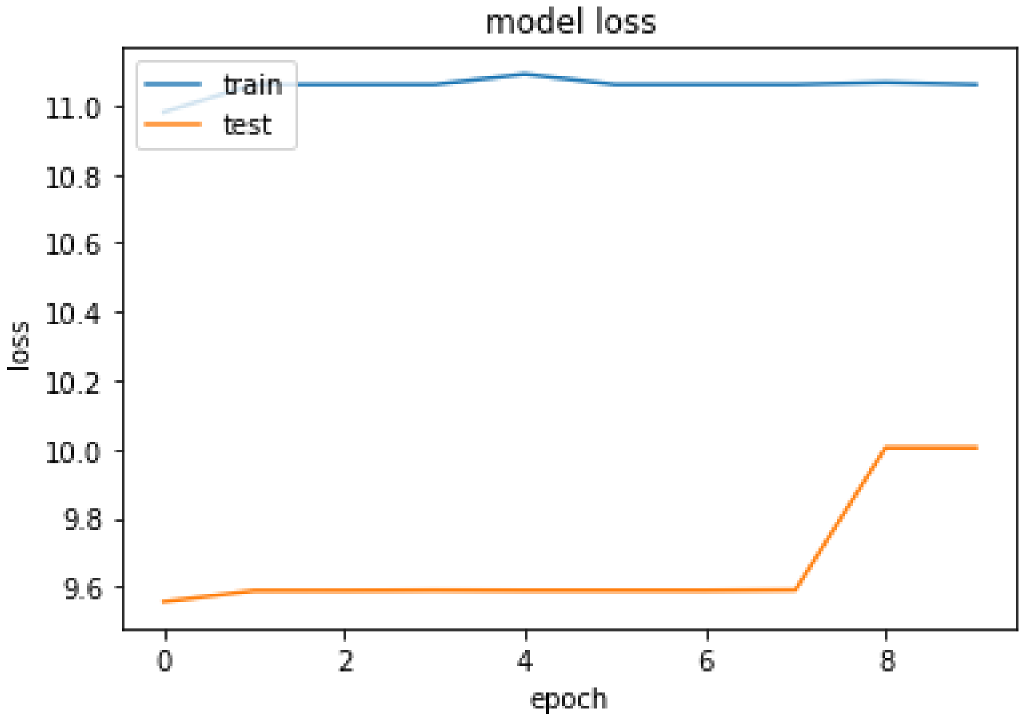


[47]:
```
model_test02=executeModel(True, False, False, False, 10)
```

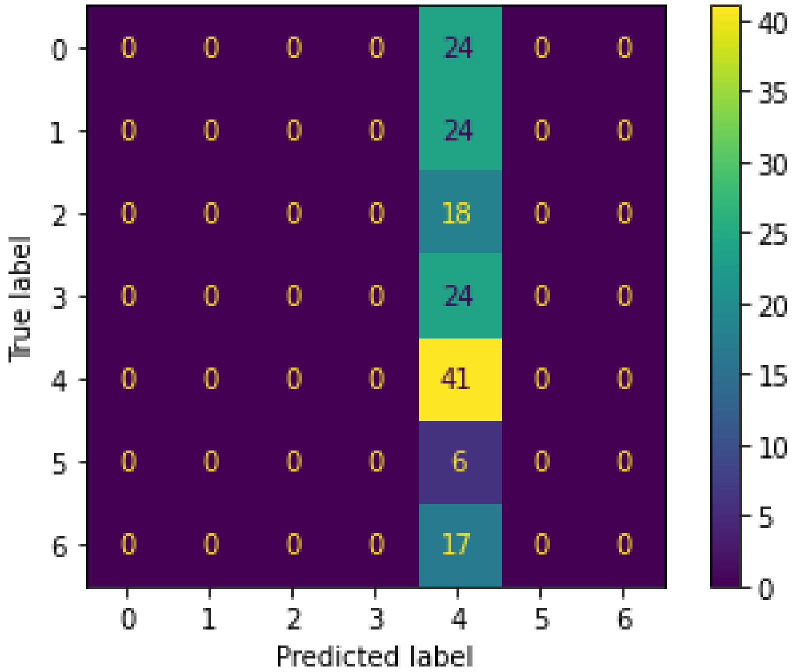
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
53/53 [==============================] - 61s 1s/step - loss: 10.9802 - accuracy:
0.3025 - val_loss: 9.5563 - val_accuracy: 0.3793
Epoch 2/10
```

```
53/53 [==============================] - 61s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5880 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5882 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5891 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 60s 1s/step - loss: 11.0907 - accuracy:
0.3119 - val_loss: 9.5885 - val_accuracy: 0.3793
Epoch 6/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5885 - val_accuracy: 0.3793
Epoch 7/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5885 - val_accuracy: 0.3793
Epoch 8/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 9.5901 - val_accuracy: 0.3793
Epoch 9/10
53/53 [==============================] - 59s 1s/step - loss: 11.0663 - accuracy:
0.3119 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 10/10
53/53 [==============================] - 60s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
```





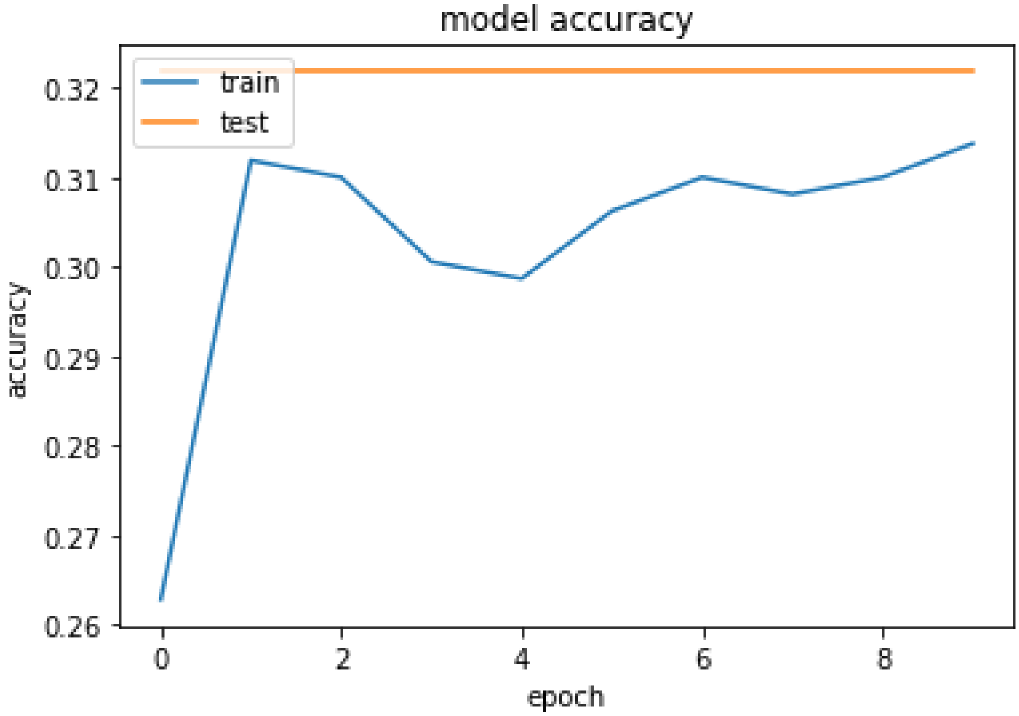
```
16/16 [==============================] - 4s 222ms/step
Test evaluation:
16/16 [==============================] - 4s 223ms/step - loss: 11.8269 -
accuracy: 0.2662
[11.826915740966797, 0.26623377203941345]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.2662337662337662
Matriz de confusión:
```

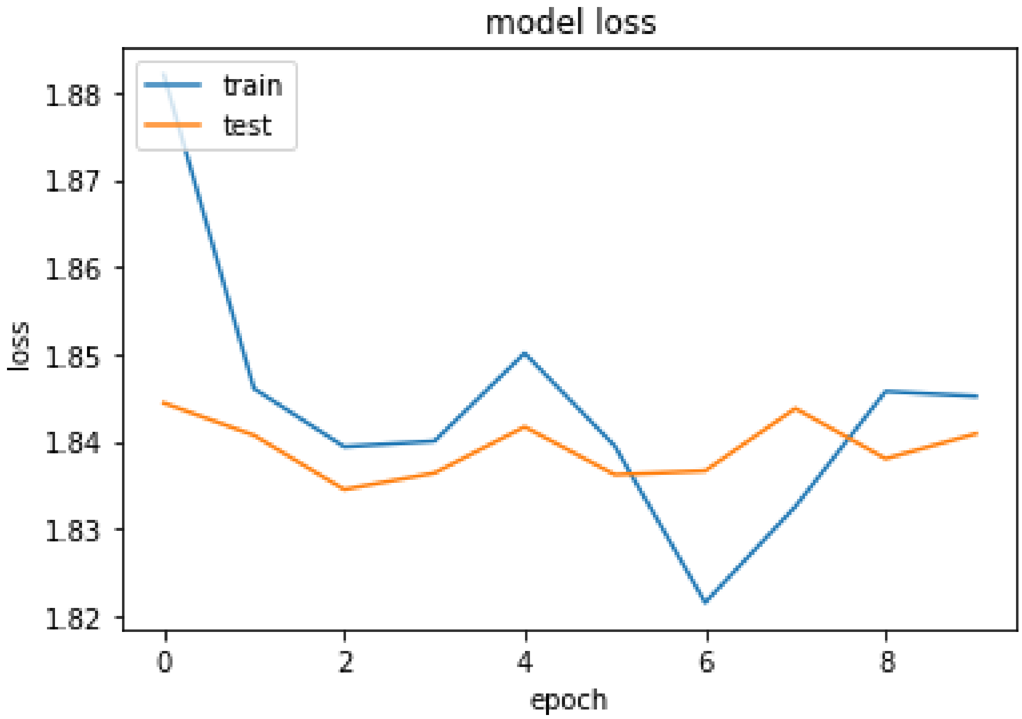


```
[179]: model_test03=executeModel(False, True, False, False, 10)
```

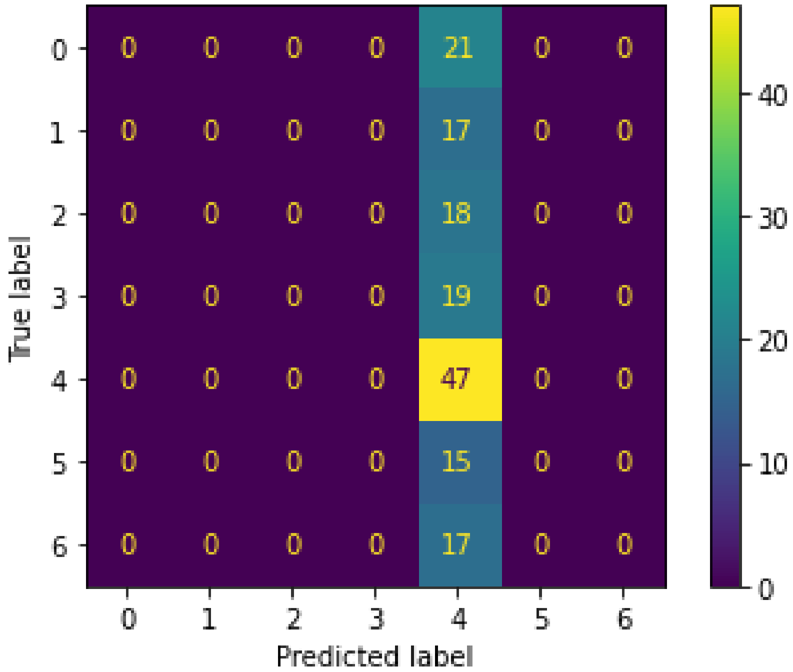
```
Training model with aumentation:False, gray:True, binary:False, crop:False and
epochs = 10
Epoch 1/10
53/53 [==============================] - 76s 1s/step - loss: 1.8820 - accuracy:
0.2628 - val_loss: 1.8444 - val_accuracy: 0.3218
Epoch 2/10
53/53 [==============================] - 73s 1s/step - loss: 1.8461 - accuracy:
0.3119 - val_loss: 1.8407 - val_accuracy: 0.3218
Epoch 3/10
53/53 [==============================] - 75s 1s/step - loss: 1.8394 - accuracy:
0.3100 - val_loss: 1.8345 - val_accuracy: 0.3218
Epoch 4/10
53/53 [==============================] - 74s 1s/step - loss: 1.8400 - accuracy:
0.3006 - val_loss: 1.8364 - val_accuracy: 0.3218
Epoch 5/10
53/53 [==============================] - 75s 1s/step - loss: 1.8501 - accuracy:
0.2987 - val_loss: 1.8417 - val_accuracy: 0.3218
Epoch 6/10
53/53 [==============================] - 75s 1s/step - loss: 1.8395 - accuracy:
0.3062 - val_loss: 1.8362 - val_accuracy: 0.3218
Epoch 7/10
53/53 [==============================] - 73s 1s/step - loss: 1.8215 - accuracy:
```

```
0.3100 - val_loss: 1.8366 - val_accuracy: 0.3218
Epoch 8/10
53/53 [==============================] - 74s 1s/step - loss: 1.8325 - accuracy:
0.3081 - val_loss: 1.8438 - val_accuracy: 0.3218
Epoch 9/10
53/53 [==============================] - 74s 1s/step - loss: 1.8457 - accuracy:
0.3100 - val_loss: 1.8380 - val_accuracy: 0.3218
Epoch 10/10
53/53 [==============================] - 76s 1s/step - loss: 1.8452 - accuracy:
0.3138 - val_loss: 1.8409 - val_accuracy: 0.3218
```





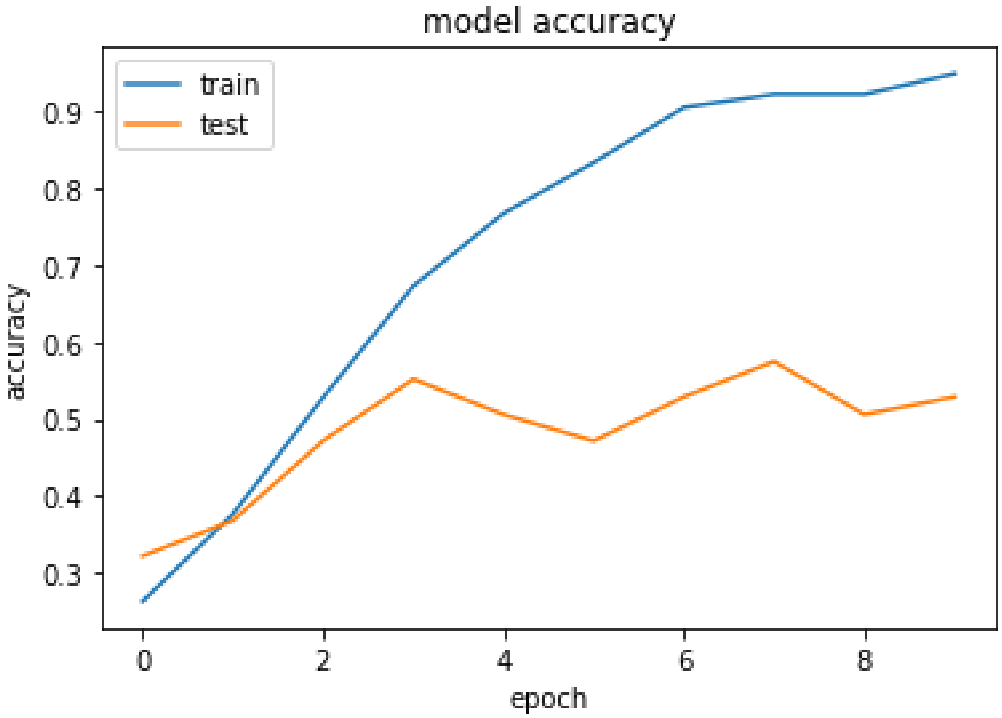
```
16/16 [==============================] - 5s 309ms/step
Test evaluation:
16/16 [==============================] - 5s 309ms/step - loss: 1.8762 -
accuracy: 0.3052
[1.8761883974075317, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

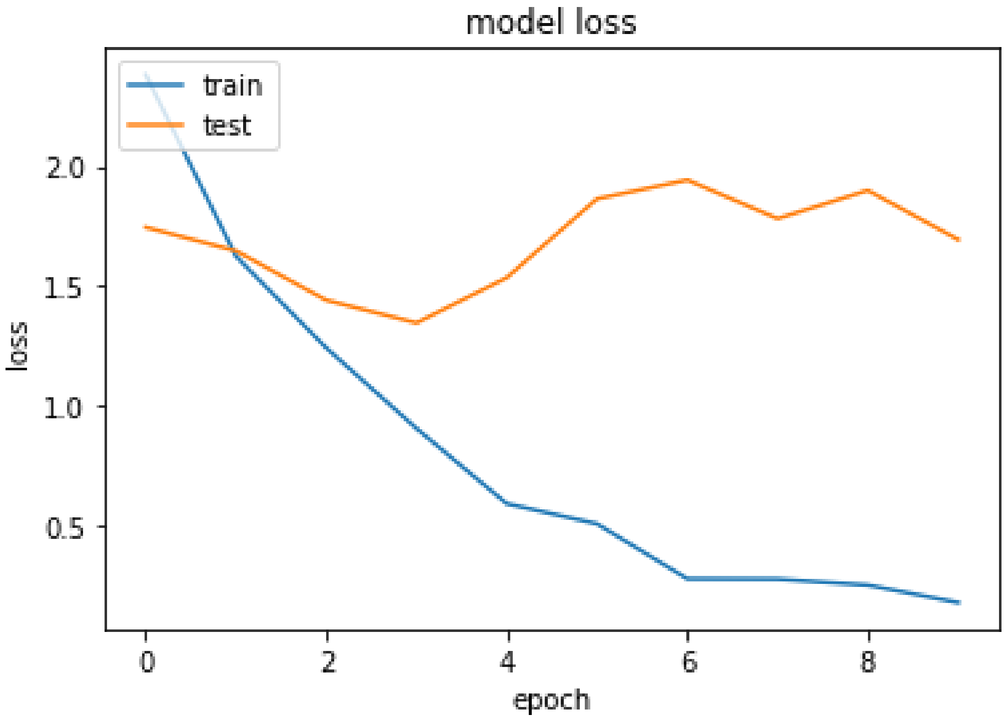


```
[187]: model_test04=executeModel(False, True, True, False, 10)
```

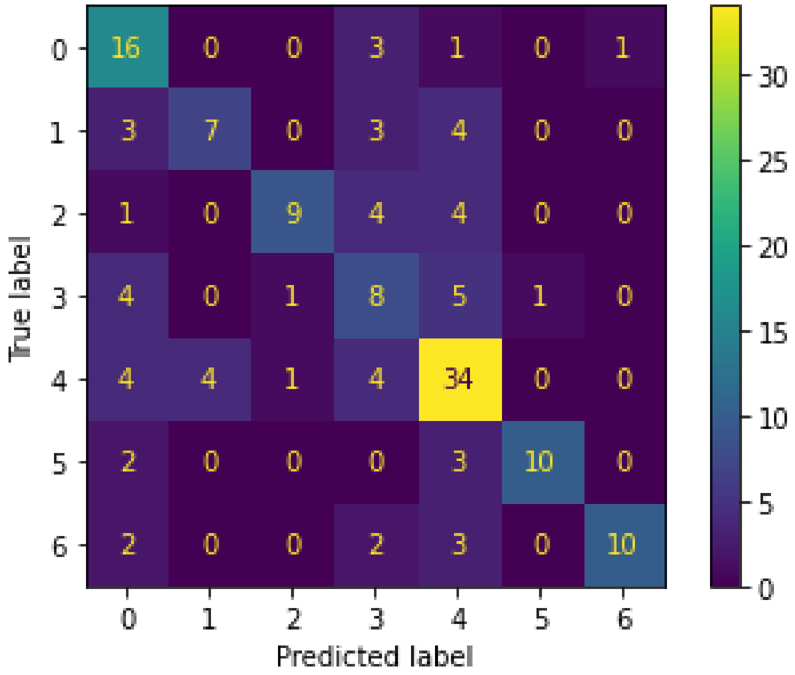
```
Training model with aumentation:False, gray:True, binary:True, crop:False and
epochs = 10
Epoch 1/10
53/53 [==============================] - 62s 1s/step - loss: 2.3828 - accuracy:
0.2628 - val_loss: 1.7450 - val_accuracy: 0.3218
Epoch 2/10
53/53 [==============================] - 59s 1s/step - loss: 1.6245 - accuracy:
0.3762 - val_loss: 1.6468 - val_accuracy: 0.3678
Epoch 3/10
53/53 [==============================] - 60s 1s/step - loss: 1.2421 - accuracy:
0.5274 - val_loss: 1.4411 - val_accuracy: 0.4713
Epoch 4/10
53/53 [==============================] - 81s 2s/step - loss: 0.9045 - accuracy:
0.6730 - val_loss: 1.3460 - val_accuracy: 0.5517
Epoch 5/10
53/53 [==============================] - 85s 2s/step - loss: 0.5910 - accuracy:
0.7675 - val_loss: 1.5350 - val_accuracy: 0.5057
Epoch 6/10
53/53 [==============================] - 77s 1s/step - loss: 0.5069 - accuracy:
0.8336 - val_loss: 1.8639 - val_accuracy: 0.4713
Epoch 7/10
53/53 [==============================] - 77s 1s/step - loss: 0.2766 - accuracy:
```

```
0.9055 - val_loss: 1.9427 - val_accuracy: 0.5287
Epoch 8/10
53/53 [==============================] - 77s 1s/step - loss: 0.2756 - accuracy:
0.9225 - val_loss: 1.7813 - val_accuracy: 0.5747
Epoch 9/10
53/53 [==============================] - 77s 1s/step - loss: 0.2505 - accuracy:
0.9225 - val_loss: 1.8993 - val_accuracy: 0.5057
Epoch 10/10
53/53 [==============================] - 77s 1s/step - loss: 0.1776 - accuracy:
0.9490 - val_loss: 1.6934 - val_accuracy: 0.5287
```





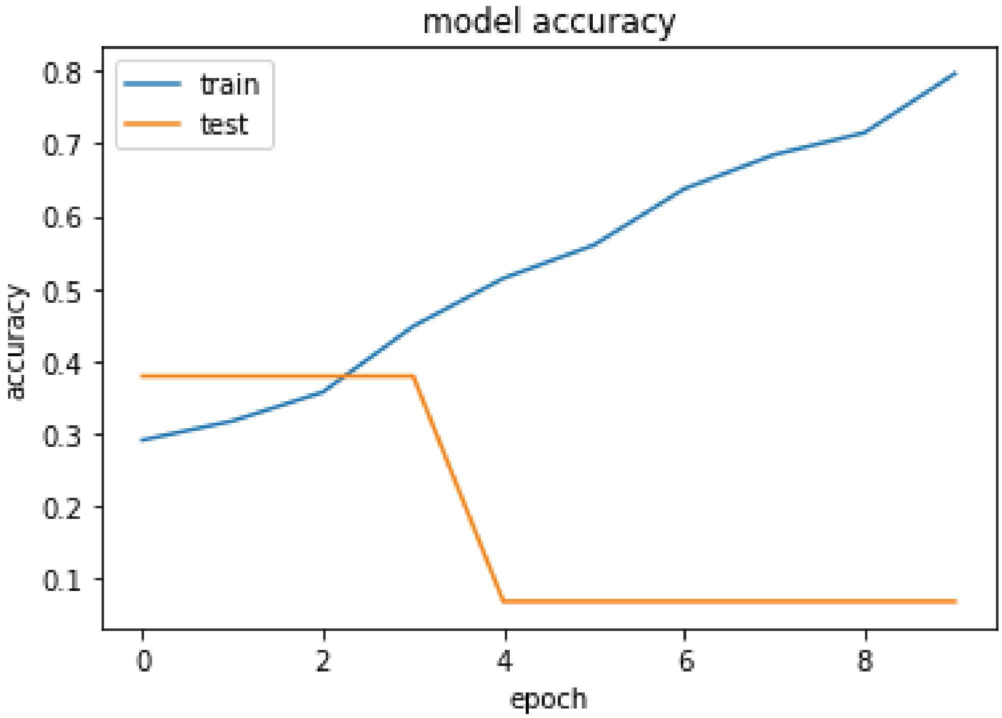
```
16/16 [==============================] - 5s 301ms/step
Test evaluation:
16/16 [==============================] - 5s 303ms/step - loss: 1.4311 -
accuracy: 0.6104
[1.4310550689697266, 0.6103895902633667]
% of correct brand in the first 3 positions:
130
0.8441558441558441
% of brand predicted with percentage >= 0.25
0.12337662337662338
% of brand predicted with percentage >= 0.5
0.12337662337662338
% of brand predicted with percentage >= 0.75
0.12337662337662338
Matriz de confusión:
```

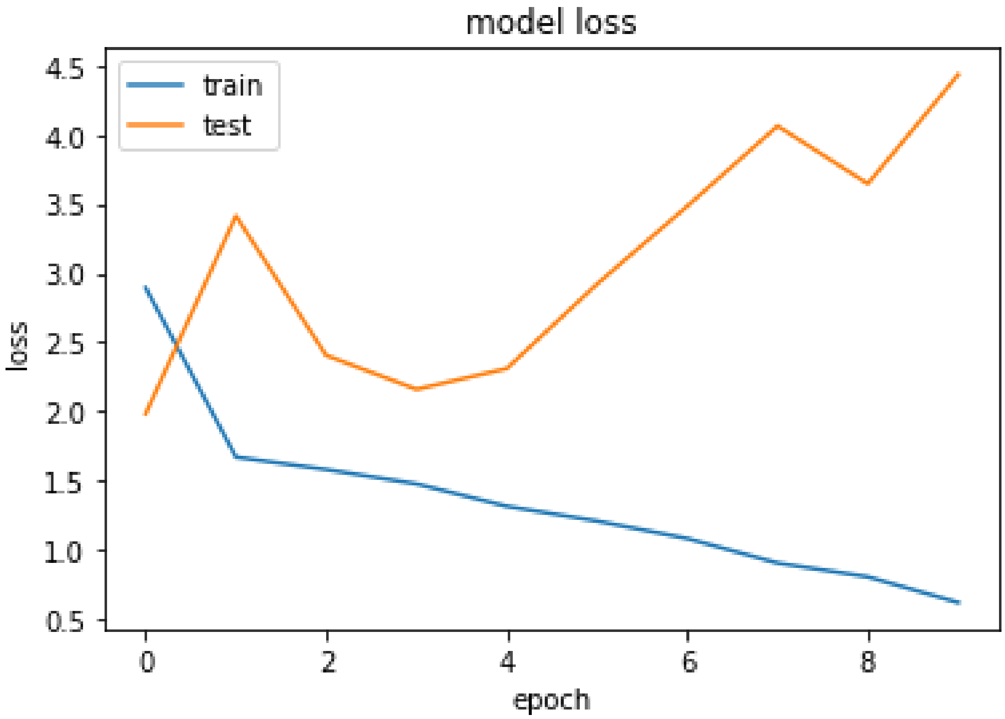


[48]:
```
model_test05=executeModel(True, True, False, False, 10)
```

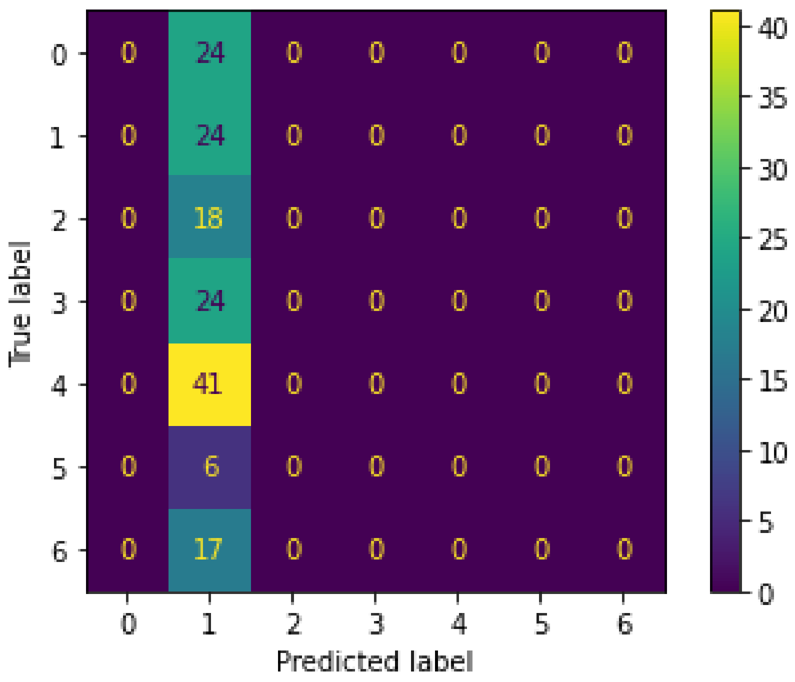
```
Training model with aumentation:True, gray:True, binary:False, crop:False and
epochs = 10
Epoch 1/10
53/53 [==============================] - 57s 1s/step - loss: 2.8948 - accuracy:
0.2911 - val_loss: 1.9839 - val_accuracy: 0.3793
Epoch 2/10
53/53 [==============================] - 54s 1s/step - loss: 1.6720 - accuracy:
0.3176 - val_loss: 3.4131 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 54s 1s/step - loss: 1.5822 - accuracy:
0.3573 - val_loss: 2.4062 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 54s 1s/step - loss: 1.4783 - accuracy:
0.4480 - val_loss: 2.1607 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 54s 1s/step - loss: 1.3163 - accuracy:
0.5142 - val_loss: 2.3105 - val_accuracy: 0.0690
Epoch 6/10
53/53 [==============================] - 55s 1s/step - loss: 1.2099 - accuracy:
0.5595 - val_loss: 2.9211 - val_accuracy: 0.0690
Epoch 7/10
53/53 [==============================] - 54s 1s/step - loss: 1.0831 - accuracy:
```

```
0.6371 - val_loss: 3.4839 - val_accuracy: 0.0690
Epoch 8/10
53/53 [==============================] - 54s 1s/step - loss: 0.9062 - accuracy:
0.6843 - val_loss: 4.0632 - val_accuracy: 0.0690
Epoch 9/10
53/53 [==============================] - 54s 1s/step - loss: 0.8064 - accuracy:
0.7146 - val_loss: 3.6453 - val_accuracy: 0.0690
Epoch 10/10
53/53 [==============================] - 54s 1s/step - loss: 0.6205 - accuracy:
0.7958 - val_loss: 4.4338 - val_accuracy: 0.0690
```





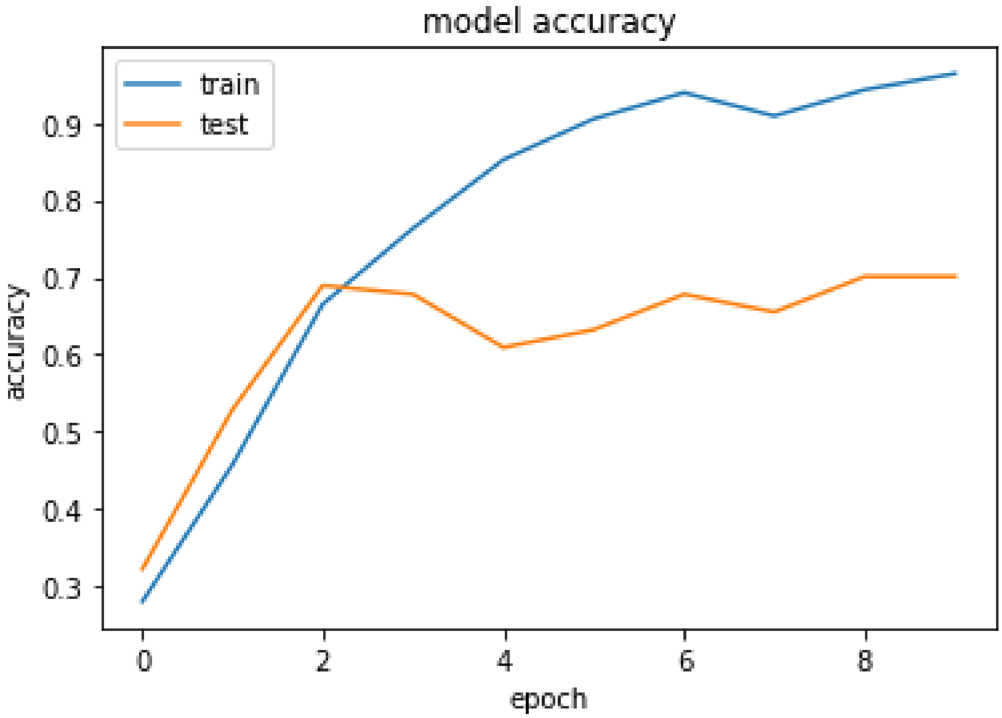
```
16/16 [==============================] - 3s 191ms/step
Test evaluation:
16/16 [==============================] - 3s 185ms/step - loss: 4.1703 -
accuracy: 0.1558
[4.170345783233643, 0.15584415197372437]
% of correct brand in the first 3 positions:
72
0.4675324675324675
% of brand predicted with percentage >= 0.25
0.3116883116883117
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

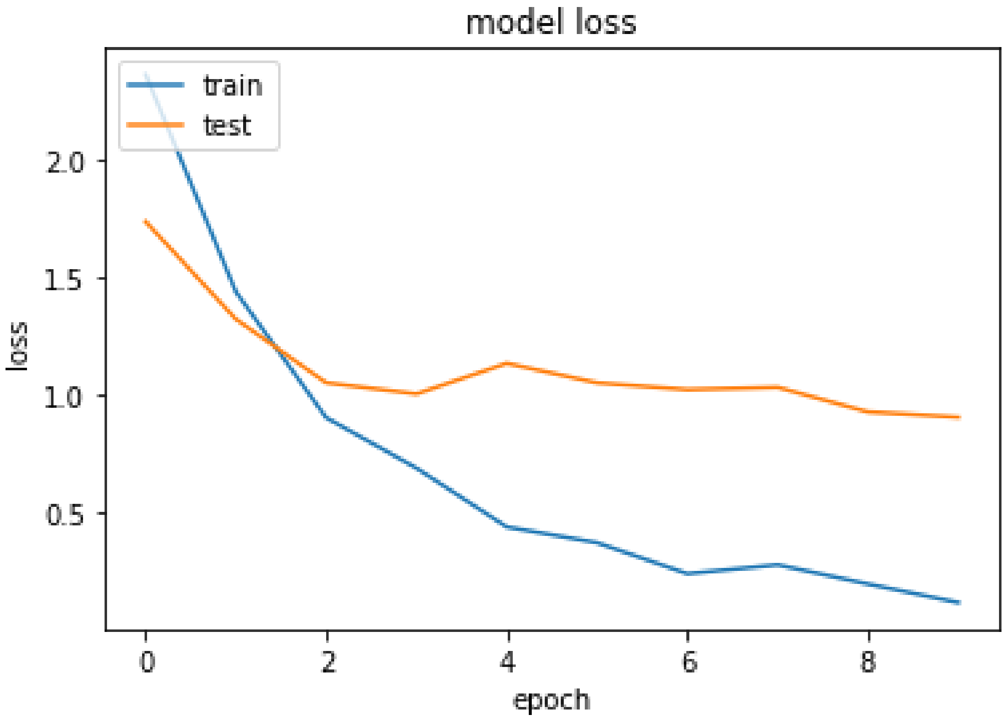


[188]:
```
model_test06=executeModel(False, True, True, True, 10)
```

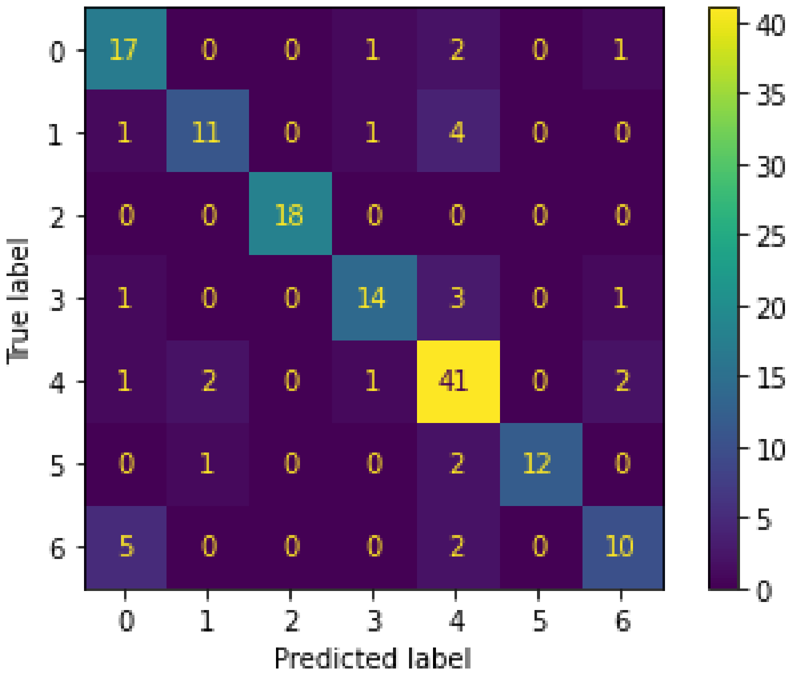
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
53/53 [==============================] - 83s 2s/step - loss: 2.3565 - accuracy:
0.2798 - val_loss: 1.7333 - val_accuracy: 0.3218
Epoch 2/10
53/53 [==============================] - 78s 1s/step - loss: 1.4362 - accuracy:
0.4575 - val_loss: 1.3203 - val_accuracy: 0.5287
Epoch 3/10
53/53 [==============================] - 78s 1s/step - loss: 0.9025 - accuracy:
0.6654 - val_loss: 1.0504 - val_accuracy: 0.6897
Epoch 4/10
53/53 [==============================] - 79s 1s/step - loss: 0.6889 - accuracy:
0.7637 - val_loss: 1.0032 - val_accuracy: 0.6782
Epoch 5/10
53/53 [==============================] - 79s 1s/step - loss: 0.4395 - accuracy:
0.8526 - val_loss: 1.1328 - val_accuracy: 0.6092
Epoch 6/10
53/53 [==============================] - 79s 1s/step - loss: 0.3727 - accuracy:
0.9055 - val_loss: 1.0501 - val_accuracy: 0.6322
Epoch 7/10
53/53 [==============================] - 78s 1s/step - loss: 0.2411 - accuracy:
```

```
0.9395 - val_loss: 1.0214 - val_accuracy: 0.6782
Epoch 8/10
53/53 [==============================] - 79s 1s/step - loss: 0.2790 - accuracy:
0.9093 - val_loss: 1.0311 - val_accuracy: 0.6552
Epoch 9/10
53/53 [==============================] - 78s 1s/step - loss: 0.1976 - accuracy:
0.9433 - val_loss: 0.9268 - val_accuracy: 0.7011
Epoch 10/10
53/53 [==============================] - 81s 2s/step - loss: 0.1189 - accuracy:
0.9641 - val_loss: 0.9042 - val_accuracy: 0.7011
```





```
16/16 [==============================] - 6s 349ms/step
Test evaluation:
16/16 [==============================] - 6s 375ms/step - loss: 0.7334 -
accuracy: 0.7987
[0.7333762645721436, 0.798701286315918]
% of correct brand in the first 3 positions:
145
0.9415584415584416
% of brand predicted with percentage >= 0.25
0.11688311688311688
% of brand predicted with percentage >= 0.5
0.11688311688311688
% of brand predicted with percentage >= 0.75
0.11688311688311688
Matriz de confusión:
```

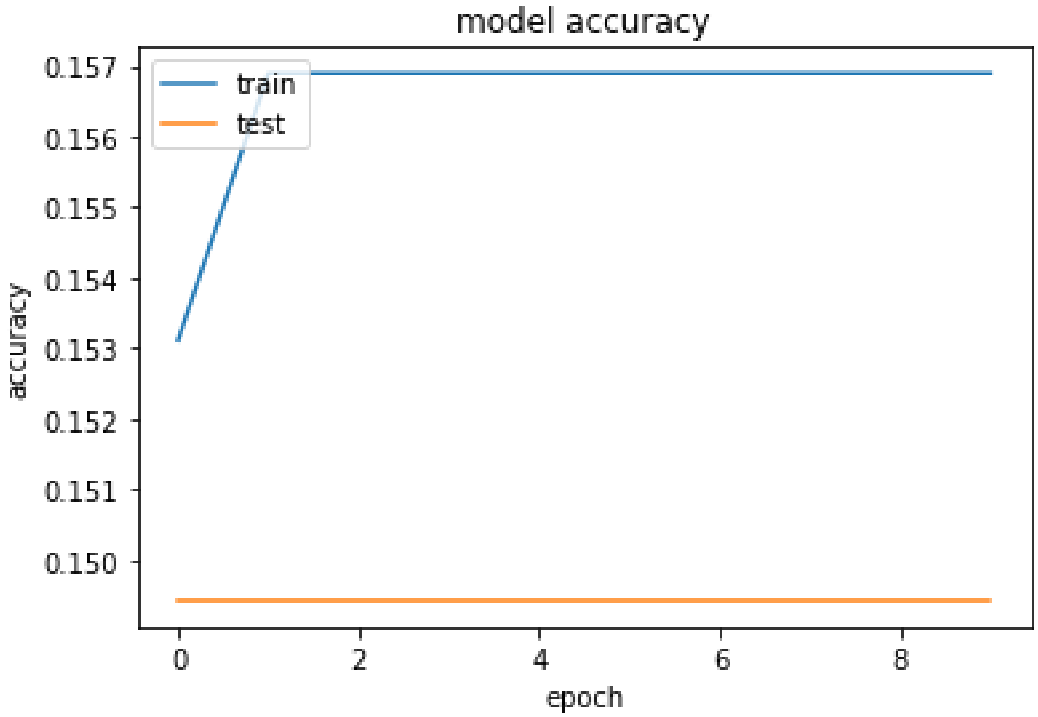


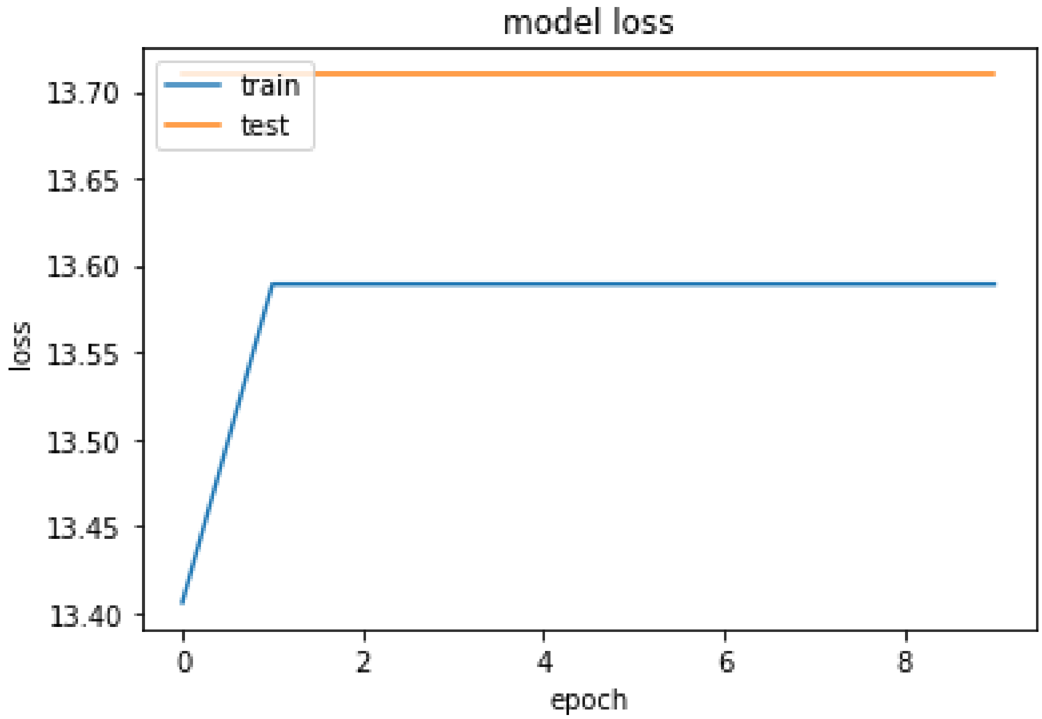
```
[ ]: modeltest06.summary()
```

```
[49]: model_test07=executeModel(True, True, True, True, 10)
```

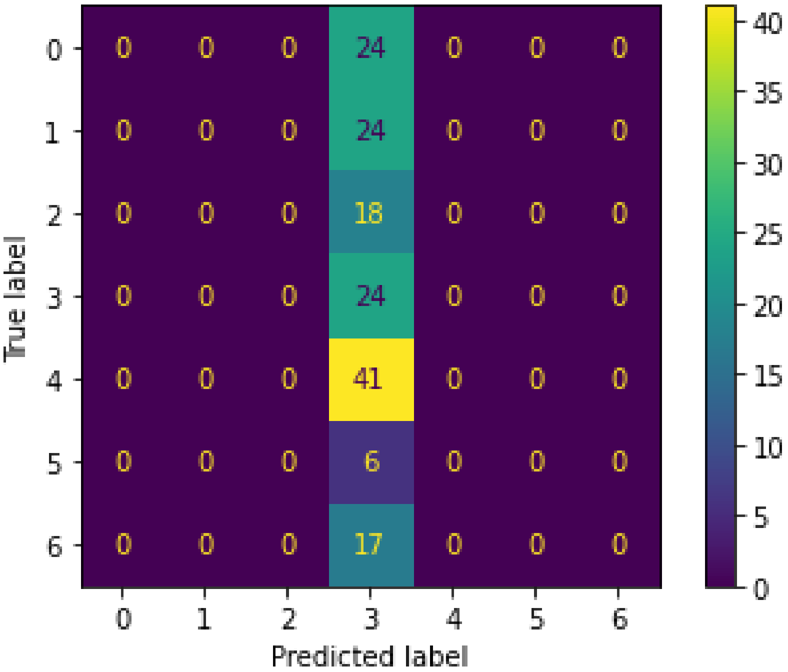
```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
53/53 [==============================] - 58s 1s/step - loss: 13.4060 - accuracy:
0.1531 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 2/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 3/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 4/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 5/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 6/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
```

```
Epoch 7/10
53/53 [==============================] - 56s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 8/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 9/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 10/10
53/53 [==============================] - 55s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
```





```
16/16 [==============================] - 4s 207ms/step
Test evaluation:
16/16 [==============================] - 3s 206ms/step - loss: 13.6062 -
accuracy: 0.1558
[13.606184959411621, 0.15584415197372437]
% of correct brand in the first 3 positions:
72
0.4675324675324675
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```

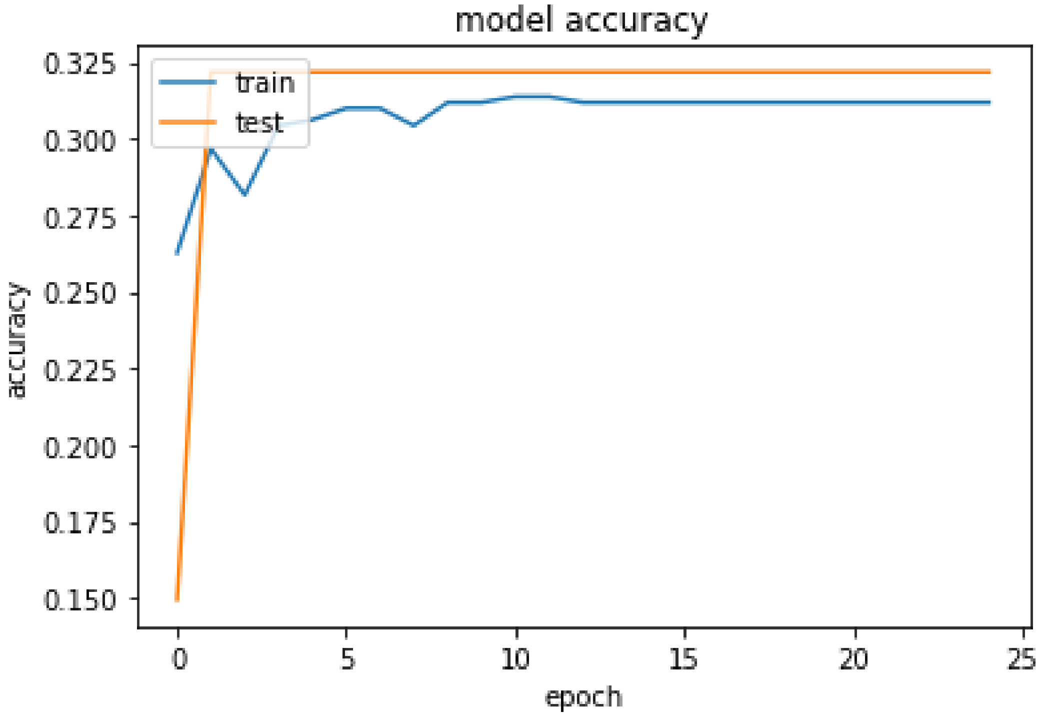


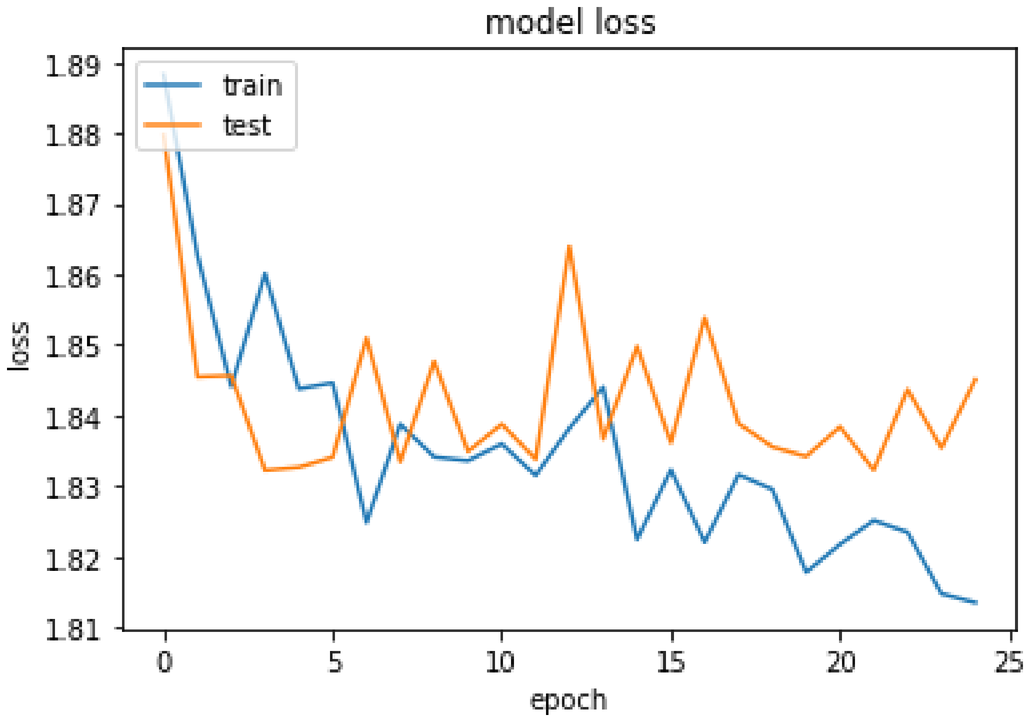
[191]:
```
model_test08=executeModel(False, False, False, False, 25)
```

```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 25
Epoch 1/25
53/53 [==============================] - 66s 1s/step - loss: 1.8883 - accuracy:
0.2628 - val_loss: 1.8797 - val_accuracy: 0.1494
Epoch 2/25
53/53 [==============================] - 64s 1s/step - loss: 1.8627 - accuracy:
0.2968 - val_loss: 1.8455 - val_accuracy: 0.3218
Epoch 3/25
53/53 [==============================] - 64s 1s/step - loss: 1.8441 - accuracy:
0.2817 - val_loss: 1.8457 - val_accuracy: 0.3218
Epoch 4/25
53/53 [==============================] - 86s 2s/step - loss: 1.8601 - accuracy:
0.3043 - val_loss: 1.8323 - val_accuracy: 0.3218
Epoch 5/25
53/53 [==============================] - 86s 2s/step - loss: 1.8438 - accuracy:
0.3062 - val_loss: 1.8327 - val_accuracy: 0.3218
Epoch 6/25
53/53 [==============================] - 84s 2s/step - loss: 1.8446 - accuracy:
0.3100 - val_loss: 1.8341 - val_accuracy: 0.3218
Epoch 7/25
53/53 [==============================] - 86s 2s/step - loss: 1.8249 - accuracy:
```

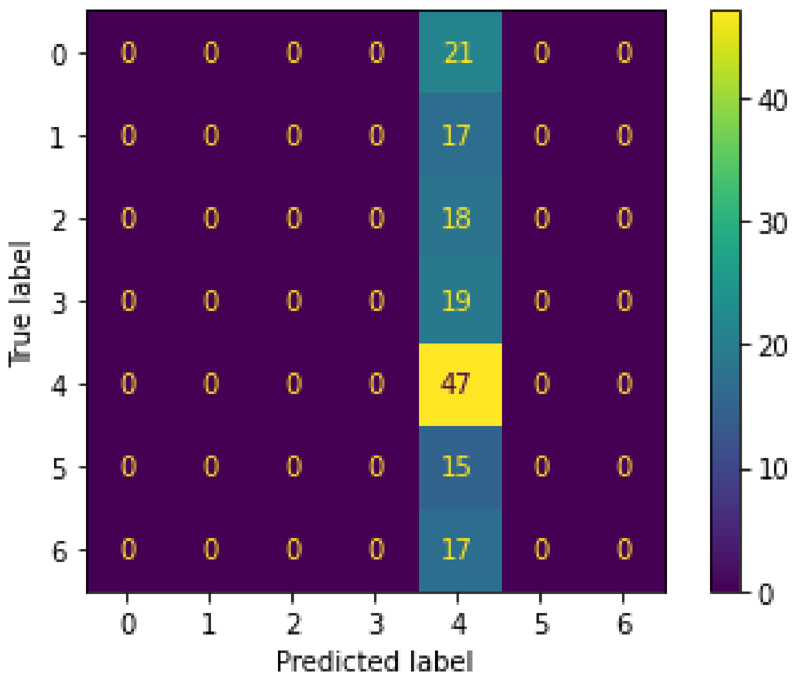
```
0.3100 - val_loss: 1.8510 - val_accuracy: 0.3218
Epoch 8/25
53/53 [==============================] - 83s 2s/step - loss: 1.8388 - accuracy:
0.3043 - val_loss: 1.8335 - val_accuracy: 0.3218
Epoch 9/25
53/53 [==============================] - 87s 2s/step - loss: 1.8342 - accuracy:
0.3119 - val_loss: 1.8477 - val_accuracy: 0.3218
Epoch 10/25
53/53 [==============================] - 84s 2s/step - loss: 1.8336 - accuracy:
0.3119 - val_loss: 1.8349 - val_accuracy: 0.3218
Epoch 11/25
53/53 [==============================] - 85s 2s/step - loss: 1.8360 - accuracy:
0.3138 - val_loss: 1.8388 - val_accuracy: 0.3218
Epoch 12/25
53/53 [==============================] - 83s 2s/step - loss: 1.8315 - accuracy:
0.3138 - val_loss: 1.8338 - val_accuracy: 0.3218
Epoch 13/25
53/53 [==============================] - 82s 2s/step - loss: 1.8382 - accuracy:
0.3119 - val_loss: 1.8639 - val_accuracy: 0.3218
Epoch 14/25
53/53 [==============================] - 85s 2s/step - loss: 1.8440 - accuracy:
0.3119 - val_loss: 1.8367 - val_accuracy: 0.3218
Epoch 15/25
53/53 [==============================] - 82s 2s/step - loss: 1.8225 - accuracy:
0.3119 - val_loss: 1.8498 - val_accuracy: 0.3218
Epoch 16/25
53/53 [==============================] - 82s 2s/step - loss: 1.8323 - accuracy:
0.3119 - val_loss: 1.8362 - val_accuracy: 0.3218
Epoch 17/25
53/53 [==============================] - 81s 2s/step - loss: 1.8221 - accuracy:
0.3119 - val_loss: 1.8539 - val_accuracy: 0.3218
Epoch 18/25
53/53 [==============================] - 82s 2s/step - loss: 1.8316 - accuracy:
0.3119 - val_loss: 1.8389 - val_accuracy: 0.3218
Epoch 19/25
53/53 [==============================] - 85s 2s/step - loss: 1.8296 - accuracy:
0.3119 - val_loss: 1.8356 - val_accuracy: 0.3218
Epoch 20/25
53/53 [==============================] - 84s 2s/step - loss: 1.8178 - accuracy:
0.3119 - val_loss: 1.8342 - val_accuracy: 0.3218
Epoch 21/25
53/53 [==============================] - 83s 2s/step - loss: 1.8218 - accuracy:
0.3119 - val_loss: 1.8384 - val_accuracy: 0.3218
Epoch 22/25
53/53 [==============================] - 83s 2s/step - loss: 1.8252 - accuracy:
0.3119 - val_loss: 1.8323 - val_accuracy: 0.3218
Epoch 23/25
53/53 [==============================] - 81s 2s/step - loss: 1.8235 - accuracy:
```

```
0.3119 - val_loss: 1.8437 - val_accuracy: 0.3218
Epoch 24/25
53/53 [==============================] - 80s 2s/step - loss: 1.8148 - accuracy:
0.3119 - val_loss: 1.8354 - val_accuracy: 0.3218
Epoch 25/25
53/53 [==============================] - 82s 2s/step - loss: 1.8135 - accuracy:
0.3119 - val_loss: 1.8451 - val_accuracy: 0.3218
```





```
16/16 [==============================] - 7s 388ms/step
Test evaluation:
16/16 [==============================] - 6s 375ms/step - loss: 1.9063 -
accuracy: 0.3052
[1.9063286781311035, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

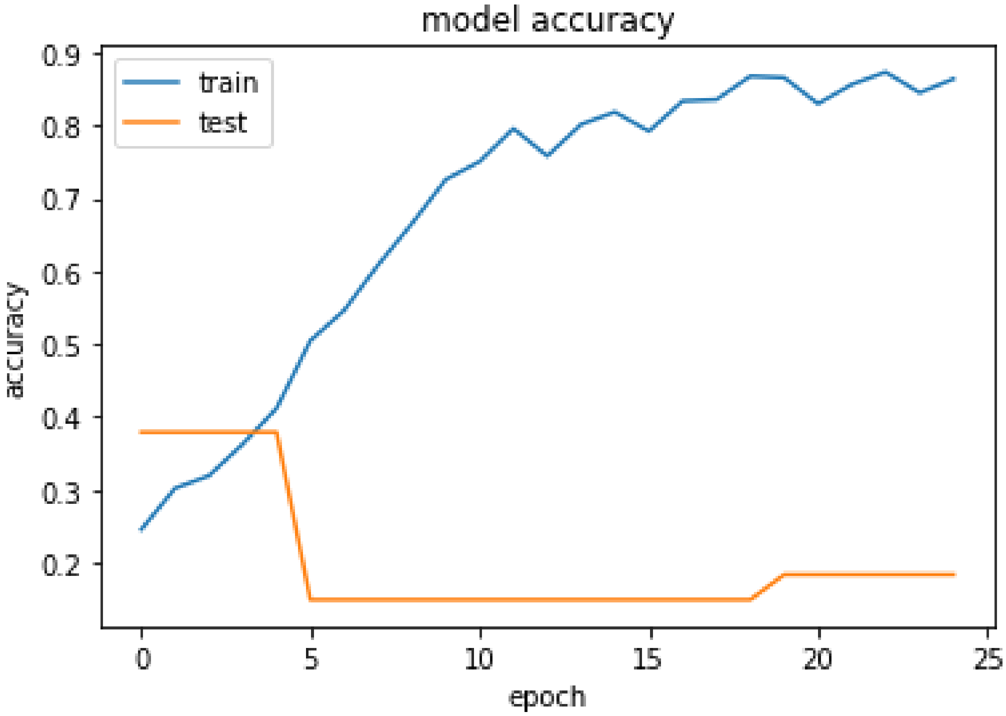


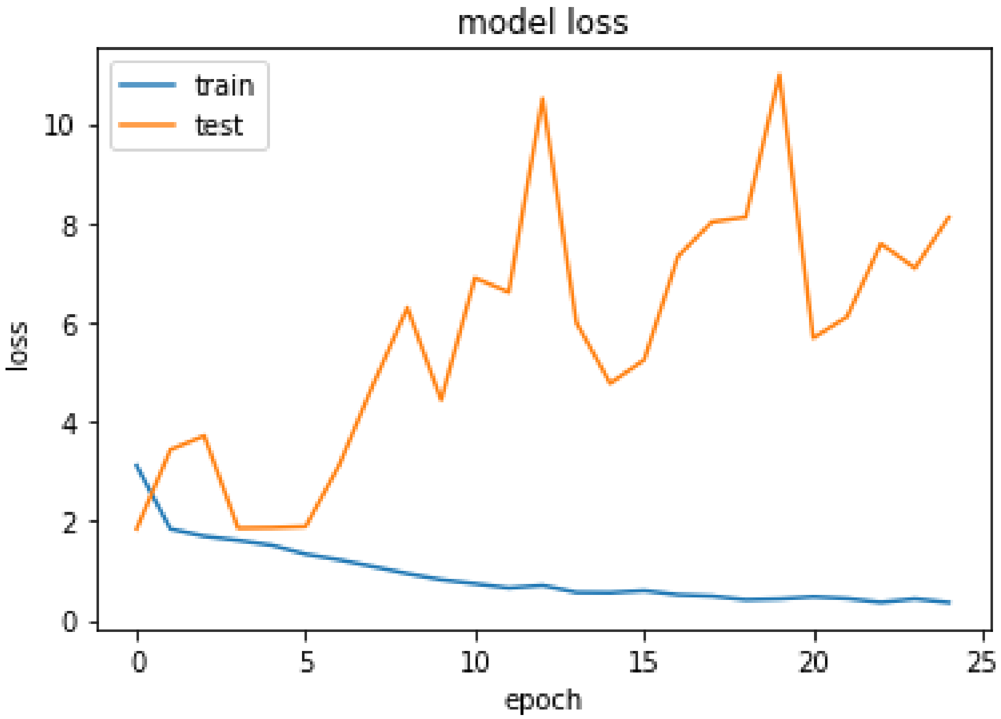
[50]:
```
model_test09=executeModel(True, False, False, False, 25)
```

```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 25
Epoch 1/25
53/53 [==============================] - 60s 1s/step - loss: 3.1171 - accuracy:
0.2457 - val_loss: 1.8418 - val_accuracy: 0.3793
Epoch 2/25
53/53 [==============================] - 59s 1s/step - loss: 1.8412 - accuracy:
0.3025 - val_loss: 3.4349 - val_accuracy: 0.3793
Epoch 3/25
53/53 [==============================] - 58s 1s/step - loss: 1.6956 - accuracy:
0.3195 - val_loss: 3.7137 - val_accuracy: 0.3793
Epoch 4/25
53/53 [==============================] - 59s 1s/step - loss: 1.6118 - accuracy:
0.3629 - val_loss: 1.8591 - val_accuracy: 0.3793
Epoch 5/25
53/53 [==============================] - 58s 1s/step - loss: 1.5133 - accuracy:
0.4121 - val_loss: 1.8674 - val_accuracy: 0.3793
Epoch 6/25
53/53 [==============================] - 59s 1s/step - loss: 1.3334 - accuracy:
0.5047 - val_loss: 1.8905 - val_accuracy: 0.1494
Epoch 7/25
53/53 [==============================] - 59s 1s/step - loss: 1.2187 - accuracy:
```

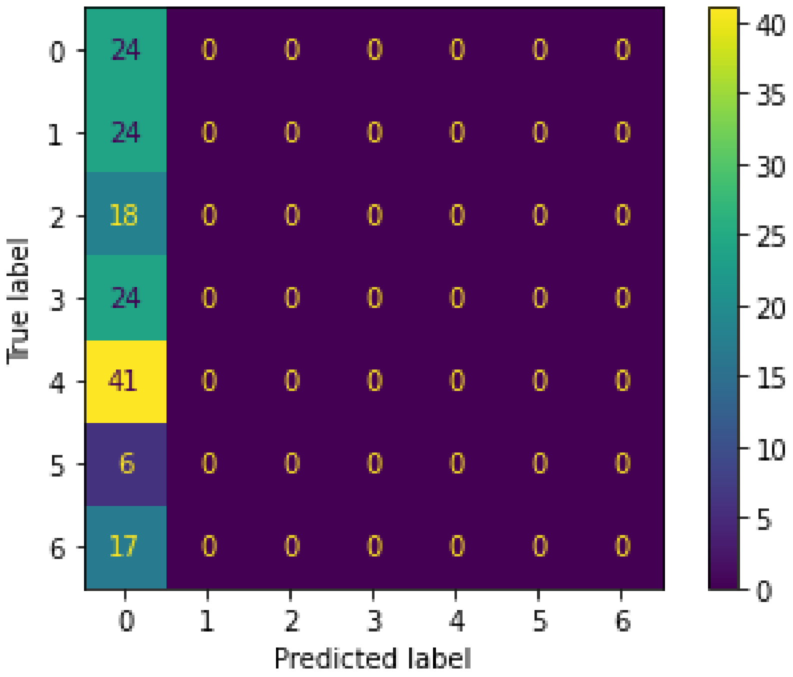
```
0.5463 - val_loss: 3.1388 - val_accuracy: 0.1494
Epoch 8/25
53/53 [==============================] - 65s 1s/step - loss: 1.0825 - accuracy:
0.6087 - val_loss: 4.7569 - val_accuracy: 0.1494
Epoch 9/25
53/53 [==============================] - 69s 1s/step - loss: 0.9412 - accuracy:
0.6654 - val_loss: 6.2931 - val_accuracy: 0.1494
Epoch 10/25
53/53 [==============================] - 65s 1s/step - loss: 0.8198 - accuracy:
0.7259 - val_loss: 4.4359 - val_accuracy: 0.1494
Epoch 11/25
53/53 [==============================] - 67s 1s/step - loss: 0.7385 - accuracy:
0.7505 - val_loss: 6.8937 - val_accuracy: 0.1494
Epoch 12/25
53/53 [==============================] - 64s 1s/step - loss: 0.6534 - accuracy:
0.7958 - val_loss: 6.6072 - val_accuracy: 0.1494
Epoch 13/25
53/53 [==============================] - 60s 1s/step - loss: 0.7047 - accuracy:
0.7580 - val_loss: 10.5051 - val_accuracy: 0.1494
Epoch 14/25
53/53 [==============================] - 59s 1s/step - loss: 0.5638 - accuracy:
0.8015 - val_loss: 5.9937 - val_accuracy: 0.1494
Epoch 15/25
53/53 [==============================] - 59s 1s/step - loss: 0.5583 - accuracy:
0.8185 - val_loss: 4.7698 - val_accuracy: 0.1494
Epoch 16/25
53/53 [==============================] - 59s 1s/step - loss: 0.5991 - accuracy:
0.7921 - val_loss: 5.2450 - val_accuracy: 0.1494
Epoch 17/25
53/53 [==============================] - 59s 1s/step - loss: 0.5148 - accuracy:
0.8336 - val_loss: 7.3252 - val_accuracy: 0.1494
Epoch 18/25
53/53 [==============================] - 58s 1s/step - loss: 0.4895 - accuracy:
0.8355 - val_loss: 8.0166 - val_accuracy: 0.1494
Epoch 19/25
53/53 [==============================] - 59s 1s/step - loss: 0.4161 - accuracy:
0.8677 - val_loss: 8.1152 - val_accuracy: 0.1494
Epoch 20/25
53/53 [==============================] - 59s 1s/step - loss: 0.4333 - accuracy:
0.8658 - val_loss: 10.9824 - val_accuracy: 0.1839
Epoch 21/25
53/53 [==============================] - 59s 1s/step - loss: 0.4757 - accuracy:
0.8299 - val_loss: 5.6836 - val_accuracy: 0.1839
Epoch 22/25
53/53 [==============================] - 59s 1s/step - loss: 0.4413 - accuracy:
0.8563 - val_loss: 6.1126 - val_accuracy: 0.1839
Epoch 23/25
53/53 [==============================] - 59s 1s/step - loss: 0.3633 - accuracy:
```

```
0.8733 - val_loss: 7.5783 - val_accuracy: 0.1839
Epoch 24/25
53/53 [==============================] - 59s 1s/step - loss: 0.4355 - accuracy:
0.8450 - val_loss: 7.0900 - val_accuracy: 0.1839
Epoch 25/25
53/53 [==============================] - 59s 1s/step - loss: 0.3599 - accuracy:
0.8639 - val_loss: 8.1088 - val_accuracy: 0.1839
```





```
16/16 [==============================] - 4s 218ms/step
Test evaluation:
16/16 [==============================] - 4s 221ms/step - loss: 9.5877 -
accuracy: 0.1558
[9.587703704833984, 0.15584415197372437]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```



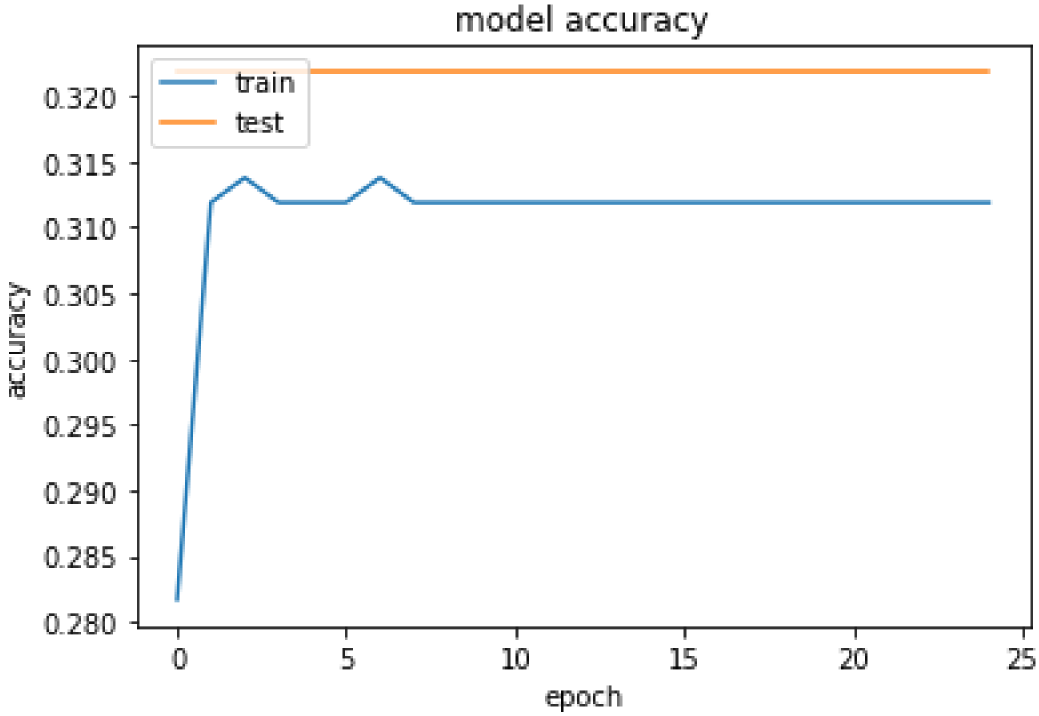
[193]:

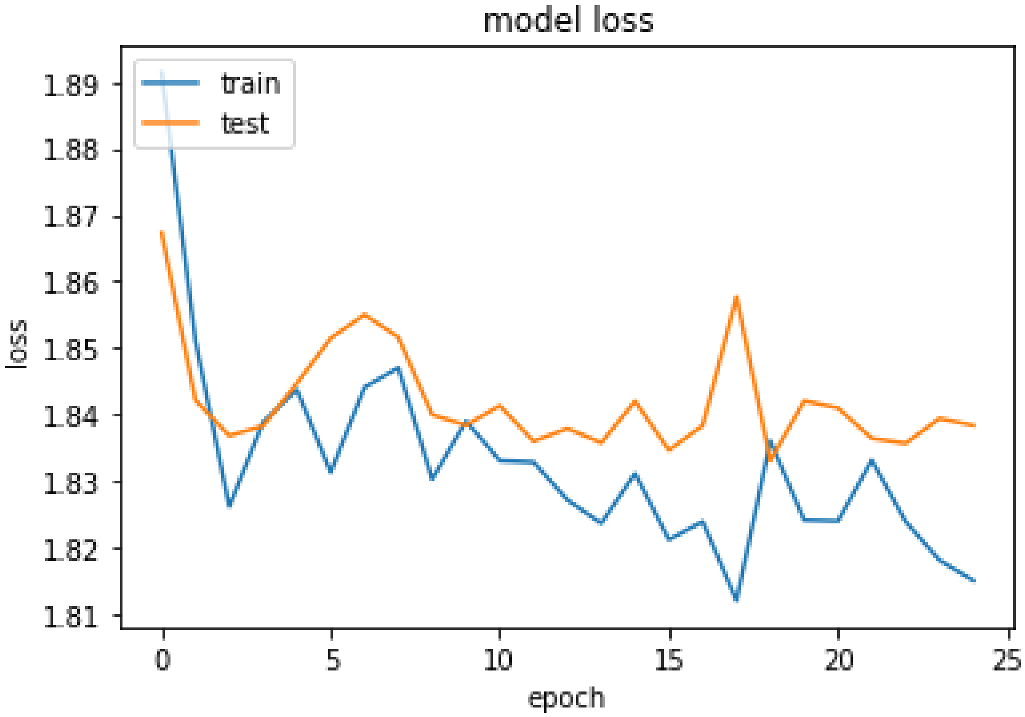
```
model_test10=executeModel(False, True, False, False, 25)
```

```
Training model with aumentation:False, gray:True, binary:False, crop:False and
epochs = 25
Epoch 1/25
53/53 [==============================] - 85s 2s/step - loss: 1.8914 - accuracy:
0.2817 - val_loss: 1.8674 - val_accuracy: 0.3218
Epoch 2/25
53/53 [==============================] - 78s 1s/step - loss: 1.8511 - accuracy:
0.3119 - val_loss: 1.8421 - val_accuracy: 0.3218
Epoch 3/25
53/53 [==============================] - 78s 1s/step - loss: 1.8262 - accuracy:
0.3138 - val_loss: 1.8368 - val_accuracy: 0.3218
Epoch 4/25
53/53 [==============================] - 88s 2s/step - loss: 1.8388 - accuracy:
0.3119 - val_loss: 1.8383 - val_accuracy: 0.3218
Epoch 5/25
53/53 [==============================] - 87s 2s/step - loss: 1.8437 - accuracy:
0.3119 - val_loss: 1.8447 - val_accuracy: 0.3218
Epoch 6/25
53/53 [==============================] - 145s 3s/step - loss: 1.8313 - accuracy:
0.3119 - val_loss: 1.8515 - val_accuracy: 0.3218
Epoch 7/25
53/53 [==============================] - 94s 2s/step - loss: 1.8441 - accuracy:
```

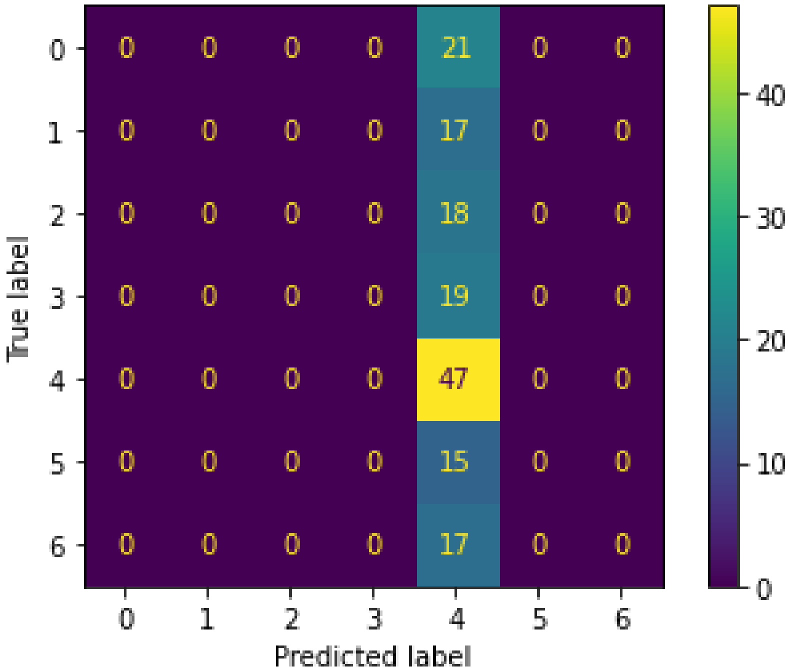
```
0.3138 - val_loss: 1.8550 - val_accuracy: 0.3218
Epoch 8/25
53/53 [==============================] - 81s 2s/step - loss: 1.8470 - accuracy:
0.3119 - val_loss: 1.8516 - val_accuracy: 0.3218
Epoch 9/25
53/53 [==============================] - 80s 2s/step - loss: 1.8303 - accuracy:
0.3119 - val_loss: 1.8400 - val_accuracy: 0.3218
Epoch 10/25
53/53 [==============================] - 79s 1s/step - loss: 1.8390 - accuracy:
0.3119 - val_loss: 1.8384 - val_accuracy: 0.3218
Epoch 11/25
53/53 [==============================] - 95s 2s/step - loss: 1.8331 - accuracy:
0.3119 - val_loss: 1.8413 - val_accuracy: 0.3218
Epoch 12/25
53/53 [==============================] - 118s 2s/step - loss: 1.8329 - accuracy:
0.3119 - val_loss: 1.8360 - val_accuracy: 0.3218
Epoch 13/25
53/53 [==============================] - 113s 2s/step - loss: 1.8272 - accuracy:
0.3119 - val_loss: 1.8379 - val_accuracy: 0.3218
Epoch 14/25
53/53 [==============================] - 107s 2s/step - loss: 1.8237 - accuracy:
0.3119 - val_loss: 1.8357 - val_accuracy: 0.3218
Epoch 15/25
53/53 [==============================] - 85s 2s/step - loss: 1.8312 - accuracy:
0.3119 - val_loss: 1.8420 - val_accuracy: 0.3218
Epoch 16/25
53/53 [==============================] - 93s 2s/step - loss: 1.8212 - accuracy:
0.3119 - val_loss: 1.8346 - val_accuracy: 0.3218
Epoch 17/25
53/53 [==============================] - 89s 2s/step - loss: 1.8239 - accuracy:
0.3119 - val_loss: 1.8383 - val_accuracy: 0.3218
Epoch 18/25
53/53 [==============================] - 82s 2s/step - loss: 1.8120 - accuracy:
0.3119 - val_loss: 1.8577 - val_accuracy: 0.3218
Epoch 19/25
53/53 [==============================] - 79s 1s/step - loss: 1.8360 - accuracy:
0.3119 - val_loss: 1.8331 - val_accuracy: 0.3218
Epoch 20/25
53/53 [==============================] - 80s 2s/step - loss: 1.8241 - accuracy:
0.3119 - val_loss: 1.8420 - val_accuracy: 0.3218
Epoch 21/25
53/53 [==============================] - 77s 1s/step - loss: 1.8240 - accuracy:
0.3119 - val_loss: 1.8410 - val_accuracy: 0.3218
Epoch 22/25
53/53 [==============================] - 74s 1s/step - loss: 1.8332 - accuracy:
0.3119 - val_loss: 1.8364 - val_accuracy: 0.3218
Epoch 23/25
53/53 [==============================] - 77s 1s/step - loss: 1.8239 - accuracy:
```

```
0.3119 - val_loss: 1.8357 - val_accuracy: 0.3218
Epoch 24/25
53/53 [==============================] - 78s 1s/step - loss: 1.8181 - accuracy:
0.3119 - val_loss: 1.8394 - val_accuracy: 0.3218
Epoch 25/25
53/53 [==============================] - 116s 2s/step - loss: 1.8151 - accuracy:
0.3119 - val_loss: 1.8384 - val_accuracy: 0.3218
```





```
16/16 [==============================] - 8s 474ms/step
Test evaluation:
16/16 [==============================] - 8s 495ms/step - loss: 1.8908 -
accuracy: 0.3052
[1.890782356262207, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



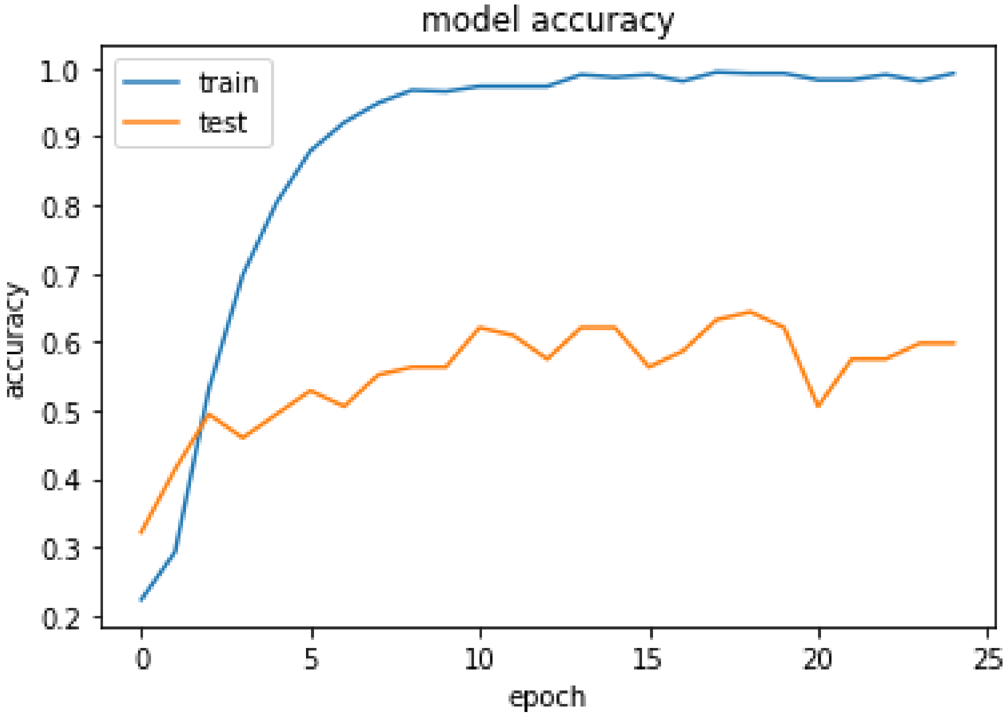
[194]:

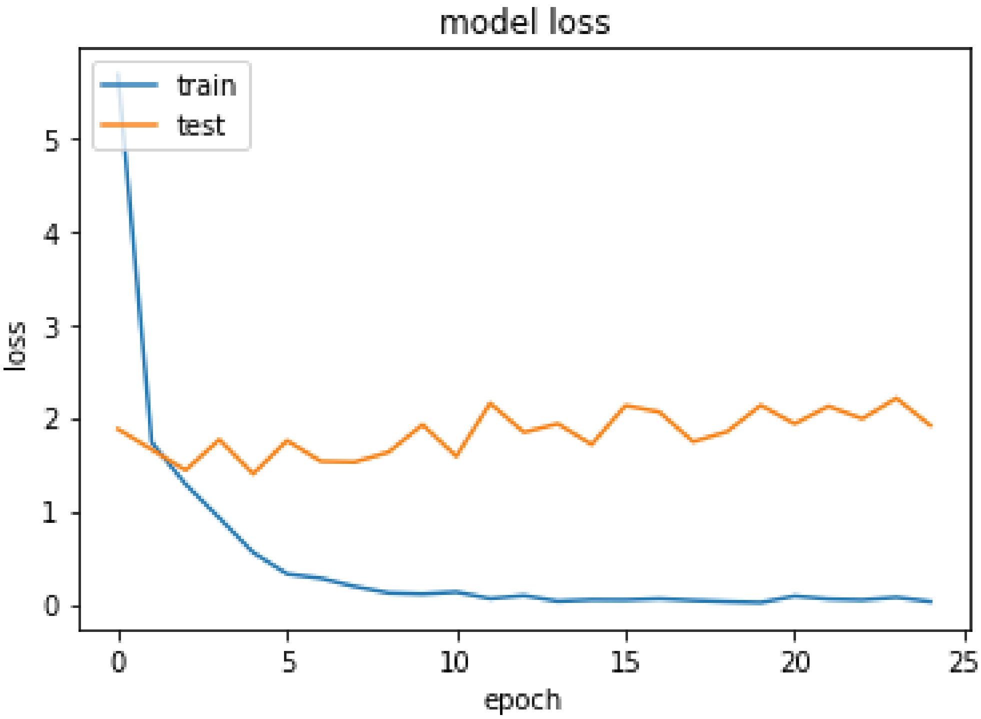
```
model_test11=executeModel(False, True, True, False, 25)
```

```
Training model with aumentation:False, gray:True, binary:True, crop:False and
epochs = 25
Epoch 1/25
53/53 [==============================] - 101s 2s/step - loss: 5.6726 - accuracy:
0.2231 - val_loss: 1.8762 - val_accuracy: 0.3218
Epoch 2/25
53/53 [==============================] - 111s 2s/step - loss: 1.7330 - accuracy:
0.2930 - val_loss: 1.6575 - val_accuracy: 0.4138
Epoch 3/25
53/53 [==============================] - 119s 2s/step - loss: 1.2875 - accuracy:
0.5312 - val_loss: 1.4377 - val_accuracy: 0.4943
Epoch 4/25
53/53 [==============================] - 113s 2s/step - loss: 0.9249 - accuracy:
0.6975 - val_loss: 1.7630 - val_accuracy: 0.4598
Epoch 5/25
53/53 [==============================] - 110s 2s/step - loss: 0.5548 - accuracy:
0.8034 - val_loss: 1.3991 - val_accuracy: 0.4943
Epoch 6/25
53/53 [==============================] - 103s 2s/step - loss: 0.3255 - accuracy:
0.8790 - val_loss: 1.7523 - val_accuracy: 0.5287
Epoch 7/25
53/53 [==============================] - 106s 2s/step - loss: 0.2787 - accuracy:
```

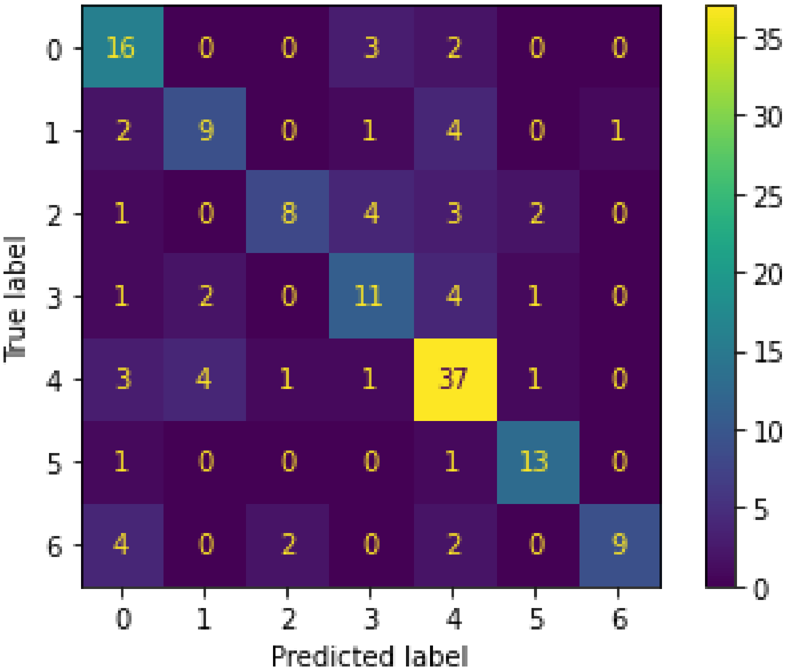
```
0.9206 - val_loss: 1.5324 - val_accuracy: 0.5057
Epoch 8/25
53/53 [==============================] - 98s 2s/step - loss: 0.1906 - accuracy:
0.9490 - val_loss: 1.5246 - val_accuracy: 0.5517
Epoch 9/25
53/53 [==============================] - 82s 2s/step - loss: 0.1217 - accuracy:
0.9679 - val_loss: 1.6299 - val_accuracy: 0.5632
Epoch 10/25
53/53 [==============================] - 79s 1s/step - loss: 0.1105 - accuracy:
0.9660 - val_loss: 1.9227 - val_accuracy: 0.5632
Epoch 11/25
53/53 [==============================] - 84s 2s/step - loss: 0.1314 - accuracy:
0.9735 - val_loss: 1.5855 - val_accuracy: 0.6207
Epoch 12/25
53/53 [==============================] - 80s 2s/step - loss: 0.0610 - accuracy:
0.9735 - val_loss: 2.1528 - val_accuracy: 0.6092
Epoch 13/25
53/53 [==============================] - 80s 2s/step - loss: 0.0940 - accuracy:
0.9735 - val_loss: 1.8416 - val_accuracy: 0.5747
Epoch 14/25
53/53 [==============================] - 78s 1s/step - loss: 0.0335 - accuracy:
0.9905 - val_loss: 1.9335 - val_accuracy: 0.6207
Epoch 15/25
53/53 [==============================] - 81s 2s/step - loss: 0.0487 - accuracy:
0.9868 - val_loss: 1.7111 - val_accuracy: 0.6207
Epoch 16/25
53/53 [==============================] - 76s 1s/step - loss: 0.0467 - accuracy:
0.9905 - val_loss: 2.1288 - val_accuracy: 0.5632
Epoch 17/25
53/53 [==============================] - 77s 1s/step - loss: 0.0602 - accuracy:
0.9811 - val_loss: 2.0594 - val_accuracy: 0.5862
Epoch 18/25
53/53 [==============================] - 83s 2s/step - loss: 0.0421 - accuracy:
0.9943 - val_loss: 1.7410 - val_accuracy: 0.6322
Epoch 19/25
53/53 [==============================] - 88s 2s/step - loss: 0.0286 - accuracy:
0.9924 - val_loss: 1.8482 - val_accuracy: 0.6437
Epoch 20/25
53/53 [==============================] - 80s 2s/step - loss: 0.0189 - accuracy:
0.9924 - val_loss: 2.1314 - val_accuracy: 0.6207
Epoch 21/25
53/53 [==============================] - 79s 1s/step - loss: 0.0887 - accuracy:
0.9830 - val_loss: 1.9325 - val_accuracy: 0.5057
Epoch 22/25
53/53 [==============================] - 77s 1s/step - loss: 0.0566 - accuracy:
0.9830 - val_loss: 2.1212 - val_accuracy: 0.5747
Epoch 23/25
53/53 [==============================] - 80s 2s/step - loss: 0.0468 - accuracy:
```

```
0.9905 - val_loss: 1.9873 - val_accuracy: 0.5747
Epoch 24/25
53/53 [==============================] - 82s 2s/step - loss: 0.0753 - accuracy:
0.9811 - val_loss: 2.2070 - val_accuracy: 0.5977
Epoch 25/25
53/53 [==============================] - 84s 2s/step - loss: 0.0295 - accuracy:
0.9924 - val_loss: 1.9169 - val_accuracy: 0.5977
```





```
16/16 [==============================] - 5s 306ms/step
Test evaluation:
16/16 [==============================] - 5s 311ms/step - loss: 1.7246 -
accuracy: 0.6688
[1.7245663404464722, 0.6688311696052551]
% of correct brand in the first 3 positions:
139
0.9025974025974026
% of brand predicted with percentage >= 0.25
0.12337662337662338
% of brand predicted with percentage >= 0.5
0.12337662337662338
% of brand predicted with percentage >= 0.75
0.12337662337662338
Matriz de confusión:
```

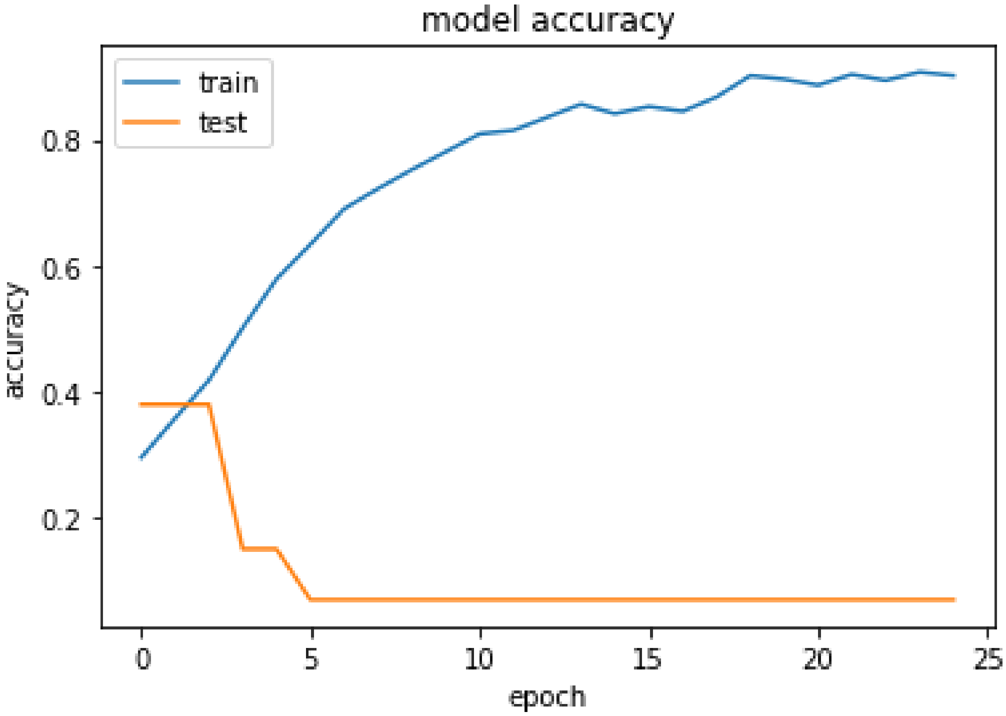


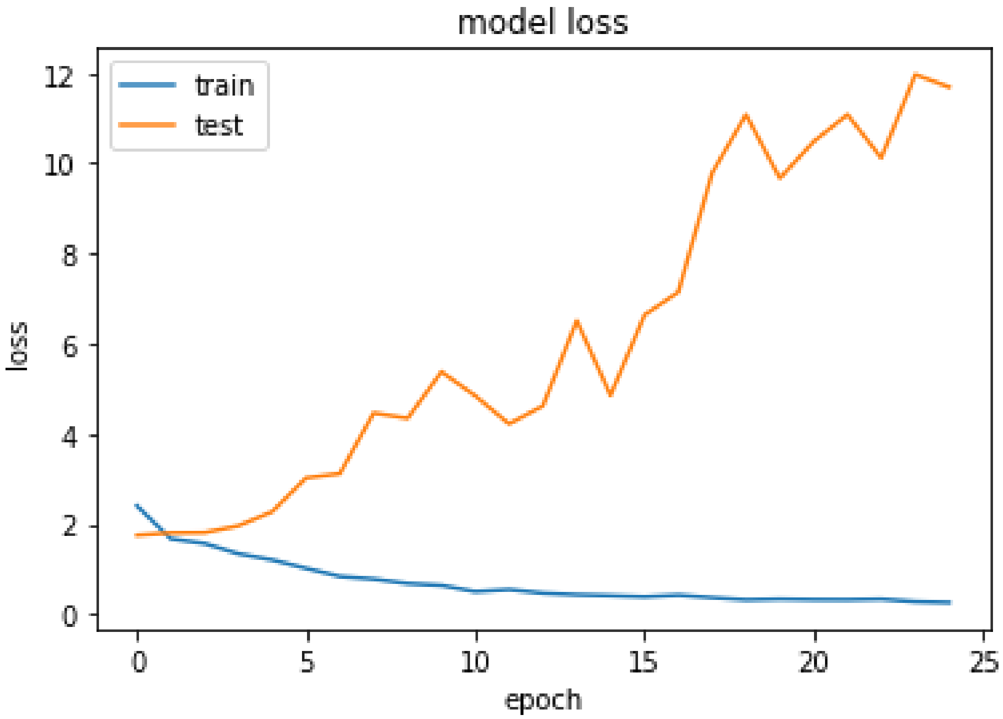
[51]:
```
model_test12=executeModel(True, True, False, False, 25)
```

```
Training model with aumentation:True, gray:True, binary:False, crop:False and
epochs = 25
Epoch 1/25
53/53 [==============================] - 56s 1s/step - loss: 2.4070 - accuracy:
0.2949 - val_loss: 1.7542 - val_accuracy: 0.3793
Epoch 2/25
53/53 [==============================] - 55s 1s/step - loss: 1.6752 - accuracy:
0.3573 - val_loss: 1.8065 - val_accuracy: 0.3793
Epoch 3/25
53/53 [==============================] - 55s 1s/step - loss: 1.5709 - accuracy:
0.4178 - val_loss: 1.8127 - val_accuracy: 0.3793
Epoch 4/25
53/53 [==============================] - 54s 1s/step - loss: 1.3428 - accuracy:
0.5009 - val_loss: 1.9631 - val_accuracy: 0.1494
Epoch 5/25
53/53 [==============================] - 54s 1s/step - loss: 1.2070 - accuracy:
0.5784 - val_loss: 2.2761 - val_accuracy: 0.1494
Epoch 6/25
53/53 [==============================] - 55s 1s/step - loss: 1.0199 - accuracy:
0.6333 - val_loss: 3.0260 - val_accuracy: 0.0690
Epoch 7/25
53/53 [==============================] - 55s 1s/step - loss: 0.8391 - accuracy:
```

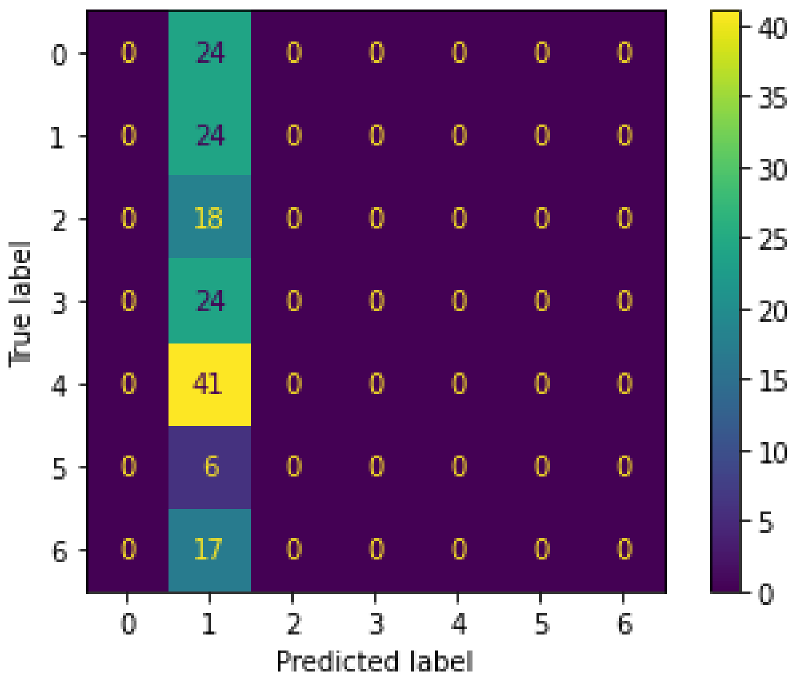
```
0.6900 - val_loss: 3.1203 - val_accuracy: 0.0690
Epoch 8/25
53/53 [==============================] - 55s 1s/step - loss: 0.7804 - accuracy:
0.7221 - val_loss: 4.4622 - val_accuracy: 0.0690
Epoch 9/25
53/53 [==============================] - 55s 1s/step - loss: 0.6830 - accuracy:
0.7524 - val_loss: 4.3450 - val_accuracy: 0.0690
Epoch 10/25
53/53 [==============================] - 55s 1s/step - loss: 0.6401 - accuracy:
0.7807 - val_loss: 5.3769 - val_accuracy: 0.0690
Epoch 11/25
53/53 [==============================] - 54s 1s/step - loss: 0.5039 - accuracy:
0.8091 - val_loss: 4.8443 - val_accuracy: 0.0690
Epoch 12/25
53/53 [==============================] - 55s 1s/step - loss: 0.5491 - accuracy:
0.8147 - val_loss: 4.2201 - val_accuracy: 0.0690
Epoch 13/25
53/53 [==============================] - 55s 1s/step - loss: 0.4689 - accuracy:
0.8355 - val_loss: 4.6212 - val_accuracy: 0.0690
Epoch 14/25
53/53 [==============================] - 54s 1s/step - loss: 0.4326 - accuracy:
0.8563 - val_loss: 6.5107 - val_accuracy: 0.0690
Epoch 15/25
53/53 [==============================] - 54s 1s/step - loss: 0.4134 - accuracy:
0.8412 - val_loss: 4.8553 - val_accuracy: 0.0690
Epoch 16/25
53/53 [==============================] - 54s 1s/step - loss: 0.3888 - accuracy:
0.8526 - val_loss: 6.6382 - val_accuracy: 0.0690
Epoch 17/25
53/53 [==============================] - 54s 1s/step - loss: 0.4246 - accuracy:
0.8450 - val_loss: 7.1472 - val_accuracy: 0.0690
Epoch 18/25
53/53 [==============================] - 54s 1s/step - loss: 0.3690 - accuracy:
0.8677 - val_loss: 9.7880 - val_accuracy: 0.0690
Epoch 19/25
53/53 [==============================] - 54s 1s/step - loss: 0.3217 - accuracy:
0.9017 - val_loss: 11.0824 - val_accuracy: 0.0690
Epoch 20/25
53/53 [==============================] - 54s 1s/step - loss: 0.3373 - accuracy:
0.8960 - val_loss: 9.6671 - val_accuracy: 0.0690
Epoch 21/25
53/53 [==============================] - 54s 1s/step - loss: 0.3257 - accuracy:
0.8866 - val_loss: 10.4817 - val_accuracy: 0.0690
Epoch 22/25
53/53 [==============================] - 54s 1s/step - loss: 0.3236 - accuracy:
0.9036 - val_loss: 11.0810 - val_accuracy: 0.0690
Epoch 23/25
53/53 [==============================] - 54s 1s/step - loss: 0.3365 - accuracy:
```

```
0.8941 - val_loss: 10.1204 - val_accuracy: 0.0690
Epoch 24/25
53/53 [==============================] - 54s 1s/step - loss: 0.2798 - accuracy:
0.9074 - val_loss: 11.9662 - val_accuracy: 0.0690
Epoch 25/25
53/53 [==============================] - 54s 1s/step - loss: 0.2604 - accuracy:
0.9017 - val_loss: 11.6922 - val_accuracy: 0.0690
```





```
16/16 [==============================] - 3s 185ms/step
Test evaluation:
16/16 [==============================] - 3s 183ms/step - loss: 11.0019 -
accuracy: 0.1558
[11.001900672912598, 0.15584415197372437]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```

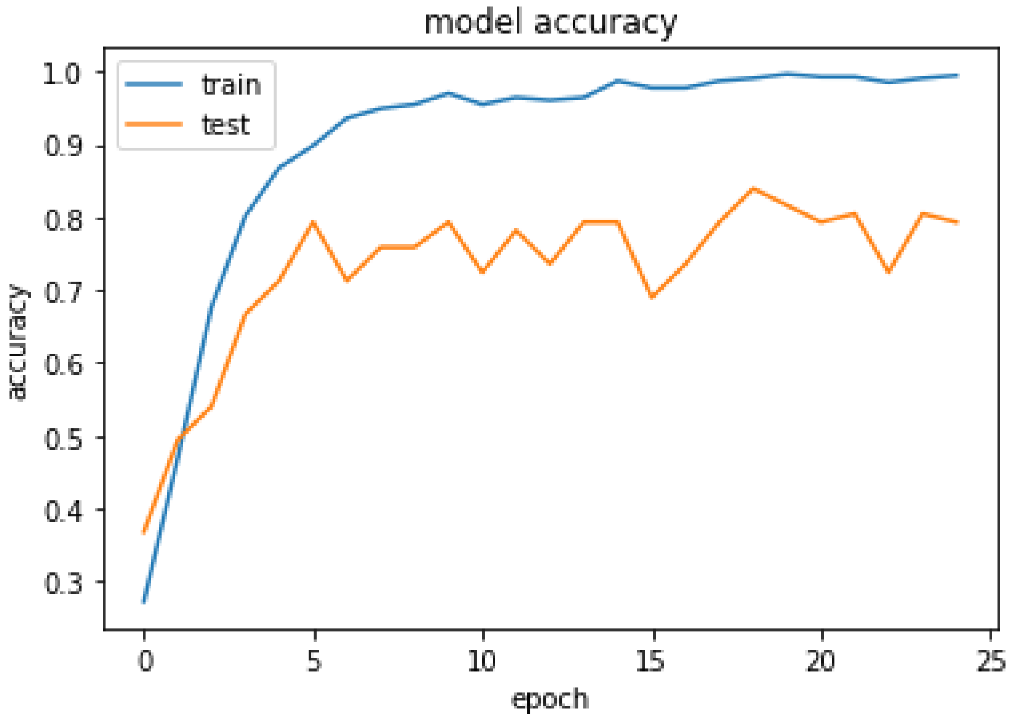


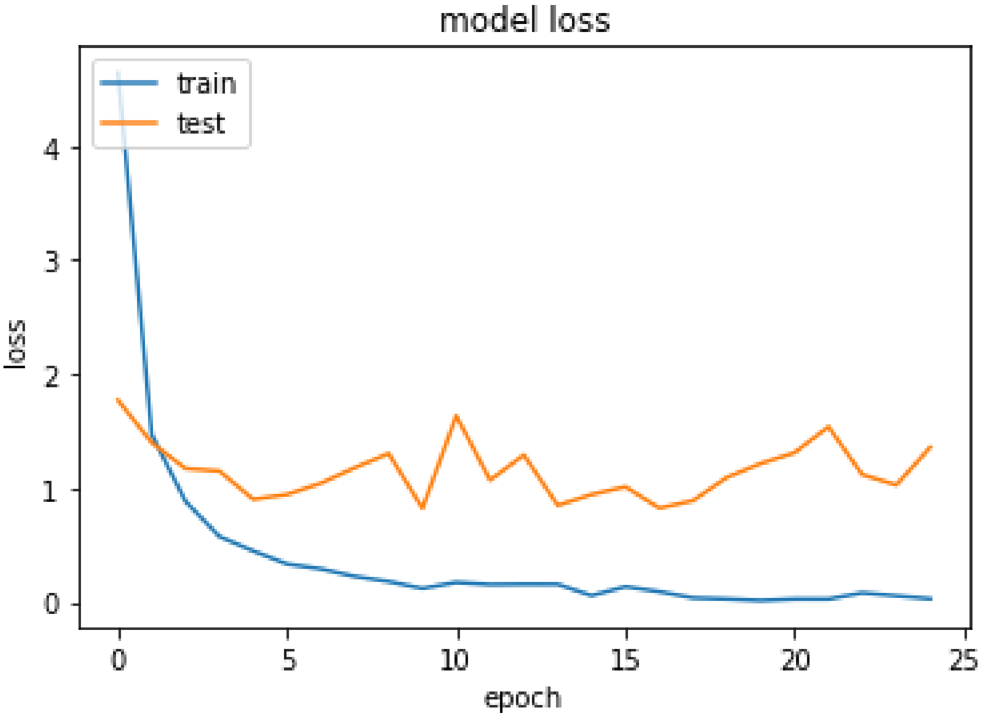
```
[196]: model_test13=executeModel(False, True, True, True, 25)
```

```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 25
Epoch 1/25
53/53 [==============================] - 61s 1s/step - loss: 4.6450 - accuracy:
0.2722 - val_loss: 1.7720 - val_accuracy: 0.3678
Epoch 2/25
53/53 [==============================] - 58s 1s/step - loss: 1.4696 - accuracy:
0.4688 - val_loss: 1.3985 - val_accuracy: 0.4943
Epoch 3/25
53/53 [==============================] - 58s 1s/step - loss: 0.8842 - accuracy:
0.6767 - val_loss: 1.1727 - val_accuracy: 0.5402
Epoch 4/25
53/53 [==============================] - 58s 1s/step - loss: 0.5761 - accuracy:
0.8015 - val_loss: 1.1511 - val_accuracy: 0.6667
Epoch 5/25
53/53 [==============================] - 57s 1s/step - loss: 0.4494 - accuracy:
0.8677 - val_loss: 0.9026 - val_accuracy: 0.7126
Epoch 6/25
53/53 [==============================] - 58s 1s/step - loss: 0.3347 - accuracy:
0.8979 - val_loss: 0.9449 - val_accuracy: 0.7931
Epoch 7/25
53/53 [==============================] - 58s 1s/step - loss: 0.2918 - accuracy:
```

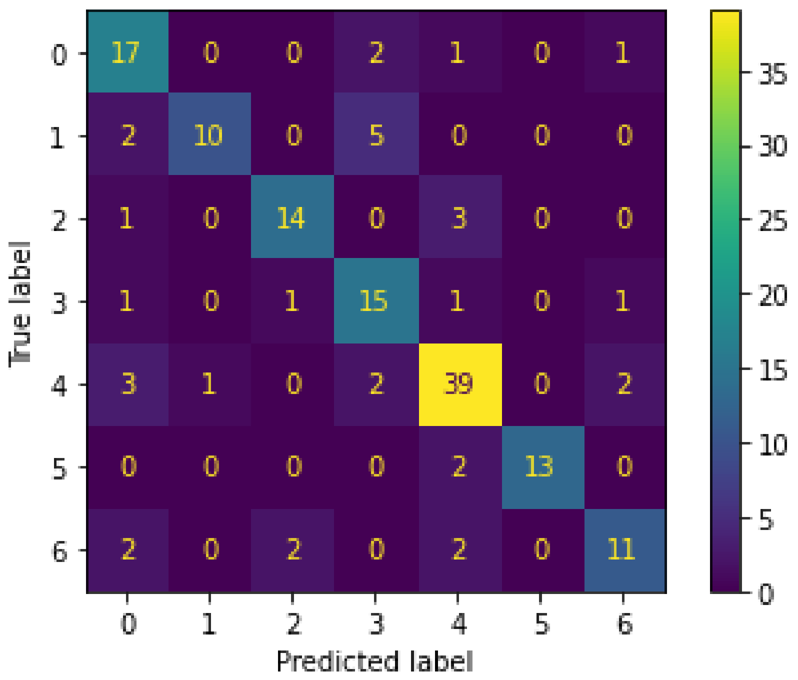
```
0.9357 - val_loss: 1.0437 - val_accuracy: 0.7126
Epoch 8/25
53/53 [==============================] - 58s 1s/step - loss: 0.2259 - accuracy:
0.9490 - val_loss: 1.1797 - val_accuracy: 0.7586
Epoch 9/25
53/53 [==============================] - 58s 1s/step - loss: 0.1811 - accuracy:
0.9546 - val_loss: 1.3051 - val_accuracy: 0.7586
Epoch 10/25
53/53 [==============================] - 58s 1s/step - loss: 0.1203 - accuracy:
0.9698 - val_loss: 0.8232 - val_accuracy: 0.7931
Epoch 11/25
53/53 [==============================] - 58s 1s/step - loss: 0.1735 - accuracy:
0.9546 - val_loss: 1.6337 - val_accuracy: 0.7241
Epoch 12/25
53/53 [==============================] - 58s 1s/step - loss: 0.1545 - accuracy:
0.9641 - val_loss: 1.0714 - val_accuracy: 0.7816
Epoch 13/25
53/53 [==============================] - 58s 1s/step - loss: 0.1572 - accuracy:
0.9603 - val_loss: 1.2920 - val_accuracy: 0.7356
Epoch 14/25
53/53 [==============================] - 58s 1s/step - loss: 0.1567 - accuracy:
0.9641 - val_loss: 0.8498 - val_accuracy: 0.7931
Epoch 15/25
53/53 [==============================] - 58s 1s/step - loss: 0.0576 - accuracy:
0.9868 - val_loss: 0.9446 - val_accuracy: 0.7931
Epoch 16/25
53/53 [==============================] - 58s 1s/step - loss: 0.1359 - accuracy:
0.9773 - val_loss: 1.0123 - val_accuracy: 0.6897
Epoch 17/25
53/53 [==============================] - 58s 1s/step - loss: 0.0917 - accuracy:
0.9773 - val_loss: 0.8254 - val_accuracy: 0.7356
Epoch 18/25
53/53 [==============================] - 58s 1s/step - loss: 0.0372 - accuracy:
0.9868 - val_loss: 0.8915 - val_accuracy: 0.7931
Epoch 19/25
53/53 [==============================] - 58s 1s/step - loss: 0.0277 - accuracy:
0.9905 - val_loss: 1.0961 - val_accuracy: 0.8391
Epoch 20/25
53/53 [==============================] - 58s 1s/step - loss: 0.0141 - accuracy:
0.9962 - val_loss: 1.2172 - val_accuracy: 0.8161
Epoch 21/25
53/53 [==============================] - 58s 1s/step - loss: 0.0275 - accuracy:
0.9924 - val_loss: 1.3118 - val_accuracy: 0.7931
Epoch 22/25
53/53 [==============================] - 57s 1s/step - loss: 0.0270 - accuracy:
0.9924 - val_loss: 1.5378 - val_accuracy: 0.8046
Epoch 23/25
53/53 [==============================] - 57s 1s/step - loss: 0.0814 - accuracy:
```

```
0.9849 - val_loss: 1.1193 - val_accuracy: 0.7241
Epoch 24/25
53/53 [==============================] - 59s 1s/step - loss: 0.0555 - accuracy:
0.9905 - val_loss: 1.0283 - val_accuracy: 0.8046
Epoch 25/25
53/53 [==============================] - 59s 1s/step - loss: 0.0299 - accuracy:
0.9943 - val_loss: 1.3573 - val_accuracy: 0.7931
```





```
16/16 [==============================] - 4s 265ms/step
Test evaluation:
16/16 [==============================] - 5s 276ms/step - loss: 1.1137 -
accuracy: 0.7727
[1.1136705875396729, 0.7727272510528564]
% of correct brand in the first 3 positions:
148
0.961038961038961
% of brand predicted with percentage >= 0.25
0.11688311688311688
% of brand predicted with percentage >= 0.5
0.11688311688311688
% of brand predicted with percentage >= 0.75
0.11688311688311688
Matriz de confusión:
```



|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 17 | 0 | 0 | 2 | 1 | 0 | 1 |
| 1 | 2 | 10 | 0 | 5 | 0 | 0 | 0 |
| 2 | 1 | 0 | 14 | 0 | 3 | 0 | 0 |
| 3 | 1 | 0 | 1 | 15 | 1 | 0 | 1 |
| 4 | 3 | 1 | 0 | 2 | 39 | 0 | 2 |
| 5 | 0 | 0 | 0 | 0 | 2 | 13 | 0 |
| 6 | 2 | 0 | 2 | 0 | 2 | 0 | 11 |

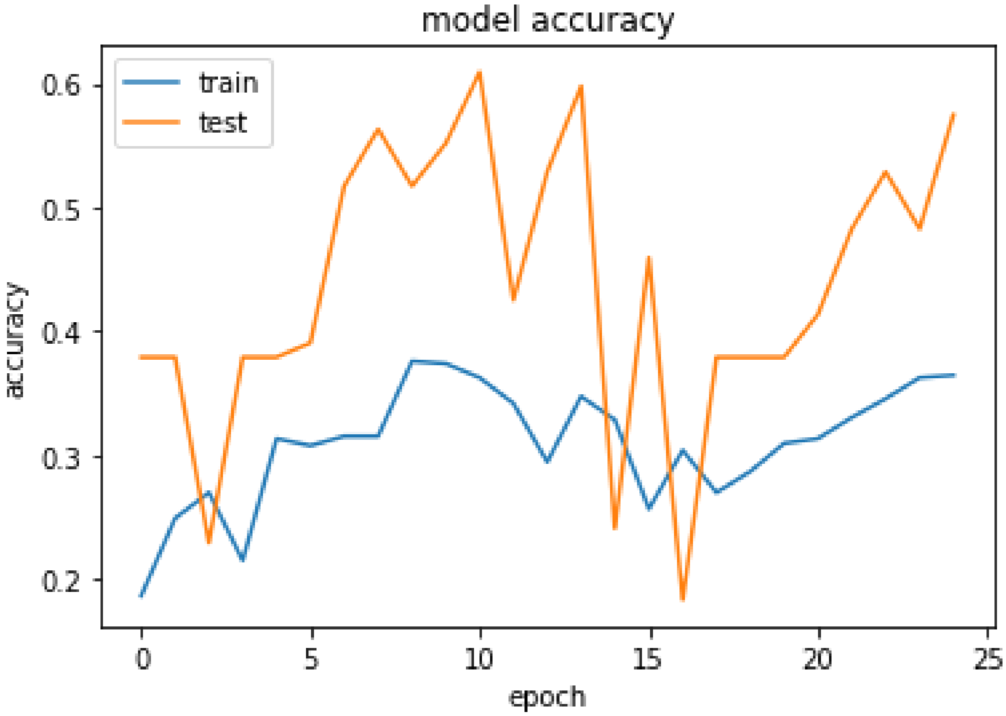
[52]:

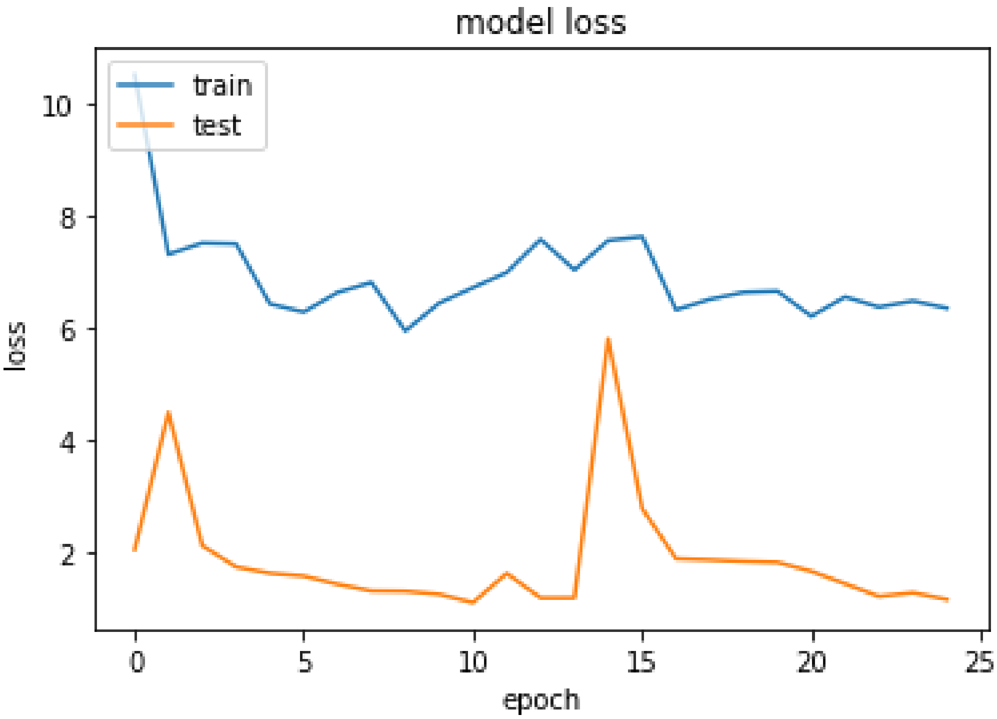
```
model_test14=executeModel(True, True, True, True, 25)
```

```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 25
Epoch 1/25
53/53 [==============================] - 57s 1s/step - loss: 10.5305 - accuracy:
0.1871 - val_loss: 2.0613 - val_accuracy: 0.3793
Epoch 2/25
53/53 [==============================] - 57s 1s/step - loss: 7.3262 - accuracy:
0.2495 - val_loss: 4.5063 - val_accuracy: 0.3793
Epoch 3/25
53/53 [==============================] - 58s 1s/step - loss: 7.5270 - accuracy:
0.2703 - val_loss: 2.1345 - val_accuracy: 0.2299
Epoch 4/25
53/53 [==============================] - 57s 1s/step - loss: 7.5129 - accuracy:
0.2155 - val_loss: 1.7536 - val_accuracy: 0.3793
Epoch 5/25
53/53 [==============================] - 56s 1s/step - loss: 6.4443 - accuracy:
0.3138 - val_loss: 1.6408 - val_accuracy: 0.3793
Epoch 6/25
53/53 [==============================] - 57s 1s/step - loss: 6.2977 - accuracy:
0.3081 - val_loss: 1.5909 - val_accuracy: 0.3908
Epoch 7/25
53/53 [==============================] - 57s 1s/step - loss: 6.6480 - accuracy:
```

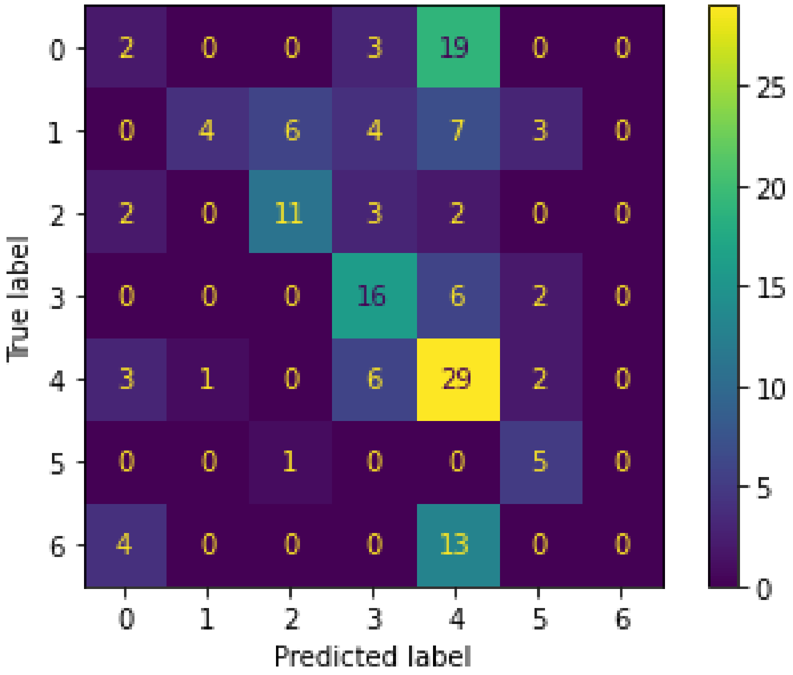
```
0.3157 - val_loss: 1.4453 - val_accuracy: 0.5172
Epoch 8/25
53/53 [==============================] - 57s 1s/step - loss: 6.8268 - accuracy:
0.3157 - val_loss: 1.3261 - val_accuracy: 0.5632
Epoch 9/25
53/53 [==============================] - 54s 1s/step - loss: 5.9605 - accuracy:
0.3762 - val_loss: 1.3197 - val_accuracy: 0.5172
Epoch 10/25
53/53 [==============================] - 55s 1s/step - loss: 6.4582 - accuracy:
0.3743 - val_loss: 1.2661 - val_accuracy: 0.5517
Epoch 11/25
53/53 [==============================] - 56s 1s/step - loss: 6.7340 - accuracy:
0.3629 - val_loss: 1.1176 - val_accuracy: 0.6092
Epoch 12/25
53/53 [==============================] - 56s 1s/step - loss: 7.0046 - accuracy:
0.3422 - val_loss: 1.6382 - val_accuracy: 0.4253
Epoch 13/25
53/53 [==============================] - 58s 1s/step - loss: 7.5916 - accuracy:
0.2949 - val_loss: 1.2011 - val_accuracy: 0.5287
Epoch 14/25
53/53 [==============================] - 57s 1s/step - loss: 7.0500 - accuracy:
0.3478 - val_loss: 1.2019 - val_accuracy: 0.5977
Epoch 15/25
53/53 [==============================] - 57s 1s/step - loss: 7.5725 - accuracy:
0.3289 - val_loss: 5.8167 - val_accuracy: 0.2414
Epoch 16/25
53/53 [==============================] - 57s 1s/step - loss: 7.6413 - accuracy:
0.2571 - val_loss: 2.7942 - val_accuracy: 0.4598
Epoch 17/25
53/53 [==============================] - 57s 1s/step - loss: 6.3378 - accuracy:
0.3043 - val_loss: 1.9006 - val_accuracy: 0.1839
Epoch 18/25
53/53 [==============================] - 57s 1s/step - loss: 6.5260 - accuracy:
0.2703 - val_loss: 1.8794 - val_accuracy: 0.3793
Epoch 19/25
53/53 [==============================] - 57s 1s/step - loss: 6.6510 - accuracy:
0.2873 - val_loss: 1.8530 - val_accuracy: 0.3793
Epoch 20/25
53/53 [==============================] - 57s 1s/step - loss: 6.6708 - accuracy:
0.3100 - val_loss: 1.8365 - val_accuracy: 0.3793
Epoch 21/25
53/53 [==============================] - 57s 1s/step - loss: 6.2240 - accuracy:
0.3138 - val_loss: 1.6761 - val_accuracy: 0.4138
Epoch 22/25
53/53 [==============================] - 58s 1s/step - loss: 6.5687 - accuracy:
0.3308 - val_loss: 1.4526 - val_accuracy: 0.4828
Epoch 23/25
53/53 [==============================] - 58s 1s/step - loss: 6.3877 - accuracy:
```

```
0.3459 - val_loss: 1.2283 - val_accuracy: 0.5287
Epoch 24/25
53/53 [==============================] - 58s 1s/step - loss: 6.4959 - accuracy:
0.3629 - val_loss: 1.2934 - val_accuracy: 0.4828
Epoch 25/25
53/53 [==============================] - 57s 1s/step - loss: 6.3685 - accuracy:
0.3648 - val_loss: 1.1734 - val_accuracy: 0.5747
```



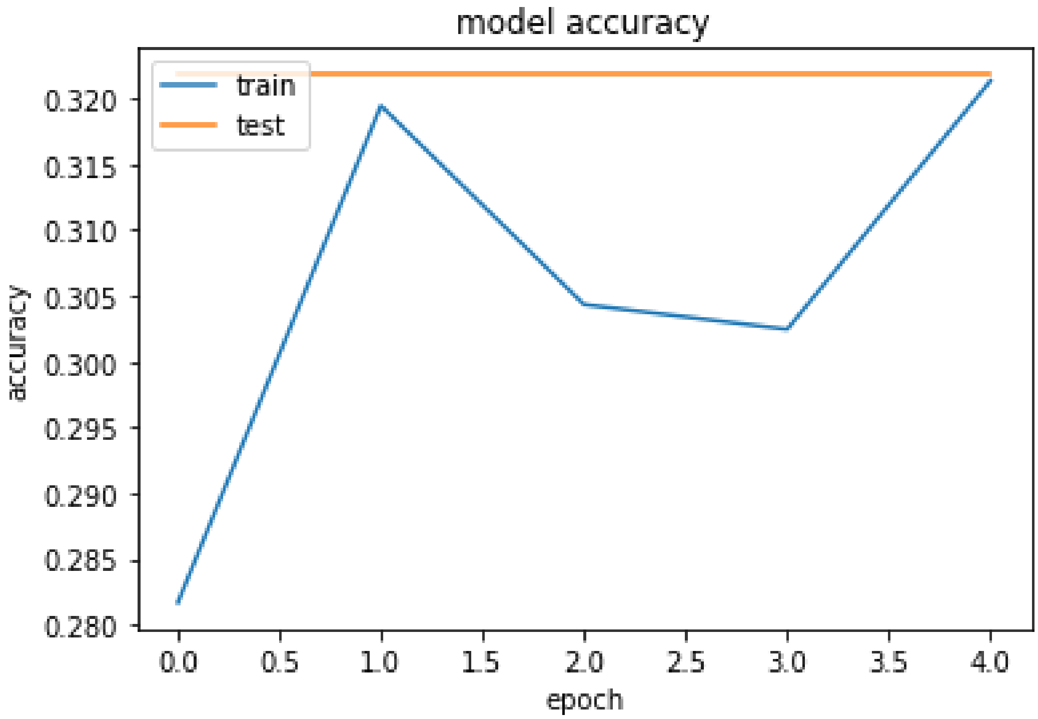


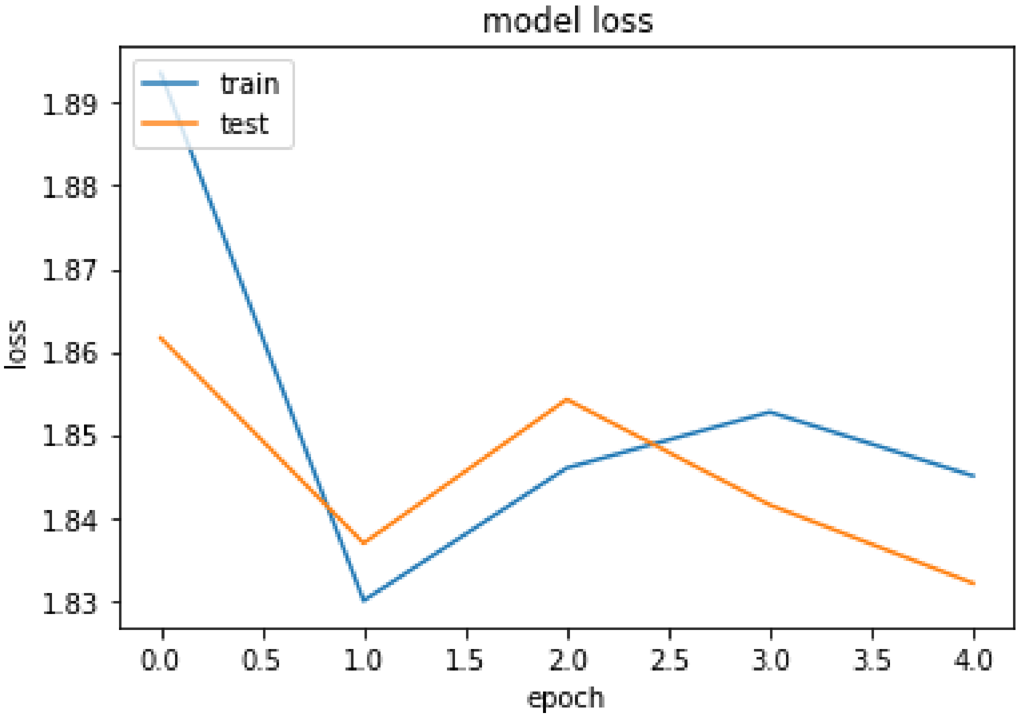
```
16/16 [==============================] - 4s 227ms/step
Test evaluation:
16/16 [==============================] - 4s 243ms/step - loss: 1.4073 -
accuracy: 0.4351
[1.4072834253311157, 0.4350649416446686]
% of correct brand in the first 3 positions:
123
0.7987012987012987
% of brand predicted with percentage >= 0.25
0.42207792207792205
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



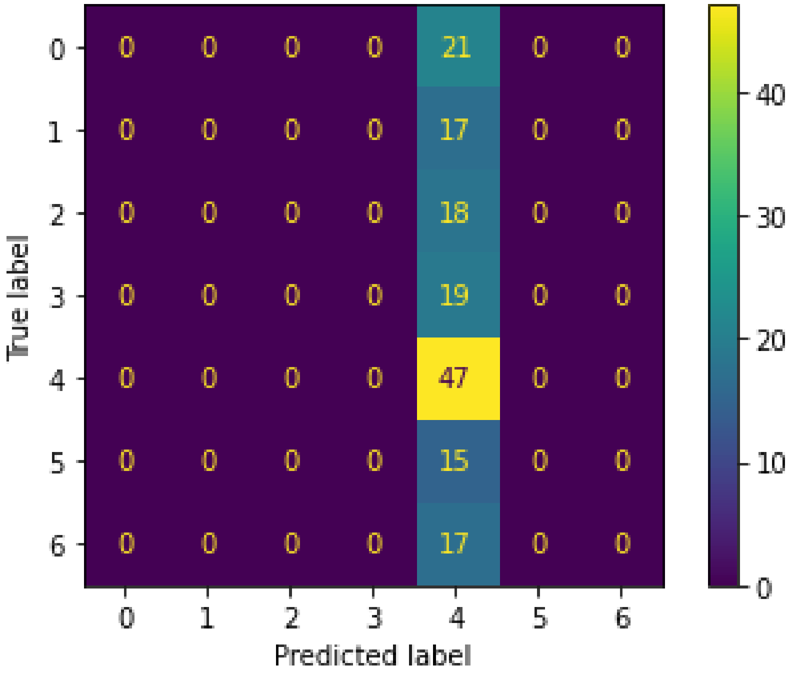
[198]:
```
model_test15=executeModel(False, False, False, False, 5)
```

```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 5
Epoch 1/5
53/53 [==============================] - 102s 2s/step - loss: 1.8936 - accuracy:
0.2817 - val_loss: 1.8616 - val_accuracy: 0.3218
Epoch 2/5
53/53 [==============================] - 93s 2s/step - loss: 1.8299 - accuracy:
0.3195 - val_loss: 1.8369 - val_accuracy: 0.3218
Epoch 3/5
53/53 [==============================] - 67s 1s/step - loss: 1.8460 - accuracy:
0.3043 - val_loss: 1.8542 - val_accuracy: 0.3218
Epoch 4/5
53/53 [==============================] - 65s 1s/step - loss: 1.8527 - accuracy:
0.3025 - val_loss: 1.8415 - val_accuracy: 0.3218
Epoch 5/5
53/53 [==============================] - 61s 1s/step - loss: 1.8450 - accuracy:
0.3214 - val_loss: 1.8320 - val_accuracy: 0.3218
```


model accuracy
train
test
0.320
0.315
0.310
0.305
0.300
0.295
0.290
0.285
0.280
accuracy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch


model loss
train
test
1.89
1.88
1.87
1.86
1.85
1.84
1.83
loss
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch

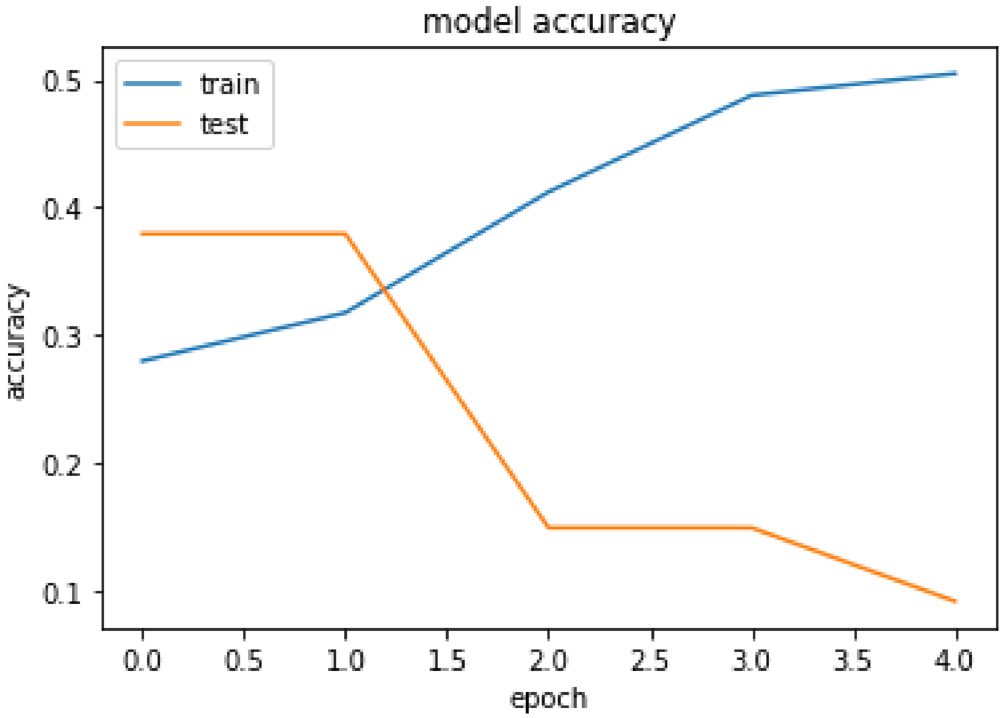
```
16/16 [==============================] - 5s 266ms/step
Test evaluation:
16/16 [==============================] - 5s 274ms/step - loss: 1.8756 -
accuracy: 0.3052
[1.8755677938461304, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

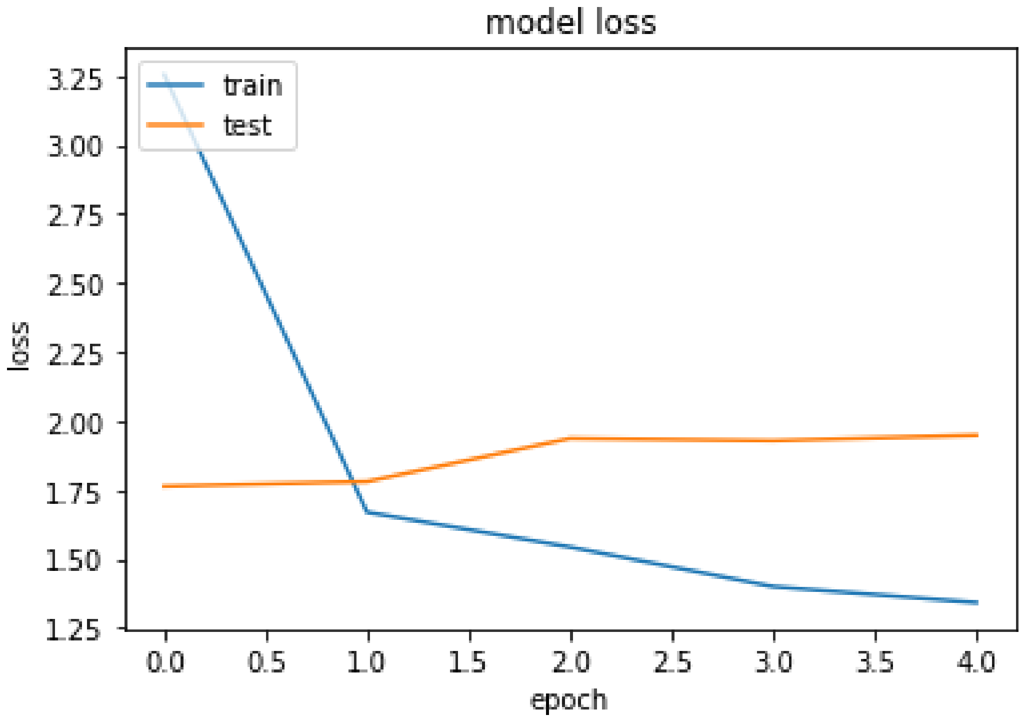


```
[53]: model_test16=executeModel(True, False, False, False, 5)
```

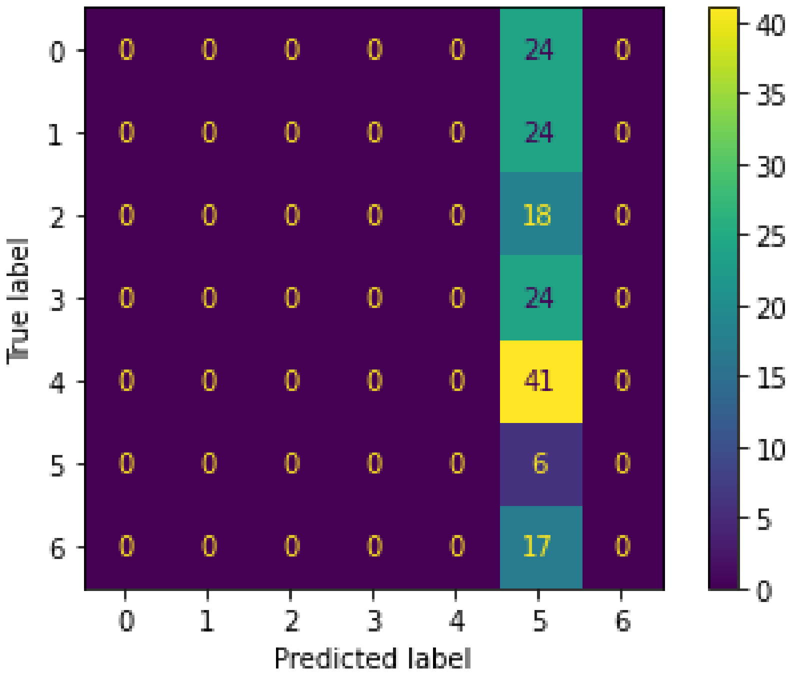
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 5
Epoch 1/5
53/53 [==============================] - 63s 1s/step - loss: 3.2550 - accuracy:
0.2798 - val_loss: 1.7631 - val_accuracy: 0.3793
Epoch 2/5
```

```
53/53 [==============================] - 61s 1s/step - loss: 1.6693 - accuracy:
0.3176 - val_loss: 1.7804 - val_accuracy: 0.3793
Epoch 3/5
53/53 [==============================] - 62s 1s/step - loss: 1.5428 - accuracy:
0.4121 - val_loss: 1.9362 - val_accuracy: 0.1494
Epoch 4/5
53/53 [==============================] - 72s 1s/step - loss: 1.3993 - accuracy:
0.4877 - val_loss: 1.9280 - val_accuracy: 0.1494
Epoch 5/5
53/53 [==============================] - 92s 2s/step - loss: 1.3414 - accuracy:
0.5047 - val_loss: 1.9478 - val_accuracy: 0.0920
```





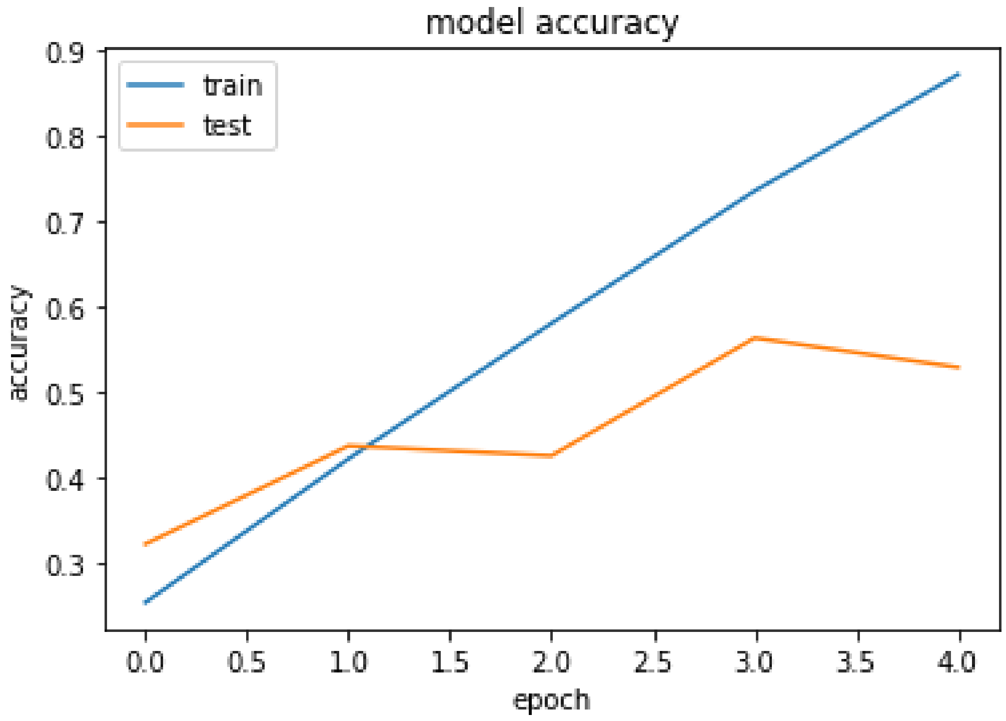
```
16/16 [==============================] - 11s 678ms/step
Test evaluation:
16/16 [==============================] - 14s 828ms/step - loss: 1.9566 -
accuracy: 0.0390
[1.9566270112991333, 0.03896103799343109]
% of correct brand in the first 3 positions:
48
0.3116883116883117
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

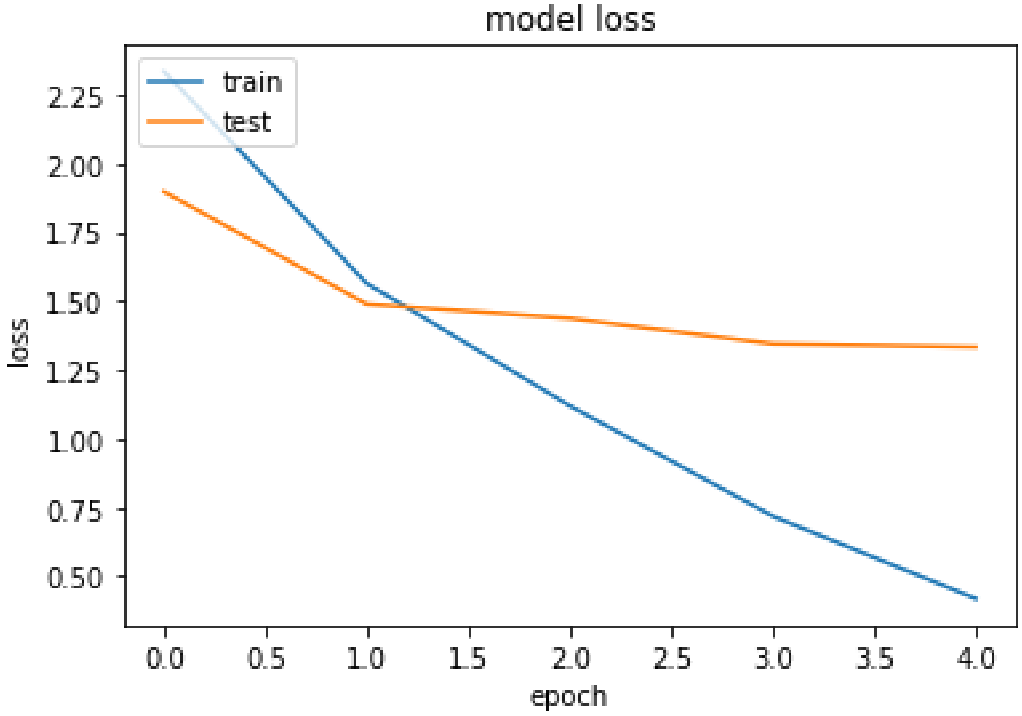


[201]:

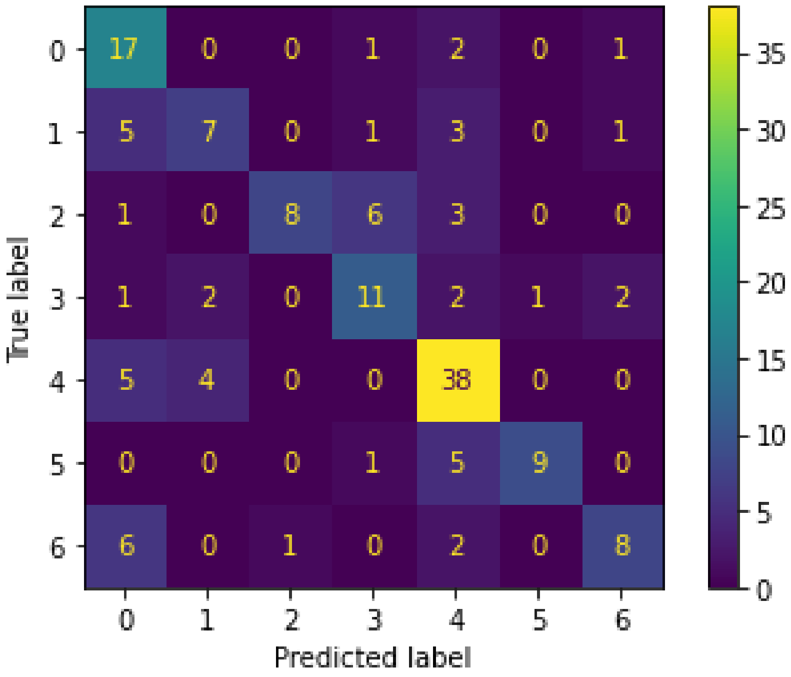
```
model_test17=executeModel(False, True, True, False, 5)
```

```
Training model with aumentation:False, gray:True, binary:True, crop:False and
epochs = 5
Epoch 1/5
53/53 [==============================] - 64s 1s/step - loss: 2.3362 - accuracy:
0.2533 - val_loss: 1.8988 - val_accuracy: 0.3218
Epoch 2/5
53/53 [==============================] - 62s 1s/step - loss: 1.5657 - accuracy:
0.4216 - val_loss: 1.4903 - val_accuracy: 0.4368
Epoch 3/5
53/53 [==============================] - 62s 1s/step - loss: 1.1201 - accuracy:
0.5803 - val_loss: 1.4387 - val_accuracy: 0.4253
Epoch 4/5
53/53 [==============================] - 58s 1s/step - loss: 0.7186 - accuracy:
0.7353 - val_loss: 1.3458 - val_accuracy: 0.5632
Epoch 5/5
53/53 [==============================] - 58s 1s/step - loss: 0.4182 - accuracy:
0.8715 - val_loss: 1.3342 - val_accuracy: 0.5287
```


model accuracy
accuracy
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch
train
test


model loss
loss
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch
train
test

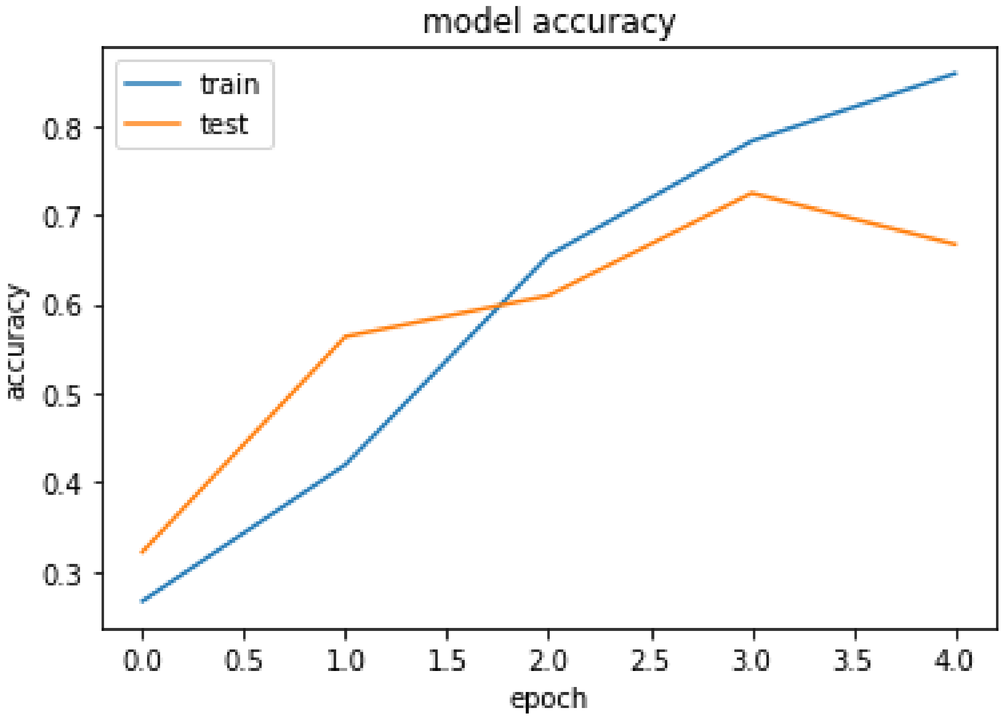
```
16/16 [==============================] - 4s 224ms/step
Test evaluation:
16/16 [==============================] - 4s 260ms/step - loss: 1.1404 -
accuracy: 0.6364
[1.1404340267181396, 0.6363636255264282]
% of correct brand in the first 3 positions:
131
0.8506493506493507
% of brand predicted with percentage >= 0.25
0.12337662337662338
% of brand predicted with percentage >= 0.5
0.12337662337662338
% of brand predicted with percentage >= 0.75
0.12337662337662338
Matriz de confusión:
```

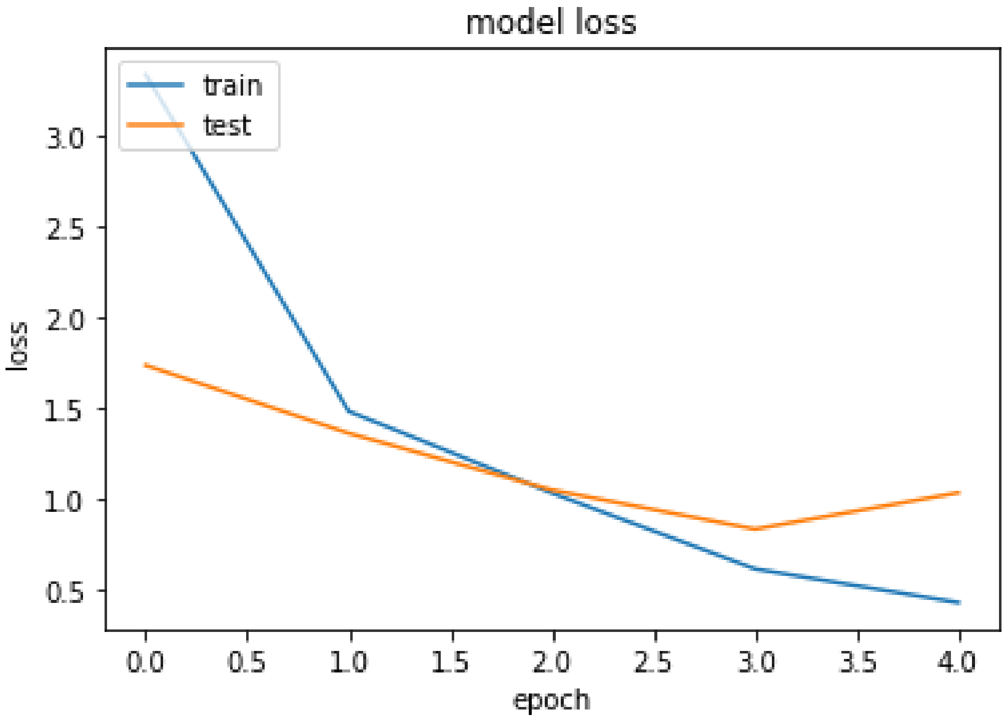


```
[204]: model_test18=executeModel(False, True, True, True, 5)
```

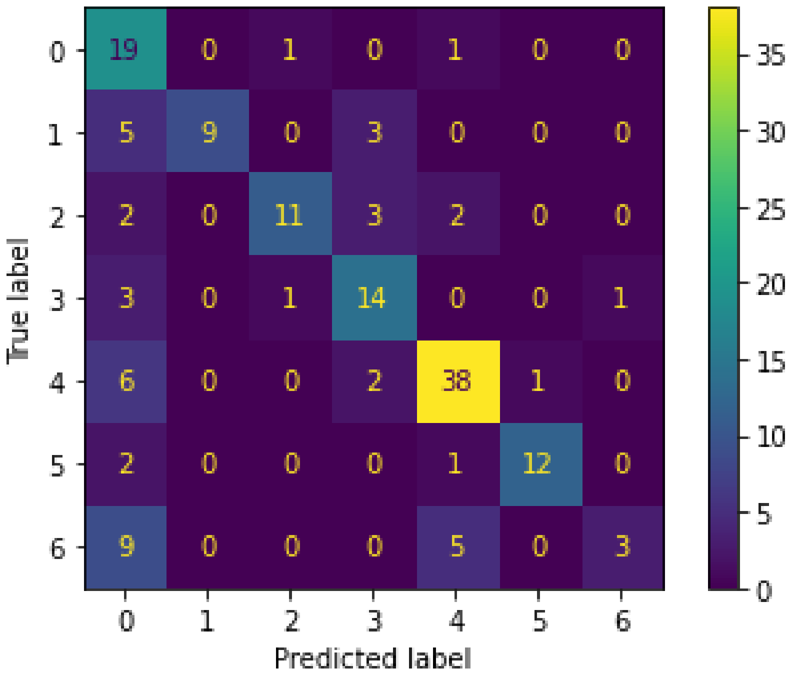
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 5
Epoch 1/5
53/53 [==============================] - 60s 1s/step - loss: 3.3377 - accuracy:
0.2665 - val_loss: 1.7368 - val_accuracy: 0.3218
Epoch 2/5
```

```
53/53 [==============================] - 58s 1s/step - loss: 1.4831 - accuracy:
0.4197 - val_loss: 1.3622 - val_accuracy: 0.5632
Epoch 3/5
53/53 [==============================] - 58s 1s/step - loss: 1.0336 - accuracy:
0.6541 - val_loss: 1.0505 - val_accuracy: 0.6092
Epoch 4/5
53/53 [==============================] - 59s 1s/step - loss: 0.6150 - accuracy:
0.7826 - val_loss: 0.8344 - val_accuracy: 0.7241
Epoch 5/5
53/53 [==============================] - 59s 1s/step - loss: 0.4297 - accuracy:
0.8582 - val_loss: 1.0351 - val_accuracy: 0.6667
```



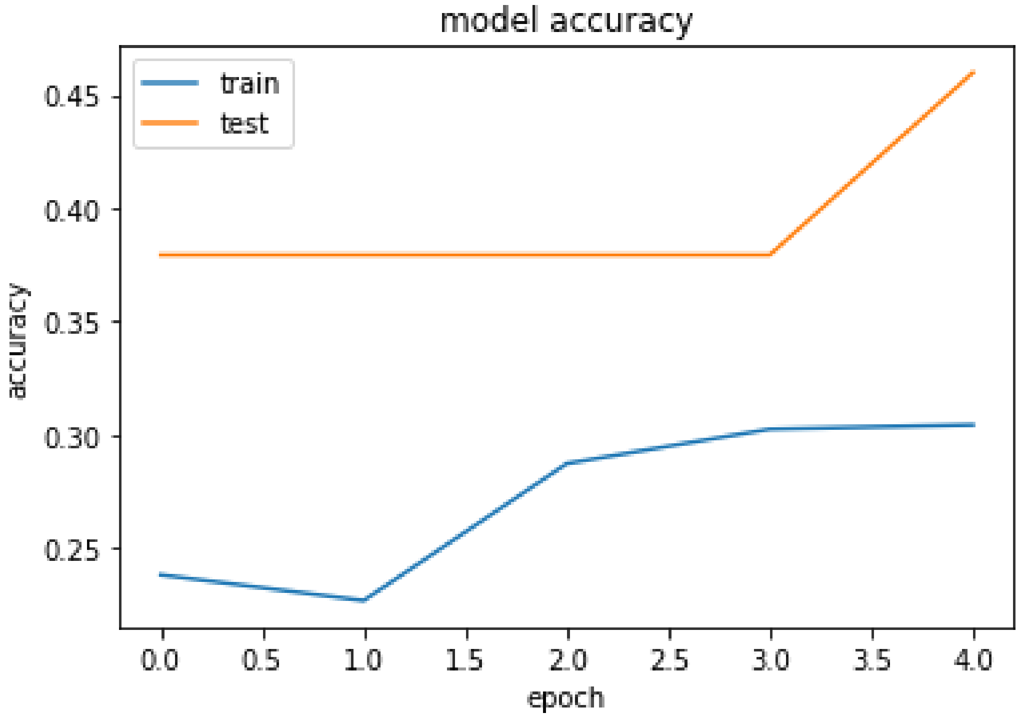


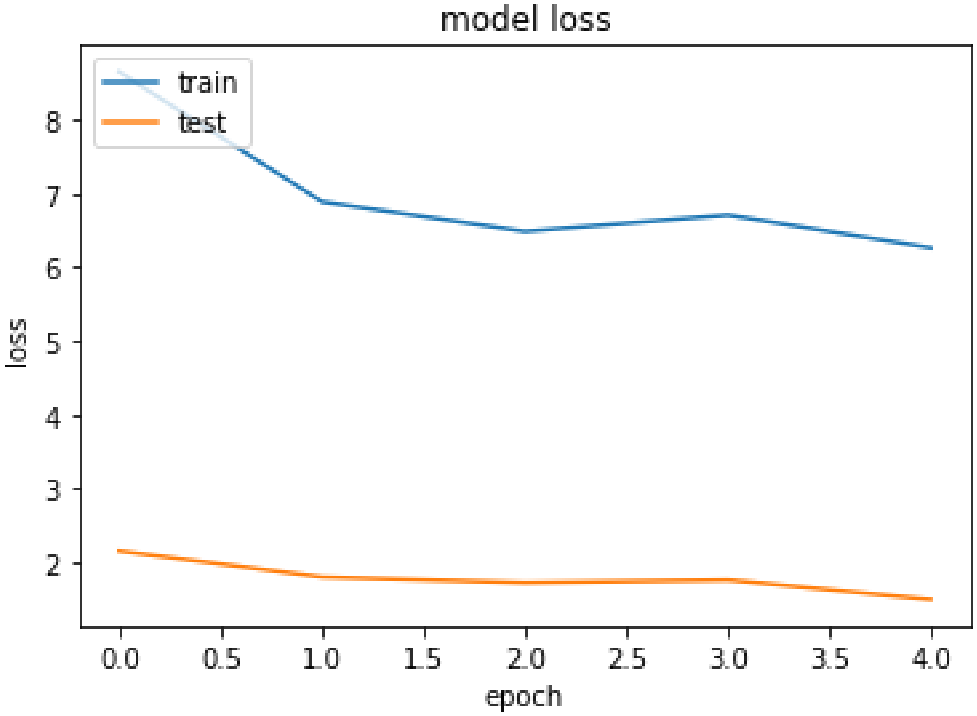
```
16/16 [==============================] - 4s 239ms/step
Test evaluation:
16/16 [==============================] - 4s 252ms/step - loss: 1.0697 -
accuracy: 0.6883
[1.069715976715088, 0.6883116960525513]
% of correct brand in the first 3 positions:
141
0.9155844155844156
% of brand predicted with percentage >= 0.25
0.11688311688311688
% of brand predicted with percentage >= 0.5
0.11688311688311688
% of brand predicted with percentage >= 0.75
0.11688311688311688
Matriz de confusión:
```



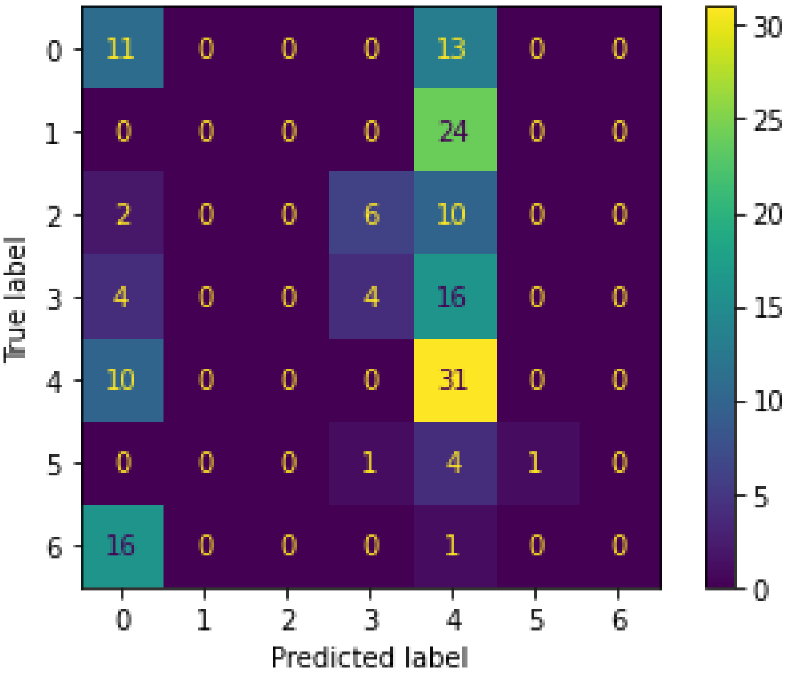
[54]:
```
model_test19=executeModel(True, True, True, True, 5)
```

```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 5
Epoch 1/5
53/53 [==============================] - 95s 2s/step - loss: 8.6425 - accuracy:
0.2382 - val_loss: 2.1593 - val_accuracy: 0.3793
Epoch 2/5
53/53 [==============================] - 84s 2s/step - loss: 6.8847 - accuracy:
0.2268 - val_loss: 1.8063 - val_accuracy: 0.3793
Epoch 3/5
53/53 [==============================] - 90s 2s/step - loss: 6.4831 - accuracy:
0.2873 - val_loss: 1.7292 - val_accuracy: 0.3793
Epoch 4/5
53/53 [==============================] - 71s 1s/step - loss: 6.7045 - accuracy:
0.3025 - val_loss: 1.7658 - val_accuracy: 0.3793
Epoch 5/5
53/53 [==============================] - 68s 1s/step - loss: 6.2600 - accuracy:
0.3043 - val_loss: 1.5028 - val_accuracy: 0.4598
```


model accuracy
train
test
accuracy
0.45
0.40
0.35
0.30
0.25
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch


model loss
train
test
loss
8
7
6
5
4
3
2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch

```
16/16 [==============================] - 5s 266ms/step
Test evaluation:
16/16 [==============================] - 5s 277ms/step - loss: 1.7120 -
accuracy: 0.3052
[1.7119717597961426, 0.30519479513168335]
% of correct brand in the first 3 positions:
117
0.7597402597402597
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



```
[206]: model_test20=executeModel(False, False, False, False, 50)
```

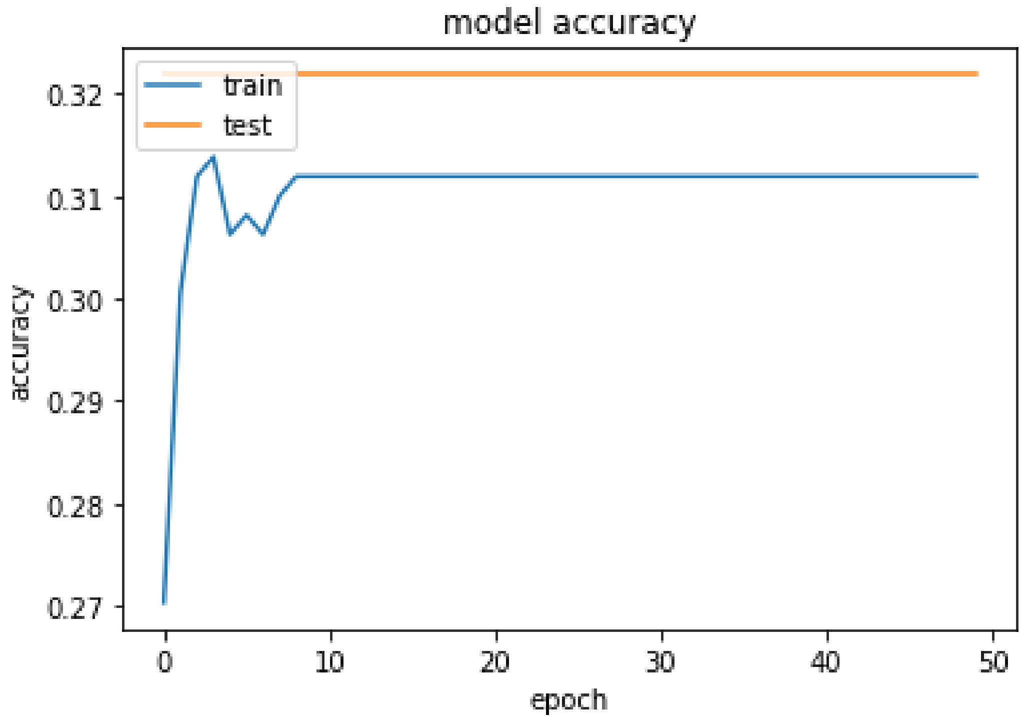
```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 50
Epoch 1/50
53/53 [==============================] - 60s 1s/step - loss: 1.8774 - accuracy:
0.2703 - val_loss: 1.8799 - val_accuracy: 0.3218
Epoch 2/50
```

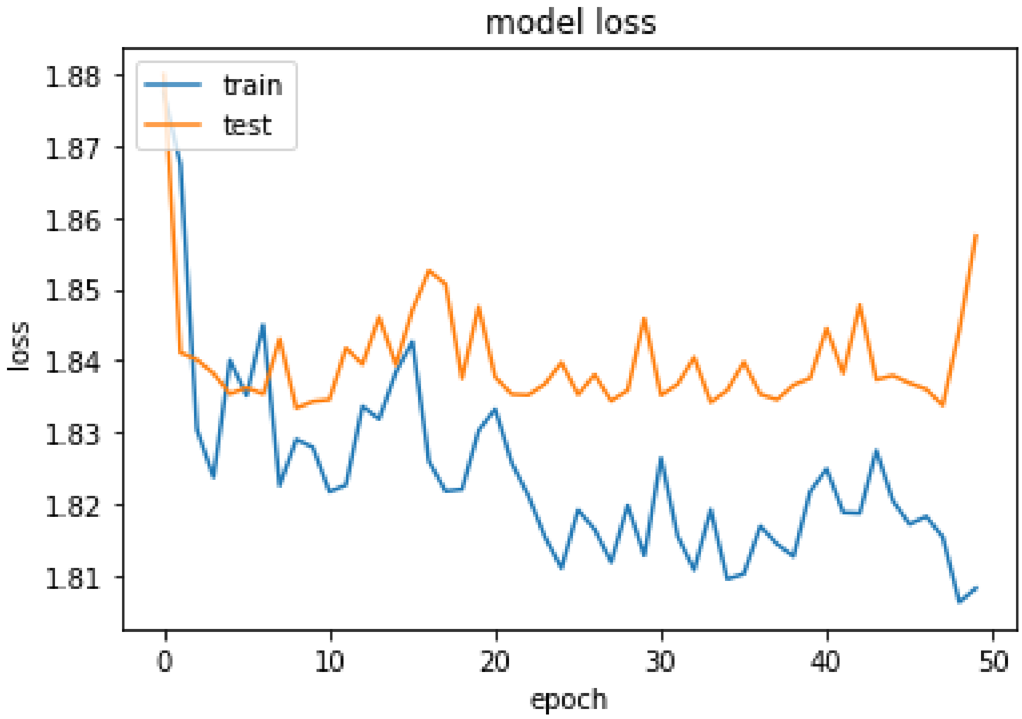
```
53/53 [==============================] - 55s 1s/step - loss: 1.8674 - accuracy:
0.3006 - val_loss: 1.8411 - val_accuracy: 0.3218
Epoch 3/50
53/53 [==============================] - 54s 1s/step - loss: 1.8305 - accuracy:
0.3119 - val_loss: 1.8402 - val_accuracy: 0.3218
Epoch 4/50
53/53 [==============================] - 60s 1s/step - loss: 1.8238 - accuracy:
0.3138 - val_loss: 1.8383 - val_accuracy: 0.3218
Epoch 5/50
53/53 [==============================] - 65s 1s/step - loss: 1.8401 - accuracy:
0.3062 - val_loss: 1.8354 - val_accuracy: 0.3218
Epoch 6/50
53/53 [==============================] - 62s 1s/step - loss: 1.8352 - accuracy:
0.3081 - val_loss: 1.8363 - val_accuracy: 0.3218
Epoch 7/50
53/53 [==============================] - 62s 1s/step - loss: 1.8450 - accuracy:
0.3062 - val_loss: 1.8354 - val_accuracy: 0.3218
Epoch 8/50
53/53 [==============================] - 61s 1s/step - loss: 1.8226 - accuracy:
0.3100 - val_loss: 1.8430 - val_accuracy: 0.3218
Epoch 9/50
53/53 [==============================] - 62s 1s/step - loss: 1.8291 - accuracy:
0.3119 - val_loss: 1.8334 - val_accuracy: 0.3218
Epoch 10/50
53/53 [==============================] - 61s 1s/step - loss: 1.8280 - accuracy:
0.3119 - val_loss: 1.8343 - val_accuracy: 0.3218
Epoch 11/50
53/53 [==============================] - 61s 1s/step - loss: 1.8218 - accuracy:
0.3119 - val_loss: 1.8346 - val_accuracy: 0.3218
Epoch 12/50
53/53 [==============================] - 61s 1s/step - loss: 1.8227 - accuracy:
0.3119 - val_loss: 1.8418 - val_accuracy: 0.3218
Epoch 13/50
53/53 [==============================] - 61s 1s/step - loss: 1.8337 - accuracy:
0.3119 - val_loss: 1.8395 - val_accuracy: 0.3218
Epoch 14/50
53/53 [==============================] - 61s 1s/step - loss: 1.8319 - accuracy:
0.3119 - val_loss: 1.8461 - val_accuracy: 0.3218
Epoch 15/50
53/53 [==============================] - 61s 1s/step - loss: 1.8384 - accuracy:
0.3119 - val_loss: 1.8395 - val_accuracy: 0.3218
Epoch 16/50
53/53 [==============================] - 60s 1s/step - loss: 1.8426 - accuracy:
0.3119 - val_loss: 1.8471 - val_accuracy: 0.3218
Epoch 17/50
53/53 [==============================] - 60s 1s/step - loss: 1.8260 - accuracy:
0.3119 - val_loss: 1.8526 - val_accuracy: 0.3218
Epoch 18/50
```

```
53/53 [==============================] - 61s 1s/step - loss: 1.8219 - accuracy:
0.3119 - val_loss: 1.8507 - val_accuracy: 0.3218
Epoch 19/50
53/53 [==============================] - 62s 1s/step - loss: 1.8221 - accuracy:
0.3119 - val_loss: 1.8376 - val_accuracy: 0.3218
Epoch 20/50
53/53 [==============================] - 61s 1s/step - loss: 1.8303 - accuracy:
0.3119 - val_loss: 1.8475 - val_accuracy: 0.3218
Epoch 21/50
53/53 [==============================] - 61s 1s/step - loss: 1.8333 - accuracy:
0.3119 - val_loss: 1.8377 - val_accuracy: 0.3218
Epoch 22/50
53/53 [==============================] - 61s 1s/step - loss: 1.8258 - accuracy:
0.3119 - val_loss: 1.8354 - val_accuracy: 0.3218
Epoch 23/50
53/53 [==============================] - 60s 1s/step - loss: 1.8212 - accuracy:
0.3119 - val_loss: 1.8352 - val_accuracy: 0.3218
Epoch 24/50
53/53 [==============================] - 61s 1s/step - loss: 1.8155 - accuracy:
0.3119 - val_loss: 1.8368 - val_accuracy: 0.3218
Epoch 25/50
53/53 [==============================] - 60s 1s/step - loss: 1.8111 - accuracy:
0.3119 - val_loss: 1.8398 - val_accuracy: 0.3218
Epoch 26/50
53/53 [==============================] - 63s 1s/step - loss: 1.8192 - accuracy:
0.3119 - val_loss: 1.8353 - val_accuracy: 0.3218
Epoch 27/50
53/53 [==============================] - 61s 1s/step - loss: 1.8165 - accuracy:
0.3119 - val_loss: 1.8381 - val_accuracy: 0.3218
Epoch 28/50
53/53 [==============================] - 61s 1s/step - loss: 1.8120 - accuracy:
0.3119 - val_loss: 1.8344 - val_accuracy: 0.3218
Epoch 29/50
53/53 [==============================] - 61s 1s/step - loss: 1.8199 - accuracy:
0.3119 - val_loss: 1.8359 - val_accuracy: 0.3218
Epoch 30/50
53/53 [==============================] - 76s 1s/step - loss: 1.8129 - accuracy:
0.3119 - val_loss: 1.8459 - val_accuracy: 0.3218
Epoch 31/50
53/53 [==============================] - 54s 1s/step - loss: 1.8265 - accuracy:
0.3119 - val_loss: 1.8352 - val_accuracy: 0.3218
Epoch 32/50
53/53 [==============================] - 55s 1s/step - loss: 1.8156 - accuracy:
0.3119 - val_loss: 1.8367 - val_accuracy: 0.3218
Epoch 33/50
53/53 [==============================] - 54s 1s/step - loss: 1.8108 - accuracy:
0.3119 - val_loss: 1.8405 - val_accuracy: 0.3218
Epoch 34/50
```

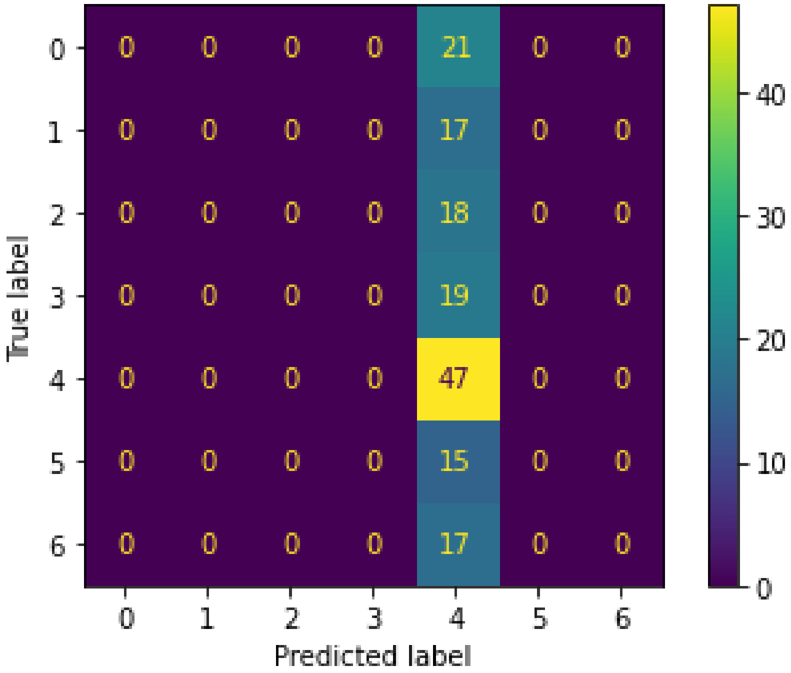
```
53/53 [==============================] - 54s 1s/step - loss: 1.8193 - accuracy:
0.3119 - val_loss: 1.8342 - val_accuracy: 0.3218
Epoch 35/50
53/53 [==============================] - 54s 1s/step - loss: 1.8096 - accuracy:
0.3119 - val_loss: 1.8359 - val_accuracy: 0.3218
Epoch 36/50
53/53 [==============================] - 54s 1s/step - loss: 1.8103 - accuracy:
0.3119 - val_loss: 1.8398 - val_accuracy: 0.3218
Epoch 37/50
53/53 [==============================] - 59s 1s/step - loss: 1.8170 - accuracy:
0.3119 - val_loss: 1.8354 - val_accuracy: 0.3218
Epoch 38/50
53/53 [==============================] - 56s 1s/step - loss: 1.8145 - accuracy:
0.3119 - val_loss: 1.8346 - val_accuracy: 0.3218
Epoch 39/50
53/53 [==============================] - 56s 1s/step - loss: 1.8128 - accuracy:
0.3119 - val_loss: 1.8366 - val_accuracy: 0.3218
Epoch 40/50
53/53 [==============================] - 57s 1s/step - loss: 1.8218 - accuracy:
0.3119 - val_loss: 1.8376 - val_accuracy: 0.3218
Epoch 41/50
53/53 [==============================] - 55s 1s/step - loss: 1.8250 - accuracy:
0.3119 - val_loss: 1.8445 - val_accuracy: 0.3218
Epoch 42/50
53/53 [==============================] - 54s 1s/step - loss: 1.8189 - accuracy:
0.3119 - val_loss: 1.8383 - val_accuracy: 0.3218
Epoch 43/50
53/53 [==============================] - 57s 1s/step - loss: 1.8188 - accuracy:
0.3119 - val_loss: 1.8478 - val_accuracy: 0.3218
Epoch 44/50
53/53 [==============================] - 69s 1s/step - loss: 1.8275 - accuracy:
0.3119 - val_loss: 1.8374 - val_accuracy: 0.3218
Epoch 45/50
53/53 [==============================] - 63s 1s/step - loss: 1.8205 - accuracy:
0.3119 - val_loss: 1.8380 - val_accuracy: 0.3218
Epoch 46/50
53/53 [==============================] - 64s 1s/step - loss: 1.8173 - accuracy:
0.3119 - val_loss: 1.8369 - val_accuracy: 0.3218
Epoch 47/50
53/53 [==============================] - 65s 1s/step - loss: 1.8183 - accuracy:
0.3119 - val_loss: 1.8361 - val_accuracy: 0.3218
Epoch 48/50
53/53 [==============================] - 66s 1s/step - loss: 1.8155 - accuracy:
0.3119 - val_loss: 1.8338 - val_accuracy: 0.3218
Epoch 49/50
53/53 [==============================] - 66s 1s/step - loss: 1.8064 - accuracy:
0.3119 - val_loss: 1.8443 - val_accuracy: 0.3218
Epoch 50/50
```

```
53/53 [==============================] - 66s 1s/step - loss: 1.8083 - accuracy:
0.3119 - val_loss: 1.8574 - val_accuracy: 0.3218
```





```
16/16 [==============================] - 5s 272ms/step
Test evaluation:
16/16 [==============================] - 5s 330ms/step - loss: 1.9241 -
accuracy: 0.3052
[1.9240790605545044, 0.30519479513168335]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.3051948051948052
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 17 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 18 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 47 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 15 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 17 | 0 | 0 |

```
[55]: model_test21=executeModel(True, False, False, False, 50)
```

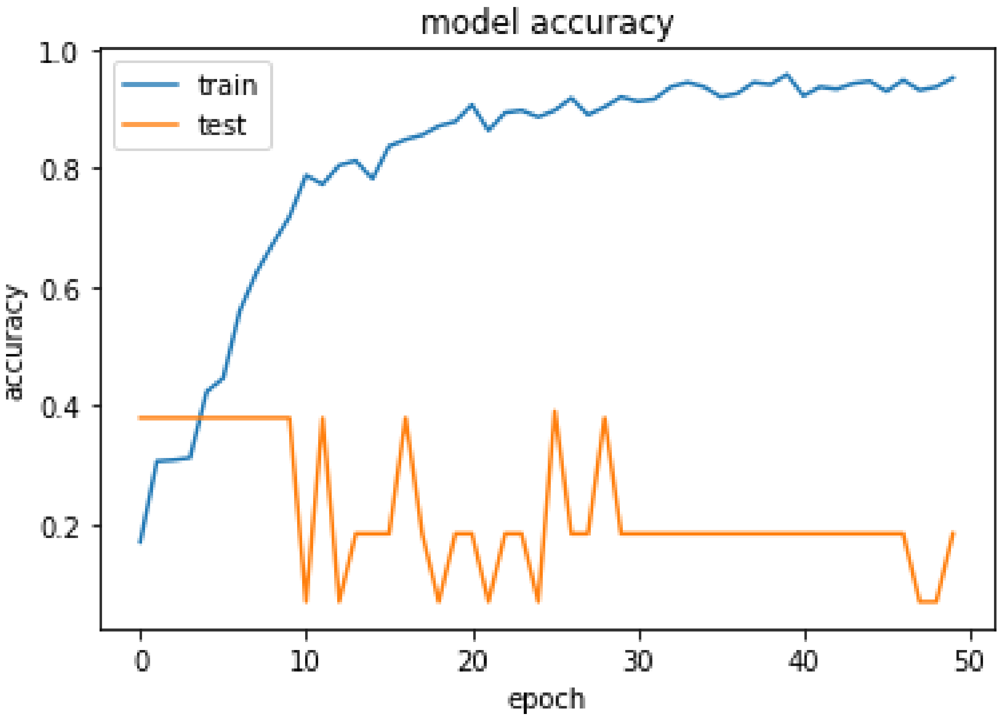
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 50
Epoch 1/50
53/53 [==============================] - 75s 1s/step - loss: 7.8539 - accuracy:
```

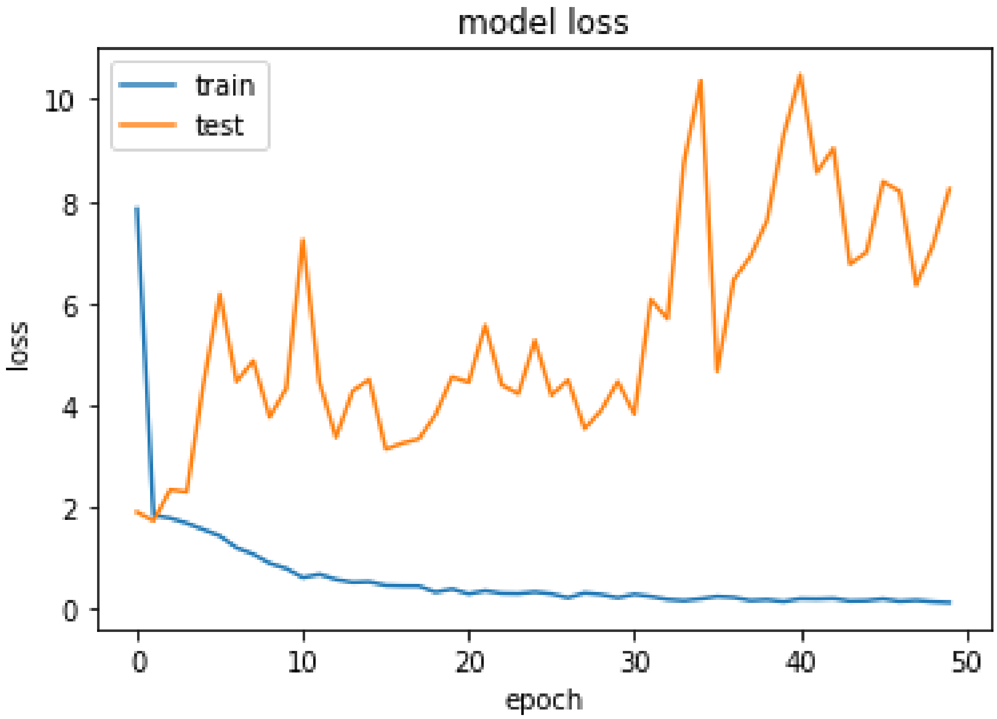
```
0.1701 - val_loss: 1.9095 - val_accuracy: 0.3793
Epoch 2/50
53/53 [==============================] - 74s 1s/step - loss: 1.8471 - accuracy:
0.3062 - val_loss: 1.7369 - val_accuracy: 0.3793
Epoch 3/50
53/53 [==============================] - 74s 1s/step - loss: 1.7899 - accuracy:
0.3081 - val_loss: 2.3456 - val_accuracy: 0.3793
Epoch 4/50
53/53 [==============================] - 73s 1s/step - loss: 1.6913 - accuracy:
0.3119 - val_loss: 2.3048 - val_accuracy: 0.3793
Epoch 5/50
53/53 [==============================] - 74s 1s/step - loss: 1.5661 - accuracy:
0.4234 - val_loss: 4.4014 - val_accuracy: 0.3793
Epoch 6/50
53/53 [==============================] - 73s 1s/step - loss: 1.4409 - accuracy:
0.4461 - val_loss: 6.1858 - val_accuracy: 0.3793
Epoch 7/50
53/53 [==============================] - 100s 2s/step - loss: 1.2095 - accuracy:
0.5595 - val_loss: 4.4645 - val_accuracy: 0.3793
Epoch 8/50
53/53 [==============================] - 80s 1s/step - loss: 1.0836 - accuracy:
0.6238 - val_loss: 4.8713 - val_accuracy: 0.3793
Epoch 9/50
53/53 [==============================] - 75s 1s/step - loss: 0.9030 - accuracy:
0.6730 - val_loss: 3.7680 - val_accuracy: 0.3793
Epoch 10/50
53/53 [==============================] - 72s 1s/step - loss: 0.8001 - accuracy:
0.7183 - val_loss: 4.3358 - val_accuracy: 0.3793
Epoch 11/50
53/53 [==============================] - 89s 2s/step - loss: 0.6217 - accuracy:
0.7883 - val_loss: 7.2474 - val_accuracy: 0.0690
Epoch 12/50
53/53 [==============================] - 108s 2s/step - loss: 0.6865 - accuracy:
0.7732 - val_loss: 4.4505 - val_accuracy: 0.3793
Epoch 13/50
53/53 [==============================] - 96s 2s/step - loss: 0.5847 - accuracy:
0.8053 - val_loss: 3.3696 - val_accuracy: 0.0690
Epoch 14/50
53/53 [==============================] - 83s 2s/step - loss: 0.5295 - accuracy:
0.8129 - val_loss: 4.2799 - val_accuracy: 0.1839
Epoch 15/50
53/53 [==============================] - 83s 2s/step - loss: 0.5409 - accuracy:
0.7826 - val_loss: 4.5071 - val_accuracy: 0.1839
Epoch 16/50
53/53 [==============================] - 75s 1s/step - loss: 0.4691 - accuracy:
0.8374 - val_loss: 3.1381 - val_accuracy: 0.1839
Epoch 17/50
53/53 [==============================] - 75s 1s/step - loss: 0.4591 - accuracy:
```

```
0.8488 - val_loss: 3.2556 - val_accuracy: 0.3793
Epoch 18/50
53/53 [==============================] - 79s 1s/step - loss: 0.4571 - accuracy:
0.8563 - val_loss: 3.3396 - val_accuracy: 0.1839
Epoch 19/50
53/53 [==============================] - 80s 1s/step - loss: 0.3364 - accuracy:
0.8715 - val_loss: 3.8138 - val_accuracy: 0.0690
Epoch 20/50
53/53 [==============================] - 75s 1s/step - loss: 0.3990 - accuracy:
0.8790 - val_loss: 4.5565 - val_accuracy: 0.1839
Epoch 21/50
53/53 [==============================] - 80s 2s/step - loss: 0.3026 - accuracy:
0.9074 - val_loss: 4.4507 - val_accuracy: 0.1839
Epoch 22/50
53/53 [==============================] - 79s 1s/step - loss: 0.3642 - accuracy:
0.8639 - val_loss: 5.5678 - val_accuracy: 0.0690
Epoch 23/50
53/53 [==============================] - 79s 1s/step - loss: 0.3136 - accuracy:
0.8941 - val_loss: 4.4007 - val_accuracy: 0.1839
Epoch 24/50
53/53 [==============================] - 88s 2s/step - loss: 0.3079 - accuracy:
0.8979 - val_loss: 4.2266 - val_accuracy: 0.1839
Epoch 25/50
53/53 [==============================] - 85s 2s/step - loss: 0.3407 - accuracy:
0.8866 - val_loss: 5.2736 - val_accuracy: 0.0690
Epoch 26/50
53/53 [==============================] - 89s 2s/step - loss: 0.3034 - accuracy:
0.8979 - val_loss: 4.1967 - val_accuracy: 0.3908
Epoch 27/50
53/53 [==============================] - 86s 2s/step - loss: 0.2253 - accuracy:
0.9187 - val_loss: 4.4966 - val_accuracy: 0.1839
Epoch 28/50
53/53 [==============================] - 85s 2s/step - loss: 0.3220 - accuracy:
0.8904 - val_loss: 3.5402 - val_accuracy: 0.1839
Epoch 29/50
53/53 [==============================] - 81s 2s/step - loss: 0.2896 - accuracy:
0.9036 - val_loss: 3.9001 - val_accuracy: 0.3793
Epoch 30/50
53/53 [==============================] - 73s 1s/step - loss: 0.2259 - accuracy:
0.9206 - val_loss: 4.4679 - val_accuracy: 0.1839
Epoch 31/50
53/53 [==============================] - 106s 2s/step - loss: 0.2943 - accuracy:
0.9130 - val_loss: 3.8258 - val_accuracy: 0.1839
Epoch 32/50
53/53 [==============================] - 107s 2s/step - loss: 0.2507 - accuracy:
0.9168 - val_loss: 6.0730 - val_accuracy: 0.1839
Epoch 33/50
53/53 [==============================] - 96s 2s/step - loss: 0.1940 - accuracy:
```

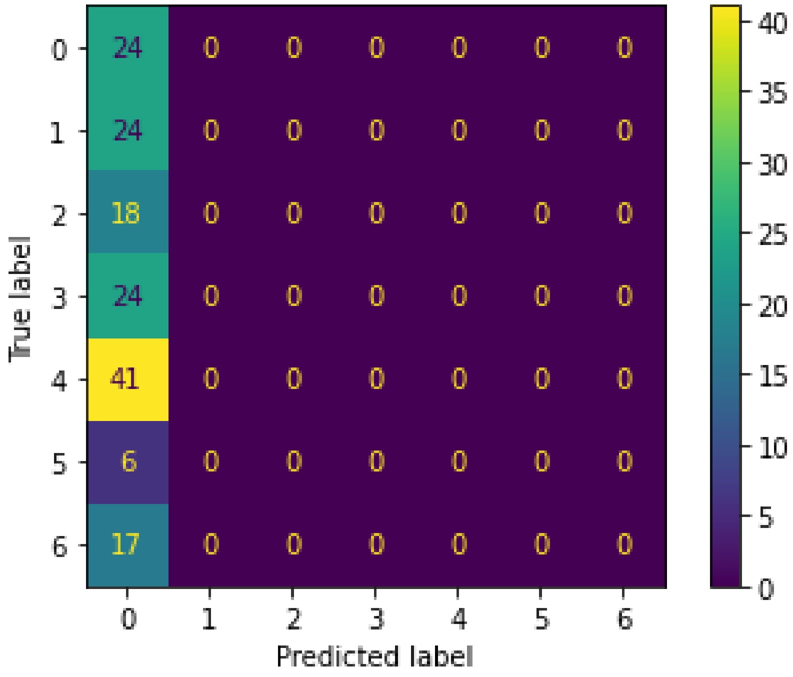
```
0.9376 - val_loss: 5.6985 - val_accuracy: 0.1839
Epoch 34/50
53/53 [==============================] - 99s 2s/step - loss: 0.1710 - accuracy:
0.9452 - val_loss: 8.7765 - val_accuracy: 0.1839
Epoch 35/50
53/53 [==============================] - 85s 2s/step - loss: 0.2059 - accuracy:
0.9376 - val_loss: 10.3619 - val_accuracy: 0.1839
Epoch 36/50
53/53 [==============================] - 83s 2s/step - loss: 0.2529 - accuracy:
0.9206 - val_loss: 4.6730 - val_accuracy: 0.1839
Epoch 37/50
53/53 [==============================] - 74s 1s/step - loss: 0.2333 - accuracy:
0.9263 - val_loss: 6.4638 - val_accuracy: 0.1839
Epoch 38/50
53/53 [==============================] - 79s 1s/step - loss: 0.1731 - accuracy:
0.9452 - val_loss: 6.9136 - val_accuracy: 0.1839
Epoch 39/50
53/53 [==============================] - 75s 1s/step - loss: 0.1890 - accuracy:
0.9414 - val_loss: 7.6281 - val_accuracy: 0.1839
Epoch 40/50
53/53 [==============================] - 70s 1s/step - loss: 0.1528 - accuracy:
0.9584 - val_loss: 9.3018 - val_accuracy: 0.1839
Epoch 41/50
53/53 [==============================] - 73s 1s/step - loss: 0.2074 - accuracy:
0.9225 - val_loss: 10.4842 - val_accuracy: 0.1839
Epoch 42/50
53/53 [==============================] - 74s 1s/step - loss: 0.2021 - accuracy:
0.9376 - val_loss: 8.5669 - val_accuracy: 0.1839
Epoch 43/50
53/53 [==============================] - 72s 1s/step - loss: 0.2124 - accuracy:
0.9338 - val_loss: 9.0402 - val_accuracy: 0.1839
Epoch 44/50
53/53 [==============================] - 76s 1s/step - loss: 0.1633 - accuracy:
0.9433 - val_loss: 6.7677 - val_accuracy: 0.1839
Epoch 45/50
53/53 [==============================] - 75s 1s/step - loss: 0.1705 - accuracy:
0.9471 - val_loss: 7.0008 - val_accuracy: 0.1839
Epoch 46/50
53/53 [==============================] - 73s 1s/step - loss: 0.2045 - accuracy:
0.9301 - val_loss: 8.3842 - val_accuracy: 0.1839
Epoch 47/50
53/53 [==============================] - 73s 1s/step - loss: 0.1577 - accuracy:
0.9490 - val_loss: 8.1974 - val_accuracy: 0.1839
Epoch 48/50
53/53 [==============================] - 72s 1s/step - loss: 0.1778 - accuracy:
0.9319 - val_loss: 6.3606 - val_accuracy: 0.0690
Epoch 49/50
53/53 [==============================] - 75s 1s/step - loss: 0.1484 - accuracy:
```

```
0.9376 - val_loss: 7.1331 - val_accuracy: 0.0690
Epoch 50/50
53/53 [==============================] - 71s 1s/step - loss: 0.1327 - accuracy:
0.9527 - val_loss: 8.2415 - val_accuracy: 0.1839
```





```
16/16 [==============================] - 5s 277ms/step
Test evaluation:
16/16 [==============================] - 5s 303ms/step - loss: 8.2145 -
accuracy: 0.1558
[8.21447467803955, 0.15584415197372437]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.3116883116883117
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 41 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 17 | 0 | 0 | 0 | 0 | 0 | 0 |

[208]:

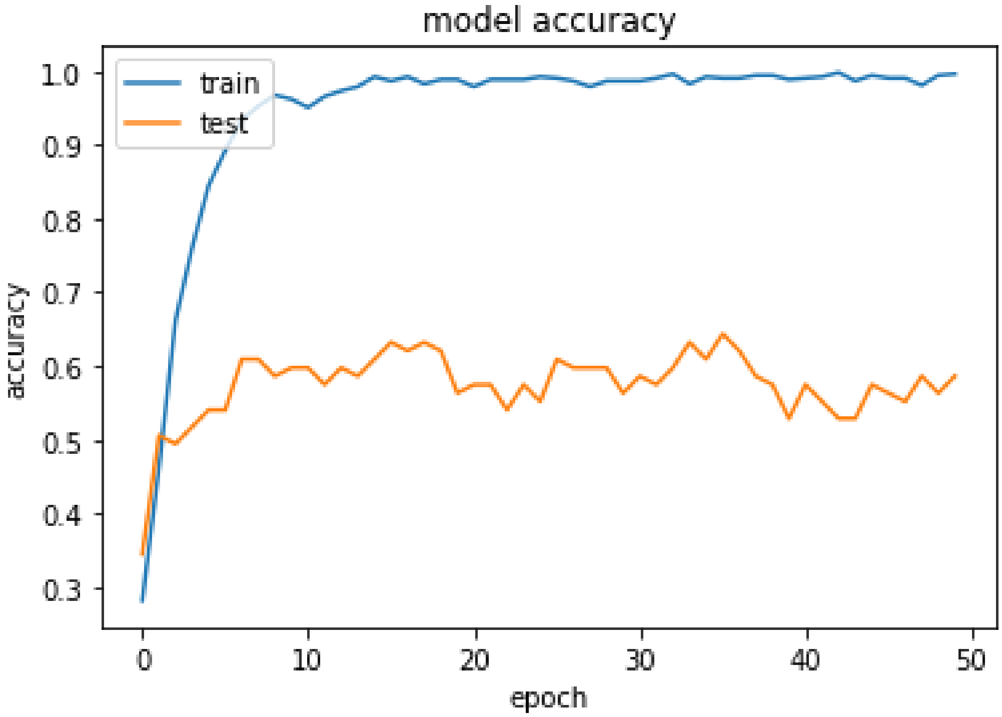
```
model_test22=executeModel(False, True, True, False, 50)
```

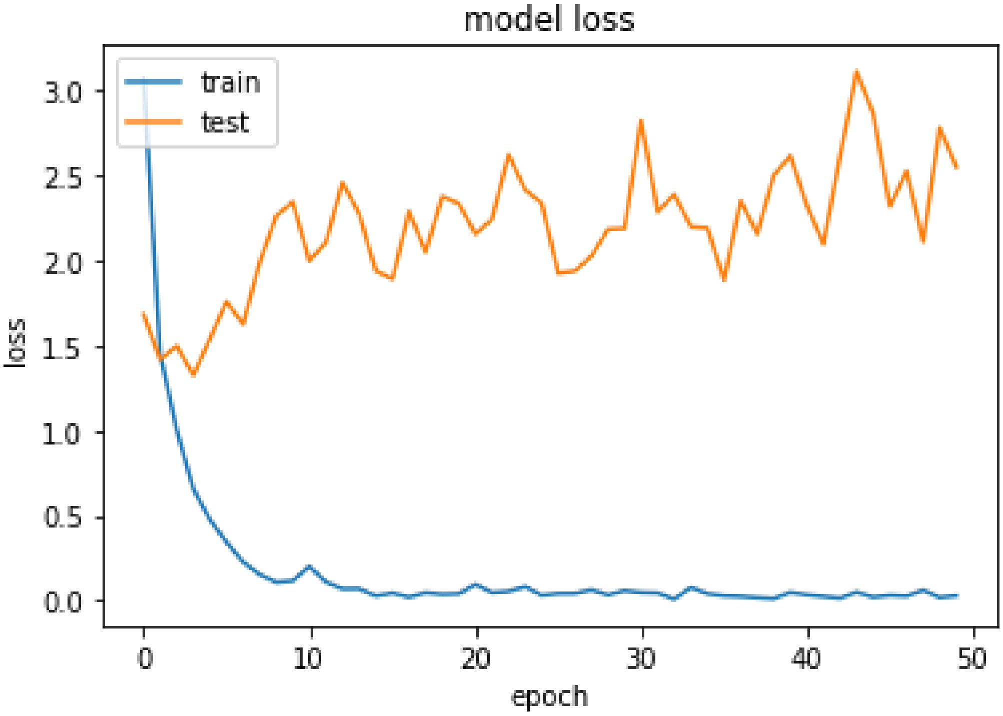
```
Training model with aumentation:False, gray:True, binary:True, crop:False and
epochs = 50
Epoch 1/50
53/53 [==============================] - 57s 1s/step - loss: 3.0693 - accuracy:
0.2817 - val_loss: 1.6831 - val_accuracy: 0.3448
Epoch 2/50
53/53 [==============================] - 56s 1s/step - loss: 1.4522 - accuracy:
0.4612 - val_loss: 1.4167 - val_accuracy: 0.5057
Epoch 3/50
53/53 [==============================] - 56s 1s/step - loss: 1.0020 - accuracy:
0.6616 - val_loss: 1.4982 - val_accuracy: 0.4943
Epoch 4/50
53/53 [==============================] - 56s 1s/step - loss: 0.6571 - accuracy:
0.7599 - val_loss: 1.3249 - val_accuracy: 0.5172
Epoch 5/50
53/53 [==============================] - 55s 1s/step - loss: 0.4764 - accuracy:
0.8450 - val_loss: 1.5395 - val_accuracy: 0.5402
Epoch 6/50
53/53 [==============================] - 56s 1s/step - loss: 0.3444 - accuracy:
0.8922 - val_loss: 1.7589 - val_accuracy: 0.5402
Epoch 7/50
53/53 [==============================] - 56s 1s/step - loss: 0.2279 - accuracy:
```

```
0.9338 - val_loss: 1.6263 - val_accuracy: 0.6092
Epoch 8/50
53/53 [==============================] - 56s 1s/step - loss: 0.1541 - accuracy:
0.9527 - val_loss: 1.9877 - val_accuracy: 0.6092
Epoch 9/50
53/53 [==============================] - 55s 1s/step - loss: 0.1085 - accuracy:
0.9679 - val_loss: 2.2621 - val_accuracy: 0.5862
Epoch 10/50
53/53 [==============================] - 56s 1s/step - loss: 0.1170 - accuracy:
0.9622 - val_loss: 2.3443 - val_accuracy: 0.5977
Epoch 11/50
53/53 [==============================] - 56s 1s/step - loss: 0.2015 - accuracy:
0.9509 - val_loss: 1.9974 - val_accuracy: 0.5977
Epoch 12/50
53/53 [==============================] - 56s 1s/step - loss: 0.1098 - accuracy:
0.9660 - val_loss: 2.1064 - val_accuracy: 0.5747
Epoch 13/50
53/53 [==============================] - 56s 1s/step - loss: 0.0698 - accuracy:
0.9735 - val_loss: 2.4593 - val_accuracy: 0.5977
Epoch 14/50
53/53 [==============================] - 56s 1s/step - loss: 0.0707 - accuracy:
0.9792 - val_loss: 2.2762 - val_accuracy: 0.5862
Epoch 15/50
53/53 [==============================] - 56s 1s/step - loss: 0.0279 - accuracy:
0.9924 - val_loss: 1.9387 - val_accuracy: 0.6092
Epoch 16/50
53/53 [==============================] - 55s 1s/step - loss: 0.0451 - accuracy:
0.9868 - val_loss: 1.8922 - val_accuracy: 0.6322
Epoch 17/50
53/53 [==============================] - 56s 1s/step - loss: 0.0207 - accuracy:
0.9924 - val_loss: 2.2886 - val_accuracy: 0.6207
Epoch 18/50
53/53 [==============================] - 55s 1s/step - loss: 0.0471 - accuracy:
0.9830 - val_loss: 2.0489 - val_accuracy: 0.6322
Epoch 19/50
53/53 [==============================] - 56s 1s/step - loss: 0.0377 - accuracy:
0.9887 - val_loss: 2.3771 - val_accuracy: 0.6207
Epoch 20/50
53/53 [==============================] - 56s 1s/step - loss: 0.0404 - accuracy:
0.9887 - val_loss: 2.3347 - val_accuracy: 0.5632
Epoch 21/50
53/53 [==============================] - 56s 1s/step - loss: 0.0963 - accuracy:
0.9792 - val_loss: 2.1551 - val_accuracy: 0.5747
Epoch 22/50
53/53 [==============================] - 60s 1s/step - loss: 0.0471 - accuracy:
0.9887 - val_loss: 2.2426 - val_accuracy: 0.5747
Epoch 23/50
53/53 [==============================] - 58s 1s/step - loss: 0.0544 - accuracy:
```

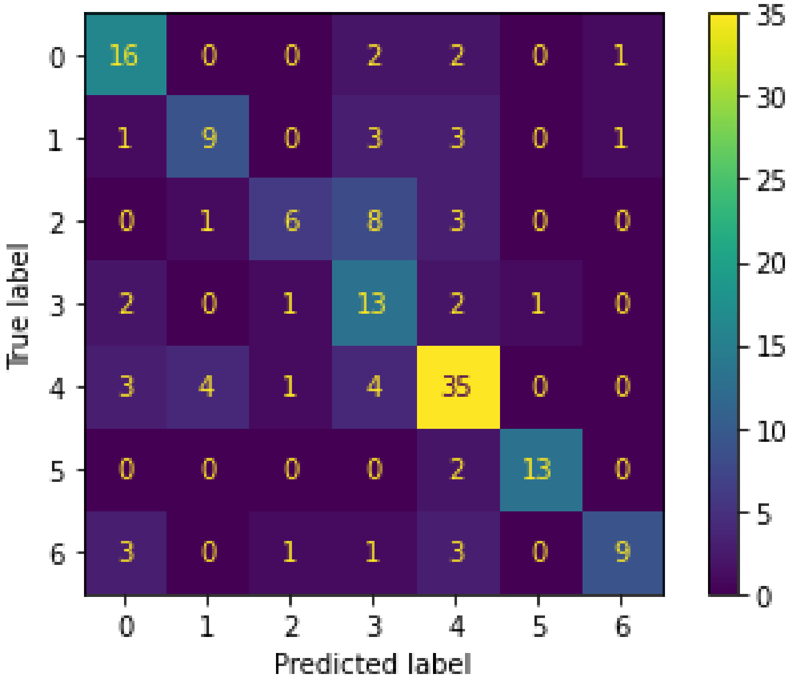
```
0.9887 - val_loss: 2.6224 - val_accuracy: 0.5402
Epoch 24/50
53/53 [==============================] - 56s 1s/step - loss: 0.0824 - accuracy:
0.9887 - val_loss: 2.4164 - val_accuracy: 0.5747
Epoch 25/50
53/53 [==============================] - 56s 1s/step - loss: 0.0315 - accuracy:
0.9924 - val_loss: 2.3374 - val_accuracy: 0.5517
Epoch 26/50
53/53 [==============================] - 57s 1s/step - loss: 0.0418 - accuracy:
0.9905 - val_loss: 1.9262 - val_accuracy: 0.6092
Epoch 27/50
53/53 [==============================] - 62s 1s/step - loss: 0.0424 - accuracy:
0.9868 - val_loss: 1.9392 - val_accuracy: 0.5977
Epoch 28/50
53/53 [==============================] - 64s 1s/step - loss: 0.0631 - accuracy:
0.9792 - val_loss: 2.0253 - val_accuracy: 0.5977
Epoch 29/50
53/53 [==============================] - 61s 1s/step - loss: 0.0340 - accuracy:
0.9868 - val_loss: 2.1833 - val_accuracy: 0.5977
Epoch 30/50
53/53 [==============================] - 58s 1s/step - loss: 0.0586 - accuracy:
0.9868 - val_loss: 2.1886 - val_accuracy: 0.5632
Epoch 31/50
53/53 [==============================] - 61s 1s/step - loss: 0.0476 - accuracy:
0.9868 - val_loss: 2.8232 - val_accuracy: 0.5862
Epoch 32/50
53/53 [==============================] - 66s 1s/step - loss: 0.0455 - accuracy:
0.9905 - val_loss: 2.2854 - val_accuracy: 0.5747
Epoch 33/50
53/53 [==============================] - 52s 973ms/step - loss: 0.0088 -
accuracy: 0.9962 - val_loss: 2.3889 - val_accuracy: 0.5977
Epoch 34/50
53/53 [==============================] - 53s 995ms/step - loss: 0.0775 -
accuracy: 0.9830 - val_loss: 2.1985 - val_accuracy: 0.6322
Epoch 35/50
53/53 [==============================] - 53s 992ms/step - loss: 0.0410 -
accuracy: 0.9924 - val_loss: 2.1911 - val_accuracy: 0.6092
Epoch 36/50
53/53 [==============================] - 51s 970ms/step - loss: 0.0288 -
accuracy: 0.9905 - val_loss: 1.8839 - val_accuracy: 0.6437
Epoch 37/50
53/53 [==============================] - 52s 973ms/step - loss: 0.0251 -
accuracy: 0.9905 - val_loss: 2.3510 - val_accuracy: 0.6207
Epoch 38/50
53/53 [==============================] - 52s 983ms/step - loss: 0.0179 -
accuracy: 0.9943 - val_loss: 2.1563 - val_accuracy: 0.5862
Epoch 39/50
53/53 [==============================] - 52s 972ms/step - loss: 0.0123 -
```

```
accuracy: 0.9943 - val_loss: 2.5008 - val_accuracy: 0.5747
Epoch 40/50
53/53 [==============================] - 51s 970ms/step - loss: 0.0485 -
accuracy: 0.9887 - val_loss: 2.6159 - val_accuracy: 0.5287
Epoch 41/50
53/53 [==============================] - 51s 959ms/step - loss: 0.0346 -
accuracy: 0.9905 - val_loss: 2.3225 - val_accuracy: 0.5747
Epoch 42/50
53/53 [==============================] - 51s 967ms/step - loss: 0.0246 -
accuracy: 0.9924 - val_loss: 2.0971 - val_accuracy: 0.5517
Epoch 43/50
53/53 [==============================] - 51s 961ms/step - loss: 0.0150 -
accuracy: 0.9981 - val_loss: 2.6130 - val_accuracy: 0.5287
Epoch 44/50
53/53 [==============================] - 51s 967ms/step - loss: 0.0500 -
accuracy: 0.9868 - val_loss: 3.1106 - val_accuracy: 0.5287
Epoch 45/50
53/53 [==============================] - 51s 968ms/step - loss: 0.0208 -
accuracy: 0.9943 - val_loss: 2.8654 - val_accuracy: 0.5747
Epoch 46/50
53/53 [==============================] - 51s 966ms/step - loss: 0.0317 -
accuracy: 0.9905 - val_loss: 2.3186 - val_accuracy: 0.5632
Epoch 47/50
53/53 [==============================] - 52s 971ms/step - loss: 0.0273 -
accuracy: 0.9905 - val_loss: 2.5256 - val_accuracy: 0.5517
Epoch 48/50
53/53 [==============================] - 51s 962ms/step - loss: 0.0613 -
accuracy: 0.9811 - val_loss: 2.1120 - val_accuracy: 0.5862
Epoch 49/50
53/53 [==============================] - 52s 971ms/step - loss: 0.0192 -
accuracy: 0.9943 - val_loss: 2.7811 - val_accuracy: 0.5632
Epoch 50/50
53/53 [==============================] - 53s 991ms/step - loss: 0.0294 -
accuracy: 0.9962 - val_loss: 2.5502 - val_accuracy: 0.5862
```


model accuracy
train
test
accuracy
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
10
20
30
40
50
epoch


model loss
train
test
loss
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
epoch

```
16/16 [==============================] - 3s 187ms/step
Test evaluation:
16/16 [==============================] - 3s 189ms/step - loss: 2.0034 -
accuracy: 0.6558
[2.003368854522705, 0.6558441519737244]
% of correct brand in the first 3 positions:
139
0.9025974025974026
% of brand predicted with percentage >= 0.25
0.12337662337662338
% of brand predicted with percentage >= 0.5
0.12337662337662338
% of brand predicted with percentage >= 0.75
0.12337662337662338
Matriz de confusión:
```



[214]:
```
model_test23=executeModel(False, True, True, True, 50)
```

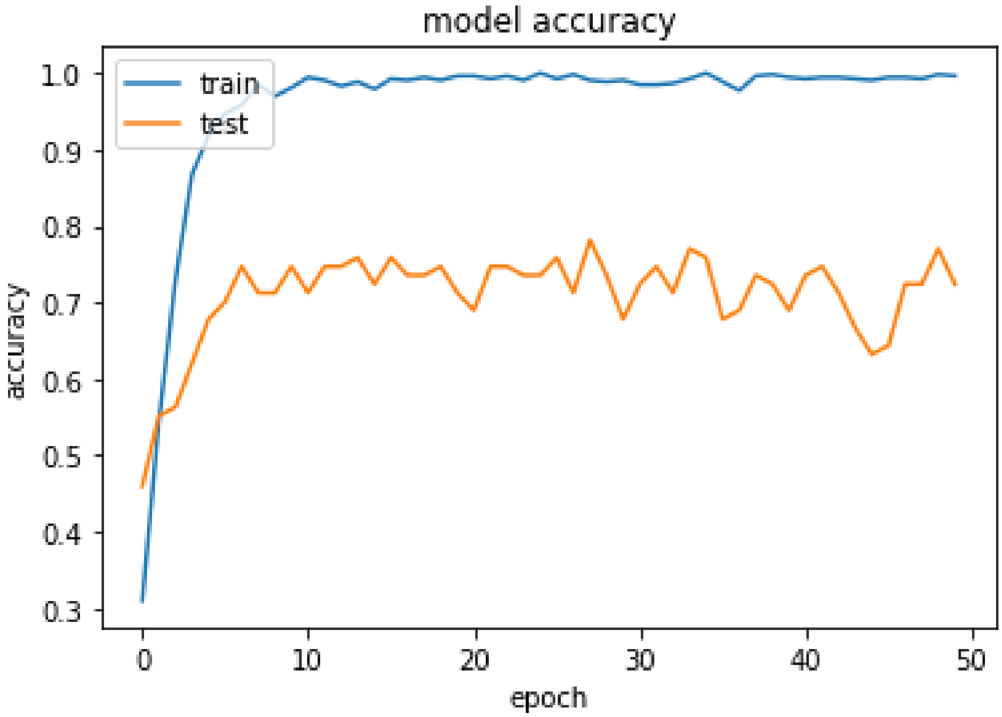
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 50
Epoch 1/50
53/53 [==============================] - 59s 1s/step - loss: 2.5266 - accuracy:
0.3100 - val_loss: 1.6954 - val_accuracy: 0.4598
Epoch 2/50
```

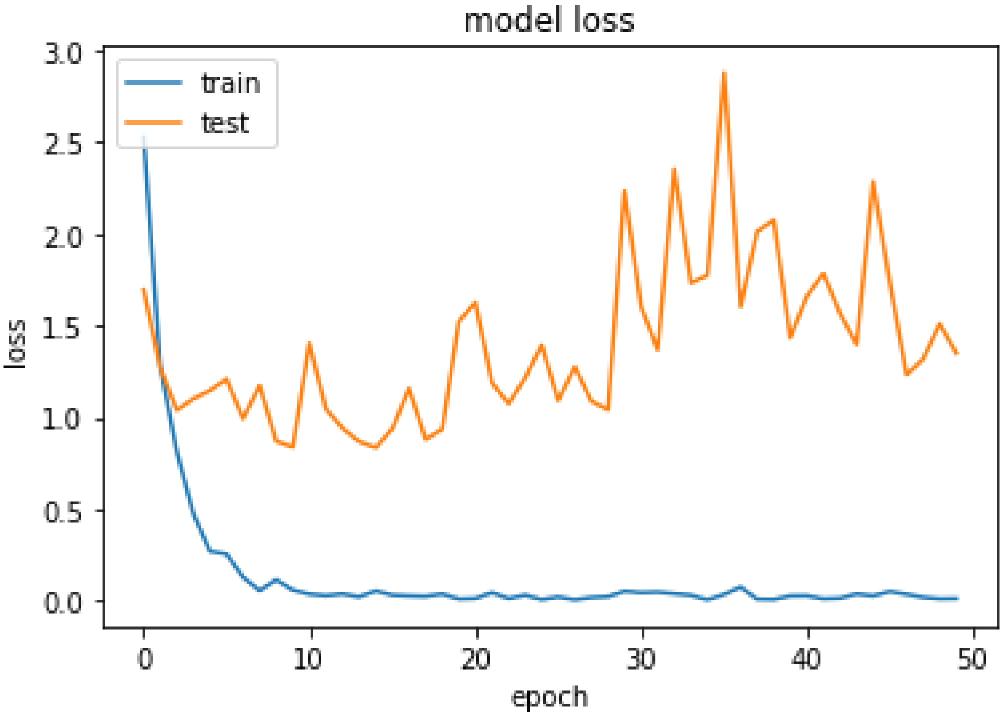
```
53/53 [==============================] - 55s 1s/step - loss: 1.2797 - accuracy:
0.5444 - val_loss: 1.2705 - val_accuracy: 0.5517
Epoch 3/50
53/53 [==============================] - 54s 1s/step - loss: 0.8139 - accuracy:
0.7297 - val_loss: 1.0391 - val_accuracy: 0.5632
Epoch 4/50
53/53 [==============================] - 53s 1s/step - loss: 0.4748 - accuracy:
0.8677 - val_loss: 1.1015 - val_accuracy: 0.6207
Epoch 5/50
53/53 [==============================] - 53s 1s/step - loss: 0.2702 - accuracy:
0.9187 - val_loss: 1.1465 - val_accuracy: 0.6782
Epoch 6/50
53/53 [==============================] - 53s 991ms/step - loss: 0.2555 -
accuracy: 0.9471 - val_loss: 1.2081 - val_accuracy: 0.7011
Epoch 7/50
53/53 [==============================] - 53s 995ms/step - loss: 0.1286 -
accuracy: 0.9584 - val_loss: 0.9935 - val_accuracy: 0.7471
Epoch 8/50
53/53 [==============================] - 53s 1s/step - loss: 0.0556 - accuracy:
0.9849 - val_loss: 1.1731 - val_accuracy: 0.7126
Epoch 9/50
53/53 [==============================] - 55s 1s/step - loss: 0.1146 - accuracy:
0.9698 - val_loss: 0.8700 - val_accuracy: 0.7126
Epoch 10/50
53/53 [==============================] - 59s 1s/step - loss: 0.0586 - accuracy:
0.9811 - val_loss: 0.8385 - val_accuracy: 0.7471
Epoch 11/50
53/53 [==============================] - 57s 1s/step - loss: 0.0366 - accuracy:
0.9943 - val_loss: 1.4020 - val_accuracy: 0.7126
Epoch 12/50
53/53 [==============================] - 57s 1s/step - loss: 0.0283 - accuracy:
0.9905 - val_loss: 1.0457 - val_accuracy: 0.7471
Epoch 13/50
53/53 [==============================] - 57s 1s/step - loss: 0.0376 - accuracy:
0.9830 - val_loss: 0.9414 - val_accuracy: 0.7471
Epoch 14/50
53/53 [==============================] - 58s 1s/step - loss: 0.0216 - accuracy:
0.9887 - val_loss: 0.8678 - val_accuracy: 0.7586
Epoch 15/50
53/53 [==============================] - 66s 1s/step - loss: 0.0538 - accuracy:
0.9792 - val_loss: 0.8355 - val_accuracy: 0.7241
Epoch 16/50
53/53 [==============================] - 67s 1s/step - loss: 0.0309 - accuracy:
0.9924 - val_loss: 0.9396 - val_accuracy: 0.7586
Epoch 17/50
53/53 [==============================] - 70s 1s/step - loss: 0.0269 - accuracy:
0.9905 - val_loss: 1.1571 - val_accuracy: 0.7356
Epoch 18/50
```

```
53/53 [==============================] - 82s 2s/step - loss: 0.0245 - accuracy:
0.9943 - val_loss: 0.8790 - val_accuracy: 0.7356
Epoch 19/50
53/53 [==============================] - 69s 1s/step - loss: 0.0372 - accuracy:
0.9905 - val_loss: 0.9362 - val_accuracy: 0.7471
Epoch 20/50
53/53 [==============================] - 68s 1s/step - loss: 0.0098 - accuracy:
0.9962 - val_loss: 1.5219 - val_accuracy: 0.7126
Epoch 21/50
53/53 [==============================] - 68s 1s/step - loss: 0.0128 - accuracy:
0.9962 - val_loss: 1.6257 - val_accuracy: 0.6897
Epoch 22/50
53/53 [==============================] - 73s 1s/step - loss: 0.0448 - accuracy:
0.9924 - val_loss: 1.1889 - val_accuracy: 0.7471
Epoch 23/50
53/53 [==============================] - 78s 1s/step - loss: 0.0127 - accuracy:
0.9962 - val_loss: 1.0741 - val_accuracy: 0.7471
Epoch 24/50
53/53 [==============================] - 79s 1s/step - loss: 0.0311 - accuracy:
0.9905 - val_loss: 1.2146 - val_accuracy: 0.7356
Epoch 25/50
53/53 [==============================] - 72s 1s/step - loss: 0.0066 - accuracy:
1.0000 - val_loss: 1.3926 - val_accuracy: 0.7356
Epoch 26/50
53/53 [==============================] - 62s 1s/step - loss: 0.0212 - accuracy:
0.9924 - val_loss: 1.0925 - val_accuracy: 0.7586
Epoch 27/50
53/53 [==============================] - 68s 1s/step - loss: 0.0056 - accuracy:
0.9981 - val_loss: 1.2747 - val_accuracy: 0.7126
Epoch 28/50
53/53 [==============================] - 74s 1s/step - loss: 0.0182 - accuracy:
0.9905 - val_loss: 1.0882 - val_accuracy: 0.7816
Epoch 29/50
53/53 [==============================] - 69s 1s/step - loss: 0.0229 - accuracy:
0.9887 - val_loss: 1.0415 - val_accuracy: 0.7356
Epoch 30/50
53/53 [==============================] - 67s 1s/step - loss: 0.0523 - accuracy:
0.9905 - val_loss: 2.2324 - val_accuracy: 0.6782
Epoch 31/50
53/53 [==============================] - 68s 1s/step - loss: 0.0448 - accuracy:
0.9849 - val_loss: 1.6018 - val_accuracy: 0.7241
Epoch 32/50
53/53 [==============================] - 63s 1s/step - loss: 0.0477 - accuracy:
0.9849 - val_loss: 1.3672 - val_accuracy: 0.7471
Epoch 33/50
53/53 [==============================] - 63s 1s/step - loss: 0.0391 - accuracy:
0.9868 - val_loss: 2.3536 - val_accuracy: 0.7126
Epoch 34/50
```

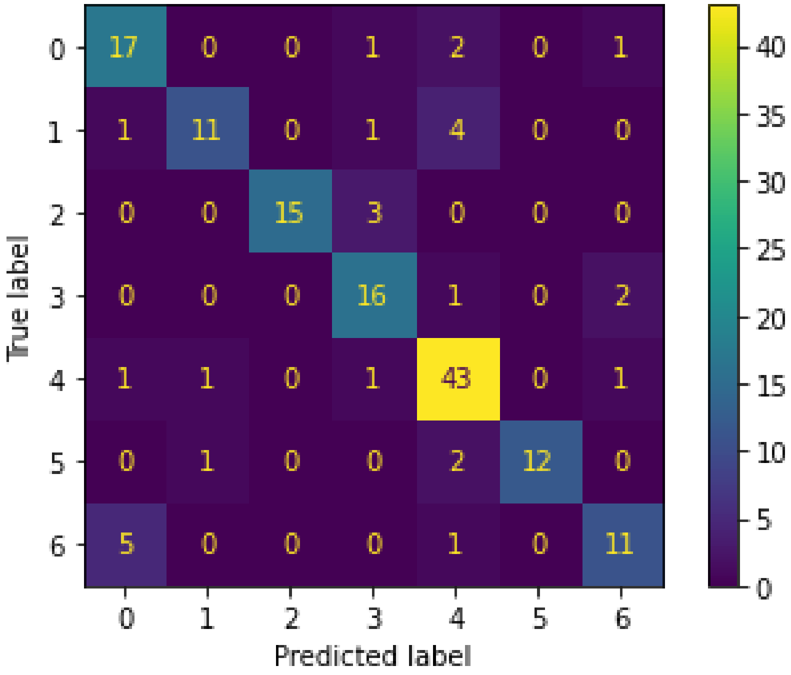
```
53/53 [==============================] - 62s 1s/step - loss: 0.0306 - accuracy:
0.9924 - val_loss: 1.7309 - val_accuracy: 0.7701
Epoch 35/50
53/53 [==============================] - 62s 1s/step - loss: 0.0057 - accuracy:
1.0000 - val_loss: 1.7737 - val_accuracy: 0.7586
Epoch 36/50
53/53 [==============================] - 63s 1s/step - loss: 0.0346 - accuracy:
0.9887 - val_loss: 2.8788 - val_accuracy: 0.6782
Epoch 37/50
53/53 [==============================] - 63s 1s/step - loss: 0.0750 - accuracy:
0.9773 - val_loss: 1.6011 - val_accuracy: 0.6897
Epoch 38/50
53/53 [==============================] - 63s 1s/step - loss: 0.0090 - accuracy:
0.9962 - val_loss: 2.0122 - val_accuracy: 0.7356
Epoch 39/50
53/53 [==============================] - 63s 1s/step - loss: 0.0074 - accuracy:
0.9981 - val_loss: 2.0745 - val_accuracy: 0.7241
Epoch 40/50
53/53 [==============================] - 63s 1s/step - loss: 0.0269 - accuracy:
0.9943 - val_loss: 1.4339 - val_accuracy: 0.6897
Epoch 41/50
53/53 [==============================] - 63s 1s/step - loss: 0.0275 - accuracy:
0.9924 - val_loss: 1.6600 - val_accuracy: 0.7356
Epoch 42/50
53/53 [==============================] - 63s 1s/step - loss: 0.0107 - accuracy:
0.9943 - val_loss: 1.7833 - val_accuracy: 0.7471
Epoch 43/50
53/53 [==============================] - 63s 1s/step - loss: 0.0142 - accuracy:
0.9943 - val_loss: 1.5656 - val_accuracy: 0.7126
Epoch 44/50
53/53 [==============================] - 63s 1s/step - loss: 0.0373 - accuracy:
0.9924 - val_loss: 1.3966 - val_accuracy: 0.6667
Epoch 45/50
53/53 [==============================] - 66s 1s/step - loss: 0.0271 - accuracy:
0.9905 - val_loss: 2.2837 - val_accuracy: 0.6322
Epoch 46/50
53/53 [==============================] - 63s 1s/step - loss: 0.0508 - accuracy:
0.9943 - val_loss: 1.7312 - val_accuracy: 0.6437
Epoch 47/50
53/53 [==============================] - 64s 1s/step - loss: 0.0357 - accuracy:
0.9943 - val_loss: 1.2324 - val_accuracy: 0.7241
Epoch 48/50
53/53 [==============================] - 64s 1s/step - loss: 0.0190 - accuracy:
0.9924 - val_loss: 1.3165 - val_accuracy: 0.7241
Epoch 49/50
53/53 [==============================] - 63s 1s/step - loss: 0.0107 - accuracy:
0.9981 - val_loss: 1.5085 - val_accuracy: 0.7701
Epoch 50/50
```

```
53/53 [==============================] - 64s 1s/step - loss: 0.0119 - accuracy:
0.9962 - val_loss: 1.3494 - val_accuracy: 0.7241
```





```
16/16 [==============================] - 5s 267ms/step
Test evaluation:
16/16 [==============================] - 5s 290ms/step - loss: 1.0314 -
accuracy: 0.8117
[1.0313525199890137, 0.8116883039474487]
% of correct brand in the first 3 positions:
150
0.974025974025974
% of brand predicted with percentage >= 0.25
0.11688311688311688
% of brand predicted with percentage >= 0.5
0.11688311688311688
% of brand predicted with percentage >= 0.75
0.11688311688311688
Matriz de confusión:
```



|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 17 | 0 | 0 | 1 | 2 | 0 | 1 |
| 1 | 1 | 11 | 0 | 1 | 4 | 0 | 0 |
| 2 | 0 | 0 | 15 | 3 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 16 | 1 | 0 | 2 |
| 4 | 1 | 1 | 0 | 1 | 43 | 0 | 1 |
| 5 | 0 | 1 | 0 | 0 | 2 | 12 | 0 |
| 6 | 5 | 0 | 0 | 0 | 1 | 0 | 11 |

```
[56]: model_test24=executeModel(True,  True, True, True, 50)
```

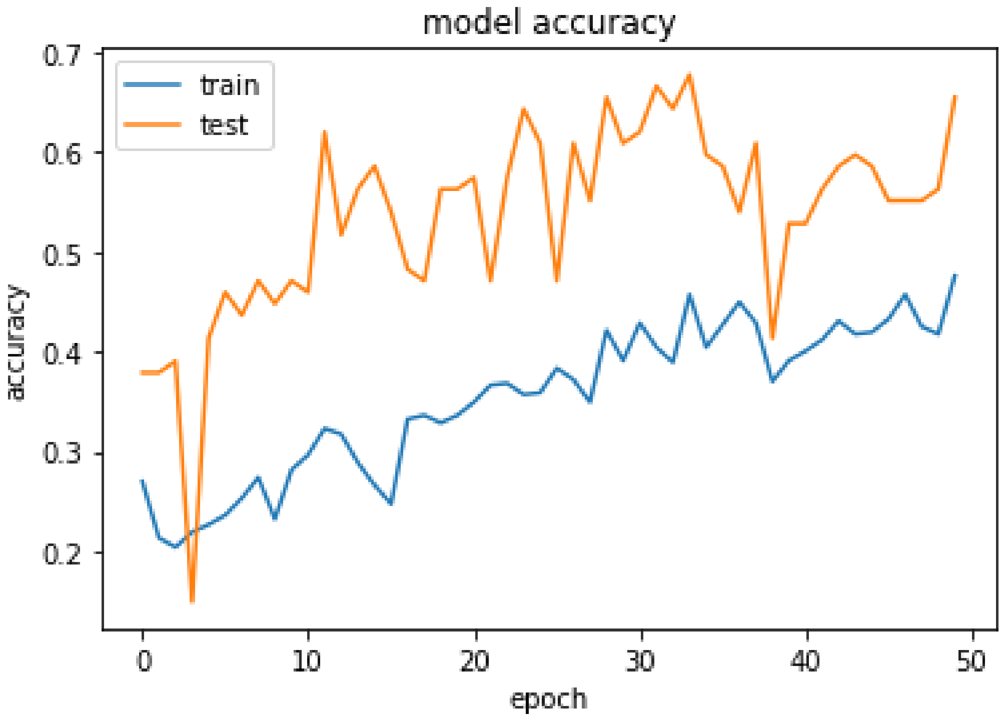
```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 50
Epoch 1/50
53/53 [==============================] - 69s 1s/step - loss: 7.3849 - accuracy:
```

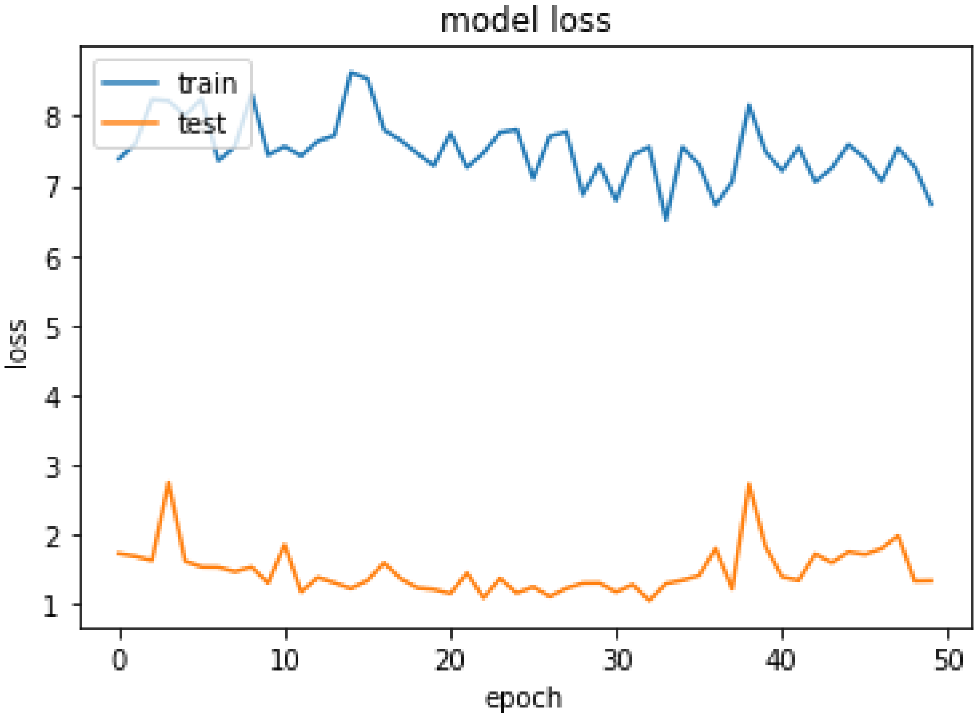
```
0.2703 - val_loss: 1.7350 - val_accuracy: 0.3793
Epoch 2/50
53/53 [==============================] - 70s 1s/step - loss: 7.5945 - accuracy:
0.2136 - val_loss: 1.6944 - val_accuracy: 0.3793
Epoch 3/50
53/53 [==============================] - 68s 1s/step - loss: 8.2336 - accuracy:
0.2042 - val_loss: 1.6338 - val_accuracy: 0.3908
Epoch 4/50
53/53 [==============================] - 72s 1s/step - loss: 8.2129 - accuracy:
0.2193 - val_loss: 2.7541 - val_accuracy: 0.1494
Epoch 5/50
53/53 [==============================] - 69s 1s/step - loss: 8.0030 - accuracy:
0.2268 - val_loss: 1.6242 - val_accuracy: 0.4138
Epoch 6/50
53/53 [==============================] - 69s 1s/step - loss: 8.2437 - accuracy:
0.2363 - val_loss: 1.5424 - val_accuracy: 0.4598
Epoch 7/50
53/53 [==============================] - 67s 1s/step - loss: 7.3553 - accuracy:
0.2533 - val_loss: 1.5389 - val_accuracy: 0.4368
Epoch 8/50
53/53 [==============================] - 67s 1s/step - loss: 7.5575 - accuracy:
0.2741 - val_loss: 1.4743 - val_accuracy: 0.4713
Epoch 9/50
53/53 [==============================] - 70s 1s/step - loss: 8.3134 - accuracy:
0.2325 - val_loss: 1.5413 - val_accuracy: 0.4483
Epoch 10/50
53/53 [==============================] - 63s 1s/step - loss: 7.4397 - accuracy:
0.2817 - val_loss: 1.3126 - val_accuracy: 0.4713
Epoch 11/50
53/53 [==============================] - 66s 1s/step - loss: 7.5582 - accuracy:
0.2968 - val_loss: 1.8611 - val_accuracy: 0.4598
Epoch 12/50
53/53 [==============================] - 66s 1s/step - loss: 7.4273 - accuracy:
0.3233 - val_loss: 1.1826 - val_accuracy: 0.6207
Epoch 13/50
53/53 [==============================] - 66s 1s/step - loss: 7.6353 - accuracy:
0.3176 - val_loss: 1.3928 - val_accuracy: 0.5172
Epoch 14/50
53/53 [==============================] - 60s 1s/step - loss: 7.7170 - accuracy:
0.2892 - val_loss: 1.3155 - val_accuracy: 0.5632
Epoch 15/50
53/53 [==============================] - 63s 1s/step - loss: 8.6159 - accuracy:
0.2665 - val_loss: 1.2336 - val_accuracy: 0.5862
Epoch 16/50
53/53 [==============================] - 61s 1s/step - loss: 8.5267 - accuracy:
0.2476 - val_loss: 1.3484 - val_accuracy: 0.5402
Epoch 17/50
53/53 [==============================] - 63s 1s/step - loss: 7.7969 - accuracy:
```

```
0.3327 - val_loss: 1.6010 - val_accuracy: 0.4828
Epoch 18/50
53/53 [==============================] - 64s 1s/step - loss: 7.6478 - accuracy:
0.3365 - val_loss: 1.3740 - val_accuracy: 0.4713
Epoch 19/50
53/53 [==============================] - 65s 1s/step - loss: 7.4623 - accuracy:
0.3289 - val_loss: 1.2434 - val_accuracy: 0.5632
Epoch 20/50
53/53 [==============================] - 62s 1s/step - loss: 7.2852 - accuracy:
0.3365 - val_loss: 1.2204 - val_accuracy: 0.5632
Epoch 21/50
53/53 [==============================] - 63s 1s/step - loss: 7.7498 - accuracy:
0.3497 - val_loss: 1.1602 - val_accuracy: 0.5747
Epoch 22/50
53/53 [==============================] - 64s 1s/step - loss: 7.2596 - accuracy:
0.3667 - val_loss: 1.4549 - val_accuracy: 0.4713
Epoch 23/50
53/53 [==============================] - 59s 1s/step - loss: 7.4677 - accuracy:
0.3686 - val_loss: 1.0996 - val_accuracy: 0.5747
Epoch 24/50
53/53 [==============================] - 59s 1s/step - loss: 7.7601 - accuracy:
0.3573 - val_loss: 1.3773 - val_accuracy: 0.6437
Epoch 25/50
53/53 [==============================] - 59s 1s/step - loss: 7.8011 - accuracy:
0.3592 - val_loss: 1.1678 - val_accuracy: 0.6092
Epoch 26/50
53/53 [==============================] - 60s 1s/step - loss: 7.1044 - accuracy:
0.3837 - val_loss: 1.2575 - val_accuracy: 0.4713
Epoch 27/50
53/53 [==============================] - 58s 1s/step - loss: 7.7071 - accuracy:
0.3724 - val_loss: 1.1180 - val_accuracy: 0.6092
Epoch 28/50
53/53 [==============================] - 59s 1s/step - loss: 7.7671 - accuracy:
0.3497 - val_loss: 1.2362 - val_accuracy: 0.5517
Epoch 29/50
53/53 [==============================] - 59s 1s/step - loss: 6.8703 - accuracy:
0.4216 - val_loss: 1.3097 - val_accuracy: 0.6552
Epoch 30/50
53/53 [==============================] - 59s 1s/step - loss: 7.3034 - accuracy:
0.3913 - val_loss: 1.3118 - val_accuracy: 0.6092
Epoch 31/50
53/53 [==============================] - 59s 1s/step - loss: 6.7815 - accuracy:
0.4291 - val_loss: 1.1816 - val_accuracy: 0.6207
Epoch 32/50
53/53 [==============================] - 59s 1s/step - loss: 7.4381 - accuracy:
0.4045 - val_loss: 1.2907 - val_accuracy: 0.6667
Epoch 33/50
53/53 [==============================] - 59s 1s/step - loss: 7.5538 - accuracy:
```

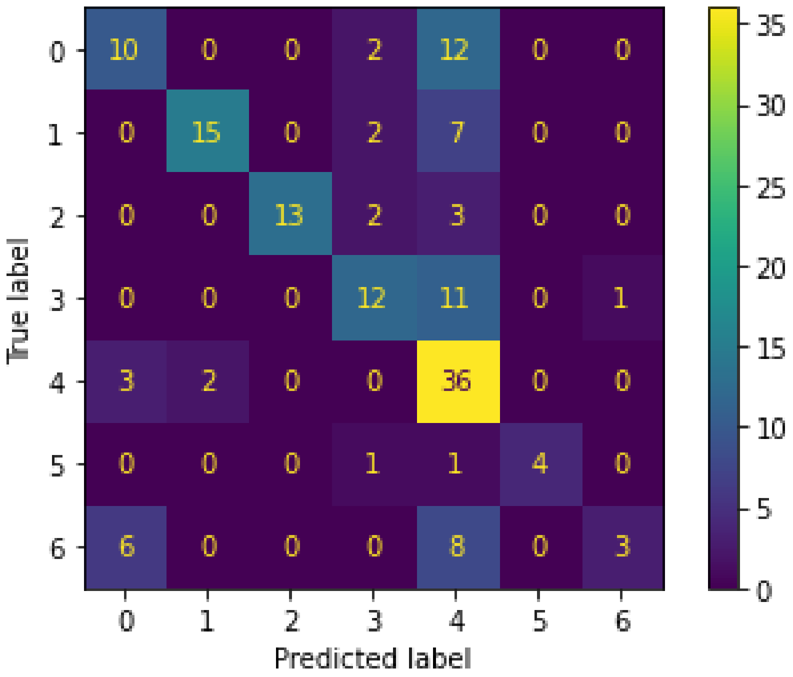
```
0.3894 - val_loss: 1.0600 - val_accuracy: 0.6437
Epoch 34/50
53/53 [==============================] - 61s 1s/step - loss: 6.5085 - accuracy:
0.4575 - val_loss: 1.3035 - val_accuracy: 0.6782
Epoch 35/50
53/53 [==============================] - 60s 1s/step - loss: 7.5521 - accuracy:
0.4045 - val_loss: 1.3514 - val_accuracy: 0.5977
Epoch 36/50
53/53 [==============================] - 59s 1s/step - loss: 7.3026 - accuracy:
0.4272 - val_loss: 1.4175 - val_accuracy: 0.5862
Epoch 37/50
53/53 [==============================] - 58s 1s/step - loss: 6.7204 - accuracy:
0.4499 - val_loss: 1.8053 - val_accuracy: 0.5402
Epoch 38/50
53/53 [==============================] - 58s 1s/step - loss: 7.0544 - accuracy:
0.4291 - val_loss: 1.2295 - val_accuracy: 0.6092
Epoch 39/50
53/53 [==============================] - 59s 1s/step - loss: 8.1553 - accuracy:
0.3705 - val_loss: 2.7324 - val_accuracy: 0.4138
Epoch 40/50
53/53 [==============================] - 58s 1s/step - loss: 7.4864 - accuracy:
0.3913 - val_loss: 1.8344 - val_accuracy: 0.5287
Epoch 41/50
53/53 [==============================] - 58s 1s/step - loss: 7.2113 - accuracy:
0.4008 - val_loss: 1.4004 - val_accuracy: 0.5287
Epoch 42/50
53/53 [==============================] - 58s 1s/step - loss: 7.5502 - accuracy:
0.4121 - val_loss: 1.3501 - val_accuracy: 0.5632
Epoch 43/50
53/53 [==============================] - 59s 1s/step - loss: 7.0536 - accuracy:
0.4310 - val_loss: 1.7284 - val_accuracy: 0.5862
Epoch 44/50
53/53 [==============================] - 58s 1s/step - loss: 7.2511 - accuracy:
0.4178 - val_loss: 1.6022 - val_accuracy: 0.5977
Epoch 45/50
53/53 [==============================] - 58s 1s/step - loss: 7.5862 - accuracy:
0.4197 - val_loss: 1.7571 - val_accuracy: 0.5862
Epoch 46/50
53/53 [==============================] - 59s 1s/step - loss: 7.3932 - accuracy:
0.4329 - val_loss: 1.7208 - val_accuracy: 0.5517
Epoch 47/50
53/53 [==============================] - 59s 1s/step - loss: 7.0649 - accuracy:
0.4575 - val_loss: 1.8047 - val_accuracy: 0.5517
Epoch 48/50
53/53 [==============================] - 58s 1s/step - loss: 7.5389 - accuracy:
0.4253 - val_loss: 1.9903 - val_accuracy: 0.5517
Epoch 49/50
53/53 [==============================] - 59s 1s/step - loss: 7.2685 - accuracy:
```

```
0.4178 - val_loss: 1.3410 - val_accuracy: 0.5632
Epoch 50/50
53/53 [==============================] - 58s 1s/step - loss: 6.7336 - accuracy:
0.4764 - val_loss: 1.3451 - val_accuracy: 0.6552
```





```
16/16 [==============================] - 4s 233ms/step
Test evaluation:
16/16 [==============================] - 4s 243ms/step - loss: 1.6034 -
accuracy: 0.6039
[1.6033967733383179, 0.6038960814476013]
% of correct brand in the first 3 positions:
144
0.935064935064935
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.2662337662337662
Matriz de confusión:
```



### 4.1.2 Experimentos con diferentes valores de muestras mínimas por marca

[57]:
```
def returnDataByMinSample ( minSample, deleteNone=True):

    dfbrandMin, dfbrandoneMin = filterMinSamples(dfbrandall, minSample,␣
 ↪deleteNone)
    num_classesMin=len(dfbrandMin)
    df_shoe_brandMin = filterBrands(df_shoe_brand_all,dfbrandoneMin, deleteNone)
    print(df_shoe_brandMin.shape)
    shoes_trainMin, shoes_testMin, shoes_valMin =␣
 ↪split_datafiles(df_shoe_brandMin)

    while checkBalancedSample(shoes_trainMin, shoes_testMin, shoes_valMin) ==␣
 ↪False:
        shoes_trainMin, shoes_testMin, shoes_valMin =␣
 ↪split_datafiles(df_shoe_brandMin)

    return num_classesMin, df_shoe_brandMin, shoes_trainMin, shoes_testMin,␣
 ↪shoes_valMin
```

[58]:
```
num_classes3, df_shoe_brand3,shoes_train3, shoes_test3, shoes_val3 =␣
 ↪returnDataByMinSample(3)
```

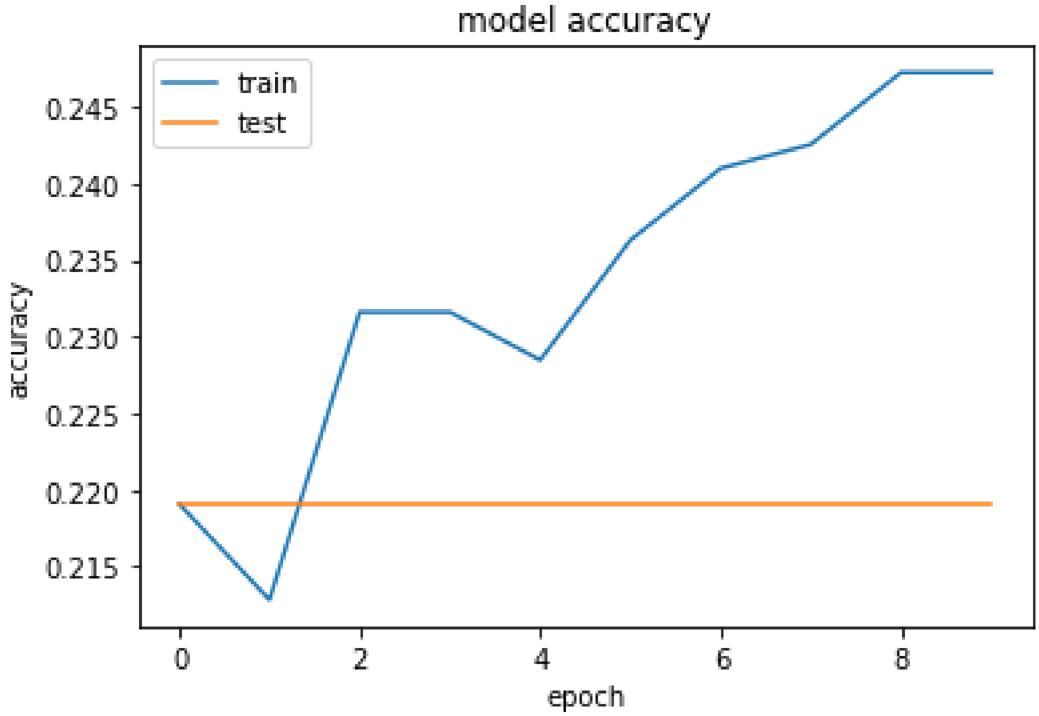
```
             x   y
0       Adidas  12
```

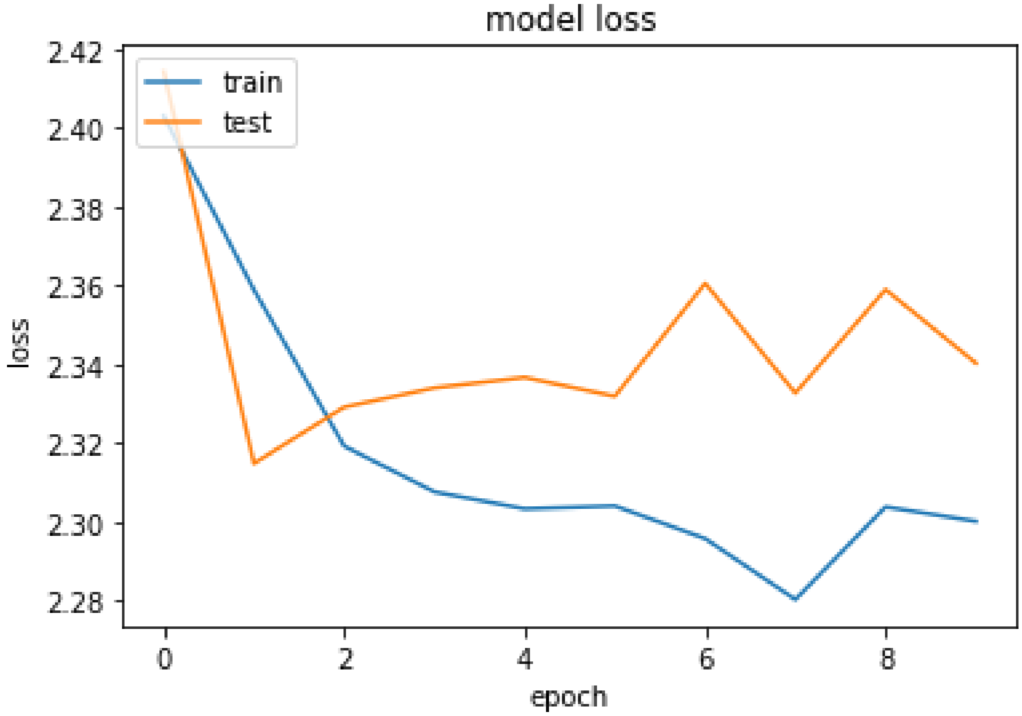
```
6        Asics  13
12    Champion   3
15    Converse   7
30        Keen   3
33  Newbalance   4
34        Nike  24
42     Saucony   6
44     Shoopen   3
46    Skechers   8
50      Sperry   7
54        Teva   3
Brands with at least 3 samples: 12
Brands with only 1 register: 47
(930, 3)
```

[225]:
```
model_test25=executeModelData(False, False, False, False, 10, shoes_train3,␣
 ↪shoes_test3, shoes_val3, df_shoe_brand3,num_classes3)
```

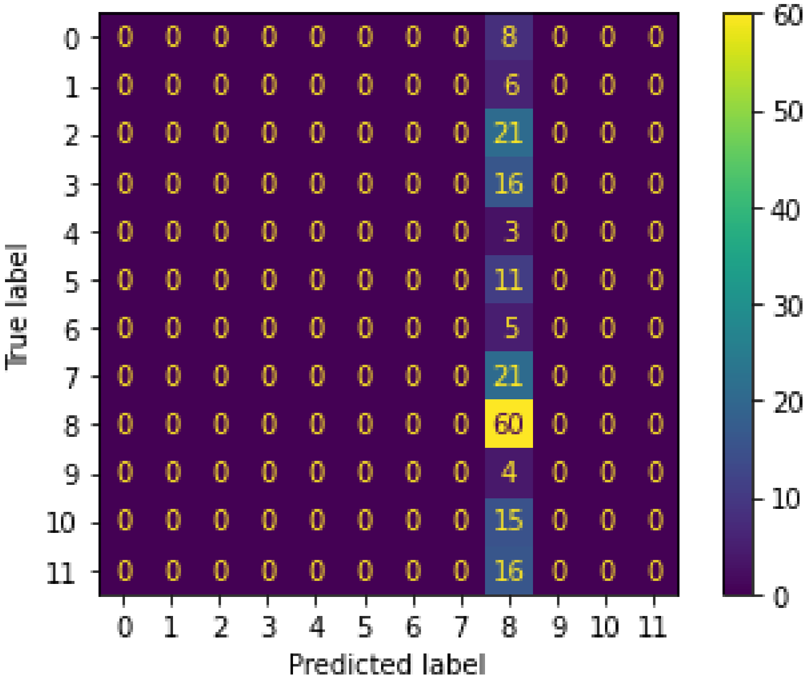
```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
64/64 [==============================] - 75s 1s/step - loss: 2.4030 - accuracy:
0.2191 - val_loss: 2.4143 - val_accuracy: 0.2190
Epoch 2/10
64/64 [==============================] - 108s 2s/step - loss: 2.3589 - accuracy:
0.2128 - val_loss: 2.3148 - val_accuracy: 0.2190
Epoch 3/10
64/64 [==============================] - 103s 2s/step - loss: 2.3192 - accuracy:
0.2316 - val_loss: 2.3290 - val_accuracy: 0.2190
Epoch 4/10
64/64 [==============================] - 106s 2s/step - loss: 2.3075 - accuracy:
0.2316 - val_loss: 2.3340 - val_accuracy: 0.2190
Epoch 5/10
64/64 [==============================] - 102s 2s/step - loss: 2.3032 - accuracy:
0.2285 - val_loss: 2.3366 - val_accuracy: 0.2190
Epoch 6/10
64/64 [==============================] - 98s 2s/step - loss: 2.3040 - accuracy:
0.2363 - val_loss: 2.3318 - val_accuracy: 0.2190
Epoch 7/10
64/64 [==============================] - 111s 2s/step - loss: 2.2957 - accuracy:
0.2410 - val_loss: 2.3605 - val_accuracy: 0.2190
Epoch 8/10
64/64 [==============================] - 106s 2s/step - loss: 2.2802 - accuracy:
0.2426 - val_loss: 2.3326 - val_accuracy: 0.2190
Epoch 9/10
64/64 [==============================] - 105s 2s/step - loss: 2.3037 - accuracy:
0.2473 - val_loss: 2.3590 - val_accuracy: 0.2190
```

```
Epoch 10/10
64/64 [==============================] - 106s 2s/step - loss: 2.3001 - accuracy:
0.2473 - val_loss: 2.3402 - val_accuracy: 0.2190
```





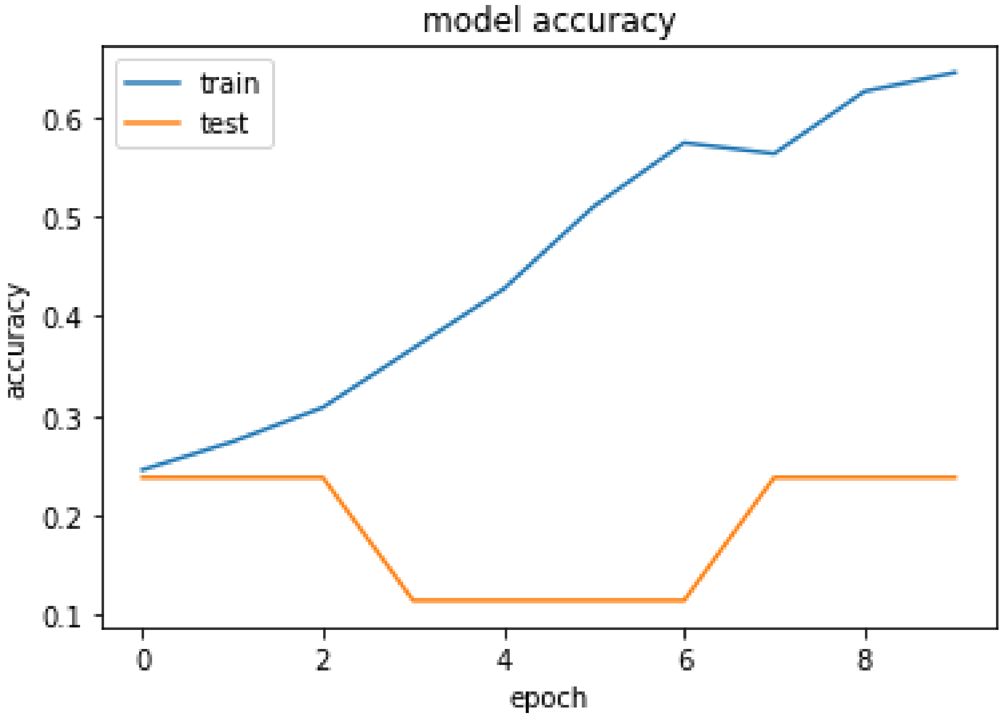
```
19/19 [==============================] - 7s 346ms/step
Test evaluation:
19/19 [==============================] - 7s 358ms/step - loss: 2.2619 -
accuracy: 0.3226
[2.261904716491699, 0.32258063554763794]
% of correct brand in the first 3 positions:
102
0.5483870967741935
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

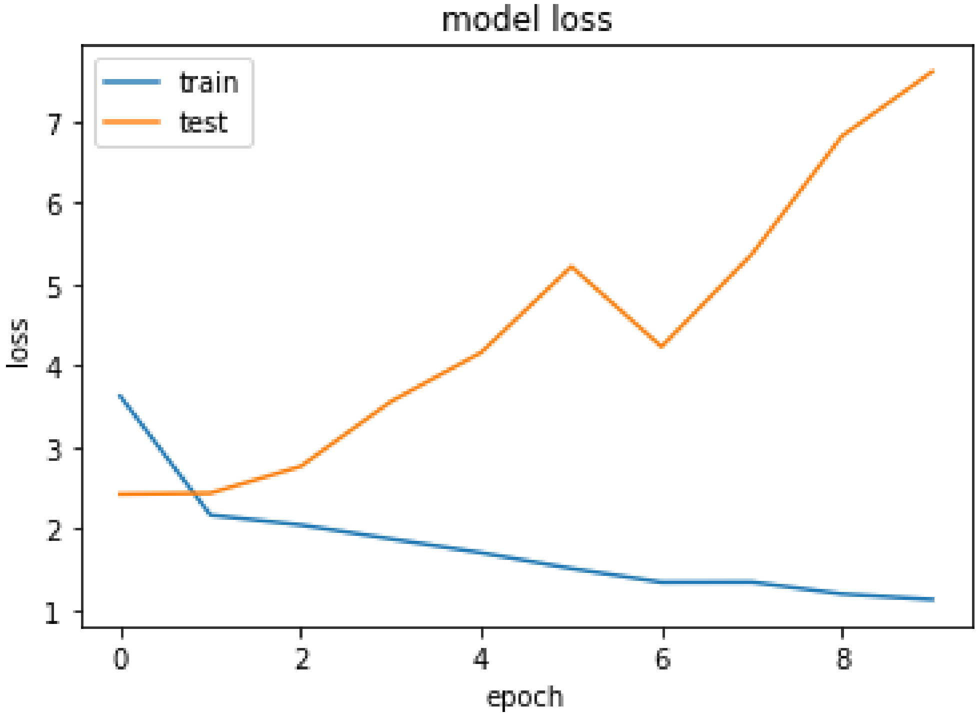


[59]:
```
model_test26=executeModelData(True, False, False, False, 10, shoes_train3,␣
 ↪shoes_test3, shoes_val3, df_shoe_brand3,num_classes3)
```

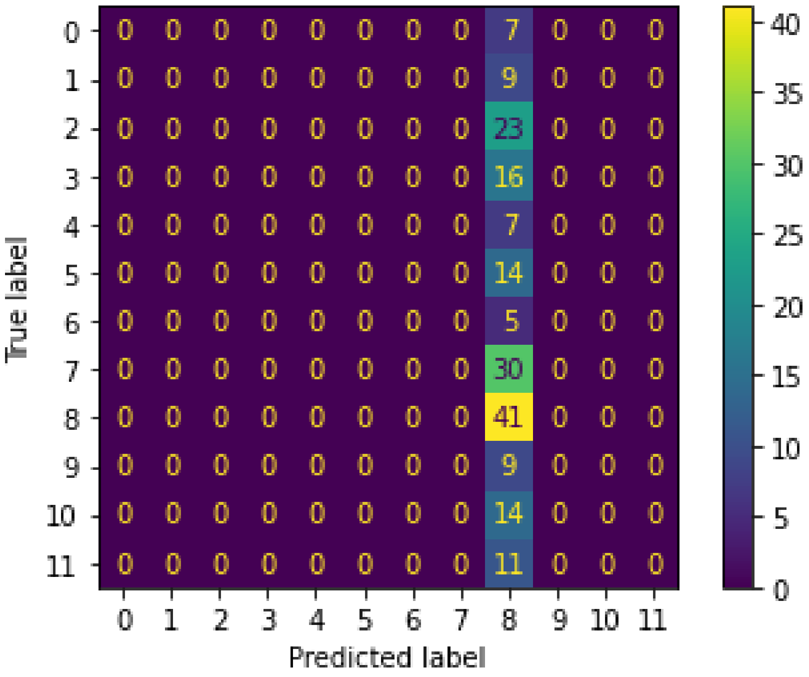
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
```

```
64/64 [==============================] - 78s 1s/step - loss: 3.6267 - accuracy:
0.2457 - val_loss: 2.4276 - val_accuracy: 0.2381
Epoch 2/10
64/64 [==============================] - 77s 1s/step - loss: 2.1708 - accuracy:
0.2739 - val_loss: 2.4399 - val_accuracy: 0.2381
Epoch 3/10
64/64 [==============================] - 77s 1s/step - loss: 2.0494 - accuracy:
0.3083 - val_loss: 2.7687 - val_accuracy: 0.2381
Epoch 4/10
64/64 [==============================] - 78s 1s/step - loss: 1.8782 - accuracy:
0.3678 - val_loss: 3.5619 - val_accuracy: 0.1143
Epoch 5/10
64/64 [==============================] - 78s 1s/step - loss: 1.7087 - accuracy:
0.4272 - val_loss: 4.1632 - val_accuracy: 0.1143
Epoch 6/10
64/64 [==============================] - 77s 1s/step - loss: 1.5154 - accuracy:
0.5102 - val_loss: 5.2166 - val_accuracy: 0.1143
Epoch 7/10
64/64 [==============================] - 77s 1s/step - loss: 1.3470 - accuracy:
0.5743 - val_loss: 4.2342 - val_accuracy: 0.1143
Epoch 8/10
64/64 [==============================] - 77s 1s/step - loss: 1.3486 - accuracy:
0.5634 - val_loss: 5.3661 - val_accuracy: 0.2381
Epoch 9/10
64/64 [==============================] - 77s 1s/step - loss: 1.2037 - accuracy:
0.6260 - val_loss: 6.8163 - val_accuracy: 0.2381
Epoch 10/10
64/64 [==============================] - 79s 1s/step - loss: 1.1348 - accuracy:
0.6448 - val_loss: 7.6047 - val_accuracy: 0.2381
```


model accuracy
train
test
accuracy
0.1
0.2
0.3
0.4
0.5
0.6
0
2
4
6
8
epoch


model loss
train
test
loss
1
2
3
4
5
6
7
0
2
4
6
8
epoch

```
19/19 [==============================] - 5s 264ms/step
Test evaluation:
19/19 [==============================] - 5s 270ms/step - loss: 7.1554 -
accuracy: 0.2204
[7.155381202697754, 0.22043010592460632]
% of correct brand in the first 3 positions:
94
0.5053763440860215
% of brand predicted with percentage >= 0.25
0.34408602150537637
% of brand predicted with percentage >= 0.5
0.22043010752688172
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

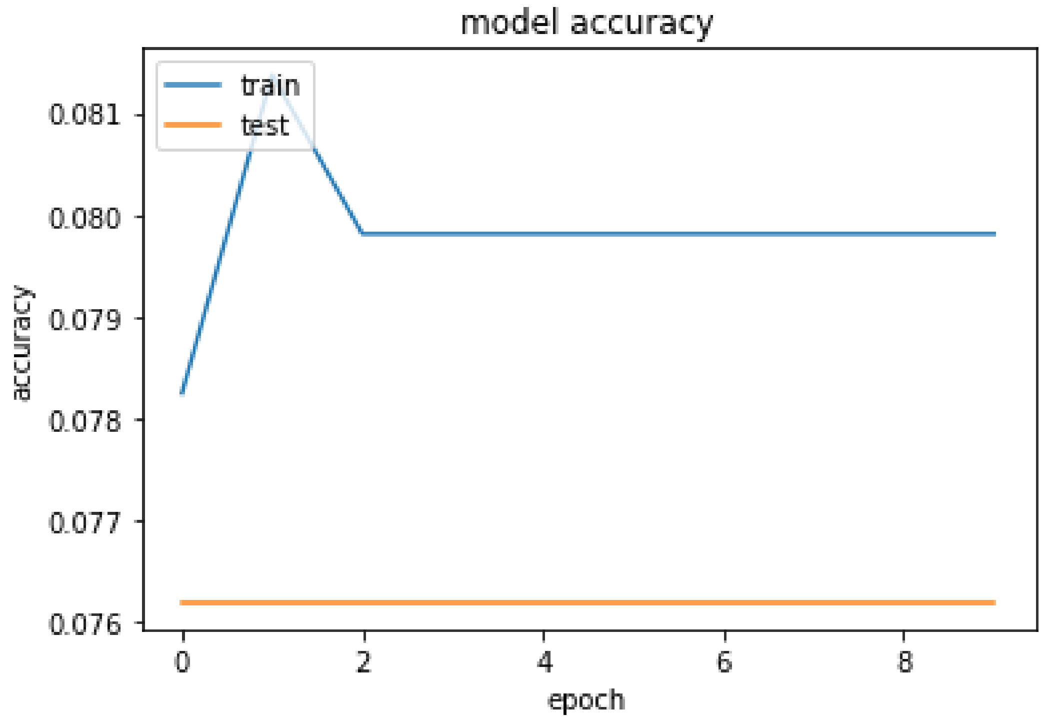


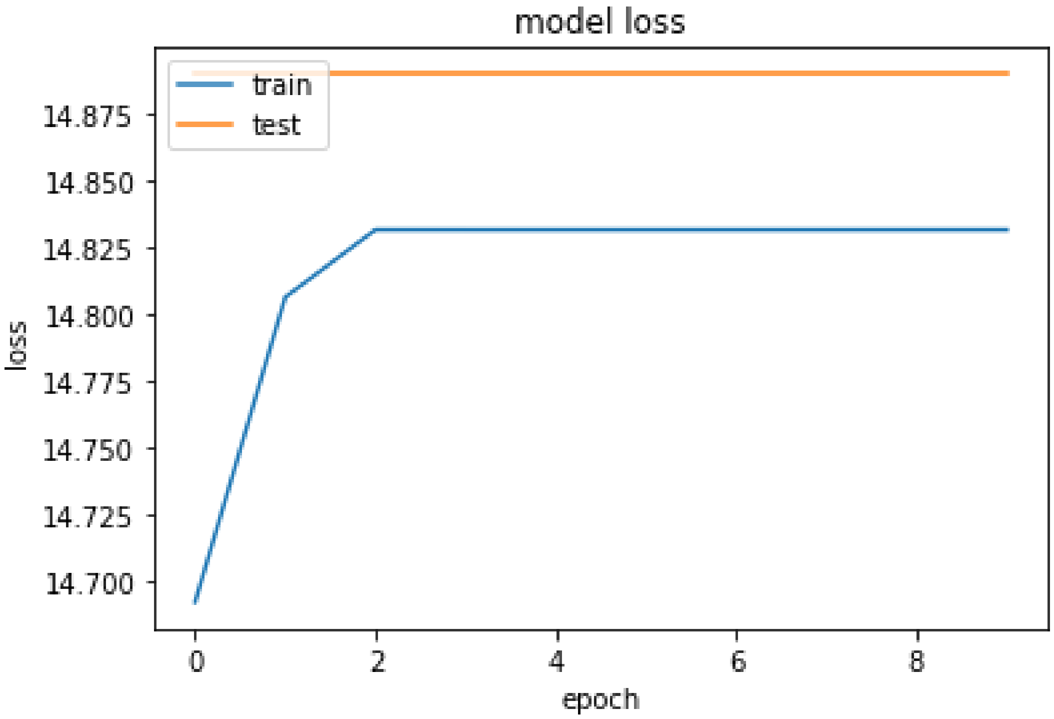
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |

```
[227]: model_test27=executeModelData(False, True, True, True, 10, shoes_train3,␣
        ↪shoes_test3, shoes_val3, df_shoe_brand3,num_classes3)
```

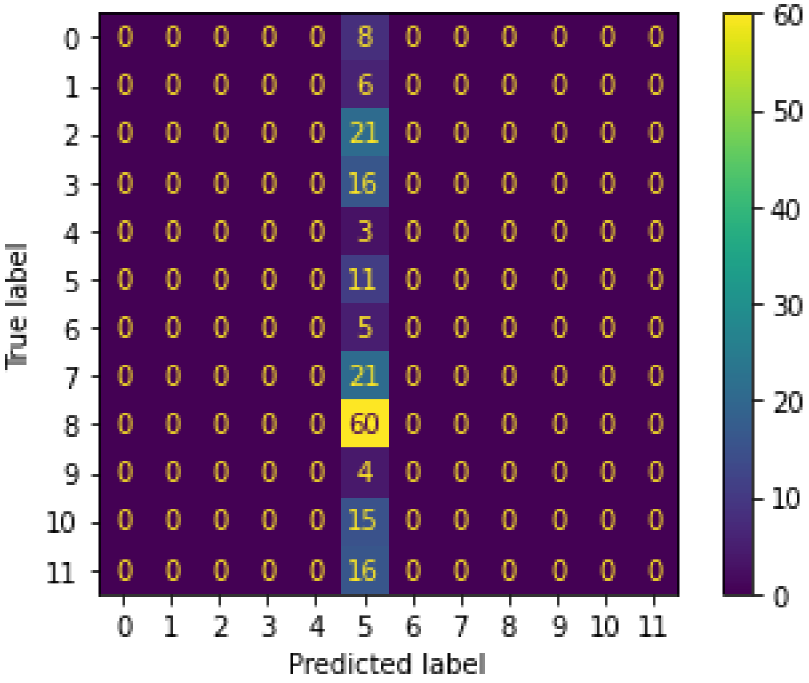
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
64/64 [==============================] - 149s 2s/step - loss: 14.6921 -
accuracy: 0.0782 - val_loss: 14.8901 - val_accuracy: 0.0762
```

```
Epoch 2/10
64/64 [==============================] - 139s 2s/step - loss: 14.8065 -
accuracy: 0.0814 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 3/10
64/64 [==============================] - 135s 2s/step - loss: 14.8317 -
accuracy: 0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 4/10
64/64 [==============================] - 132s 2s/step - loss: 14.8317 -
accuracy: 0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 5/10
64/64 [==============================] - 70s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 6/10
64/64 [==============================] - 75s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 7/10
64/64 [==============================] - 72s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 8/10
64/64 [==============================] - 70s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 9/10
64/64 [==============================] - 72s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
Epoch 10/10
64/64 [==============================] - 77s 1s/step - loss: 14.8317 - accuracy:
0.0798 - val_loss: 14.8901 - val_accuracy: 0.0762
```


model accuracy
train
test
0.081
0.080
0.079
0.078
0.077
0.076
accuracy
0
2
4
6
8
epoch


model loss
train
test
14.875
14.850
14.825
14.800
14.775
14.750
14.725
14.700
loss
0
2
4
6
8
epoch

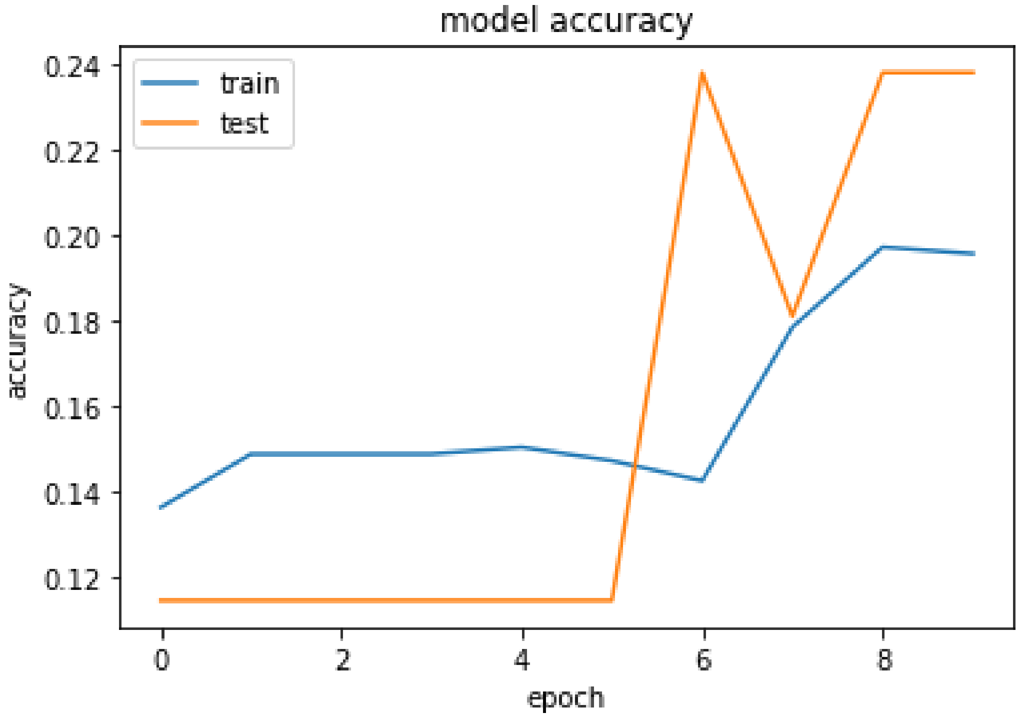
```
19/19 [==============================] - 4s 218ms/step
Test evaluation:
19/19 [==============================] - 5s 234ms/step - loss: 15.1649 -
accuracy: 0.0591
[15.164875984191895, 0.059139784425497055]
% of correct brand in the first 3 positions:
25
0.13440860215053763
% of brand predicted with percentage >= 0.25
0.05913978494623656
% of brand predicted with percentage >= 0.5
0.05913978494623656
% of brand predicted with percentage >= 0.75
0.05913978494623656
Matriz de confusión:
```

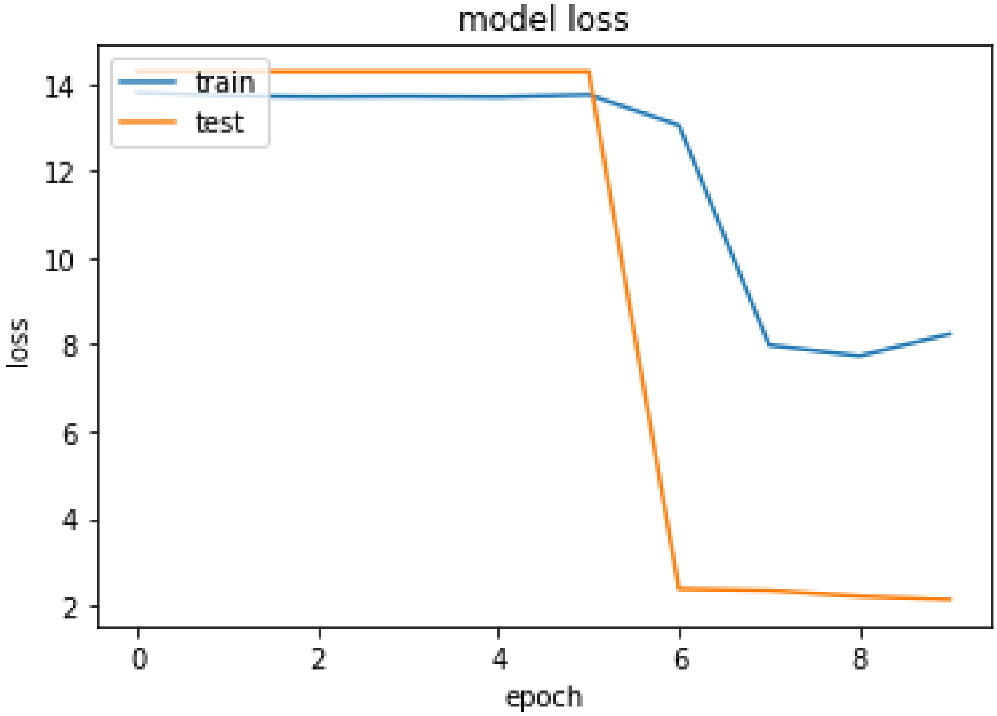


```
[60]: model_test28=executeModelData(True, True, True, True, 10, shoes_train3, shoes_test3, shoes_val3, df_shoe_brand3,num_classes3)
```

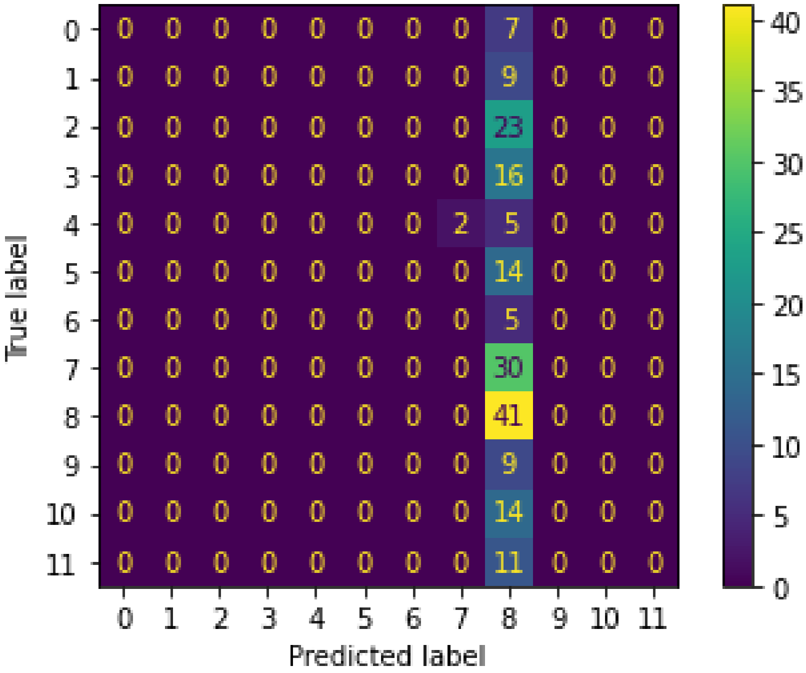
```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
64/64 [==============================] - 74s 1s/step - loss: 13.7955 - accuracy:
0.1362 - val_loss: 14.2760 - val_accuracy: 0.1143
```

```
Epoch 2/10
64/64 [==============================] - 70s 1s/step - loss: 13.7218 - accuracy:
0.1487 - val_loss: 14.2760 - val_accuracy: 0.1143
Epoch 3/10
64/64 [==============================] - 70s 1s/step - loss: 13.7011 - accuracy:
0.1487 - val_loss: 14.2760 - val_accuracy: 0.1143
Epoch 4/10
64/64 [==============================] - 70s 1s/step - loss: 13.7128 - accuracy:
0.1487 - val_loss: 14.2760 - val_accuracy: 0.1143
Epoch 5/10
64/64 [==============================] - 70s 1s/step - loss: 13.6966 - accuracy:
0.1502 - val_loss: 14.2760 - val_accuracy: 0.1143
Epoch 6/10
64/64 [==============================] - 70s 1s/step - loss: 13.7470 - accuracy:
0.1471 - val_loss: 14.2760 - val_accuracy: 0.1143
Epoch 7/10
64/64 [==============================] - 70s 1s/step - loss: 13.0454 - accuracy:
0.1424 - val_loss: 2.3781 - val_accuracy: 0.2381
Epoch 8/10
64/64 [==============================] - 70s 1s/step - loss: 7.9836 - accuracy:
0.1784 - val_loss: 2.3399 - val_accuracy: 0.1810
Epoch 9/10
64/64 [==============================] - 70s 1s/step - loss: 7.7338 - accuracy:
0.1972 - val_loss: 2.2106 - val_accuracy: 0.2381
Epoch 10/10
64/64 [==============================] - 70s 1s/step - loss: 8.2435 - accuracy:
0.1956 - val_loss: 2.1331 - val_accuracy: 0.2381
```


model accuracy
train
test
accuracy
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0
2
4
6
8
epoch


model loss
train
test
loss
14
12
10
8
6
4
2
0
2
4
6
8
epoch

```
19/19 [==============================] - 5s 247ms/step
Test evaluation:
19/19 [==============================] - 5s 248ms/step - loss: 2.1736 -
accuracy: 0.2204
[2.173585891723633, 0.22043010592460632]
% of correct brand in the first 3 positions:
108
0.5806451612903226
% of brand predicted with percentage >= 0.25
0.22043010752688172
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |

```
[61]: num_classes2, df_shoe_brand2,shoes_train2, shoes_test2, shoes_val2 =␣
       ↪returnDataByMinSample(2)
```

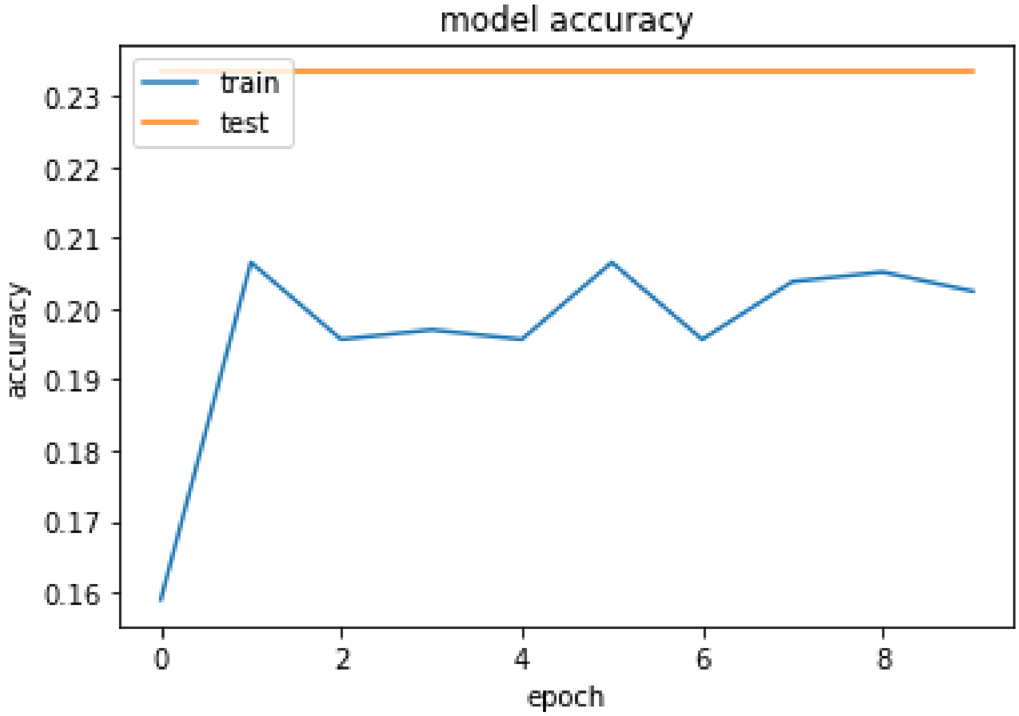
```
              x   y
0        Adidas  12
6         Asics  13
10       Brooks   2
12     Champion   3
15     Converse   7
```

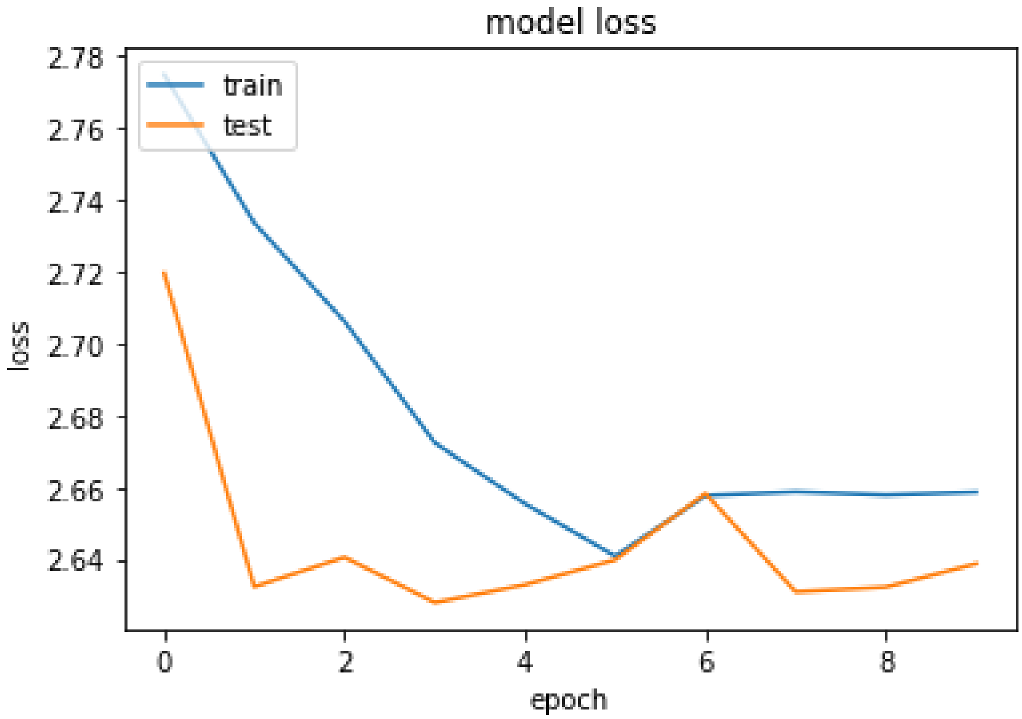
```
21        Ecco   2
30        Keen   3
32    Namuhana   2
33  Newbalance   4
34        Nike  24
39    Prospecs   2
42     Saucony   6
44     Shoopen   3
46    Skechers   8
49       Sorel   2
50      Sperry   7
53         T2R   2
54        Teva   3
57        Vans   2
Brands with at least 2 samples: 19
Brands with only 1 register: 40
(1070, 3)
```

[230]:
```
model_test29=executeModelData(False, False, False, False, 10, shoes_train2,␣
 ↪shoes_test2, shoes_val2, df_shoe_brand2,num_classes2)
```

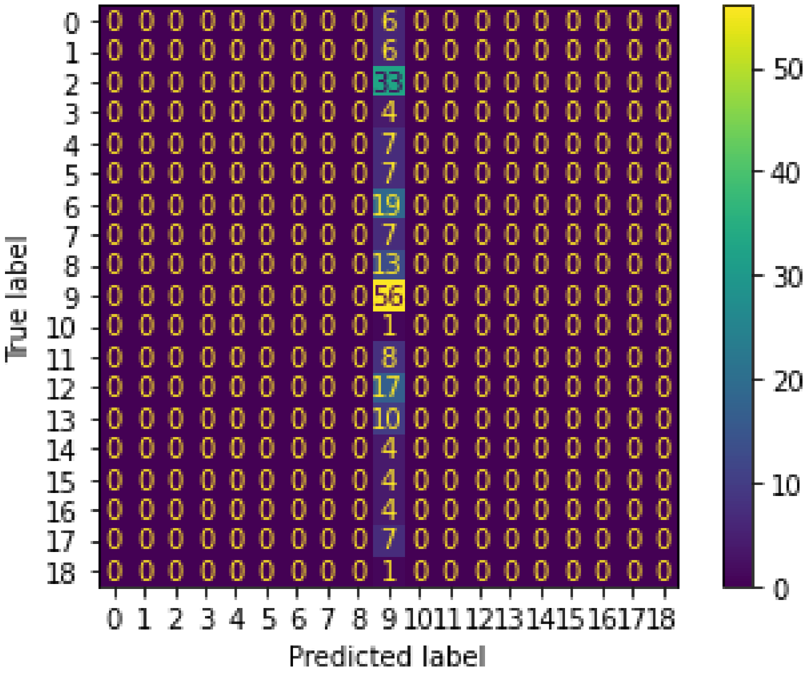
```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
74/74 [==============================] - 86s 1s/step - loss: 2.7749 - accuracy:
0.1590 - val_loss: 2.7197 - val_accuracy: 0.2333
Epoch 2/10
74/74 [==============================] - 85s 1s/step - loss: 2.7336 - accuracy:
0.2065 - val_loss: 2.6323 - val_accuracy: 0.2333
Epoch 3/10
74/74 [==============================] - 86s 1s/step - loss: 2.7062 - accuracy:
0.1957 - val_loss: 2.6405 - val_accuracy: 0.2333
Epoch 4/10
74/74 [==============================] - 96s 1s/step - loss: 2.6724 - accuracy:
0.1970 - val_loss: 2.6279 - val_accuracy: 0.2333
Epoch 5/10
74/74 [==============================] - 91s 1s/step - loss: 2.6554 - accuracy:
0.1957 - val_loss: 2.6329 - val_accuracy: 0.2333
Epoch 6/10
74/74 [==============================] - 88s 1s/step - loss: 2.6408 - accuracy:
0.2065 - val_loss: 2.6398 - val_accuracy: 0.2333
Epoch 7/10
74/74 [==============================] - 89s 1s/step - loss: 2.6577 - accuracy:
0.1957 - val_loss: 2.6583 - val_accuracy: 0.2333
Epoch 8/10
74/74 [==============================] - 84s 1s/step - loss: 2.6588 - accuracy:
0.2038 - val_loss: 2.6309 - val_accuracy: 0.2333
```

```
Epoch 9/10
74/74 [==============================] - 89s 1s/step - loss: 2.6579 - accuracy:
0.2052 - val_loss: 2.6322 - val_accuracy: 0.2333
Epoch 10/10
74/74 [==============================] - 85s 1s/step - loss: 2.6587 - accuracy:
0.2024 - val_loss: 2.6387 - val_accuracy: 0.2333
```





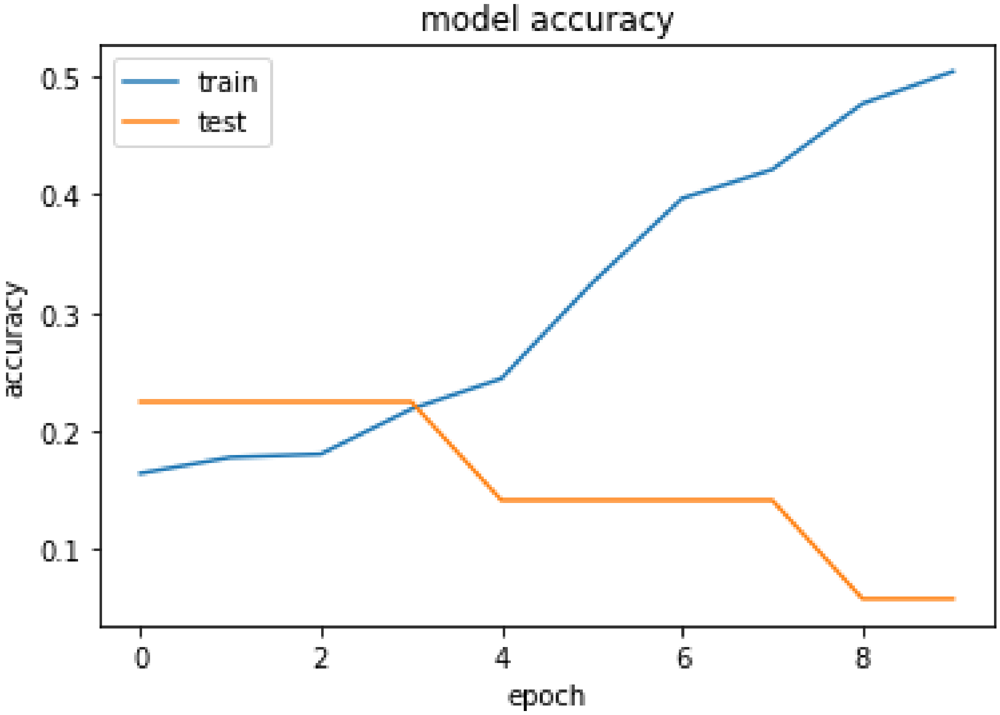
```
22/22 [==============================] - 6s 251ms/step
Test evaluation:
22/22 [==============================] - 7s 299ms/step - loss: 2.5919 -
accuracy: 0.2617
[2.59185528755188, 0.2616822421550751]
% of correct brand in the first 3 positions:
102
0.4766355140186916
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

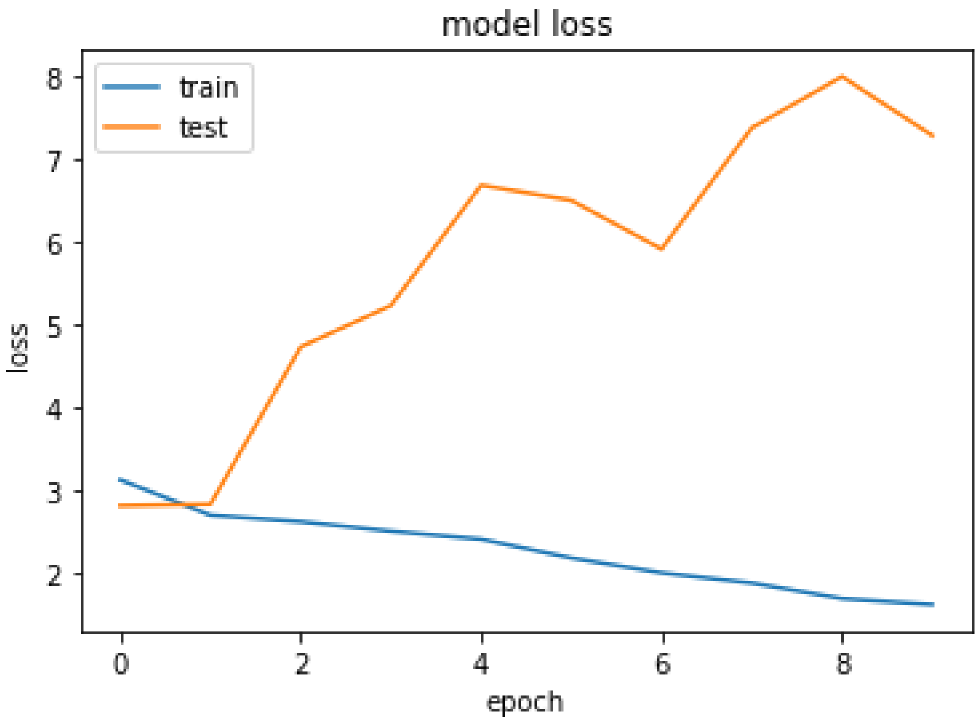


[62]:
```
model_test30=executeModelData(True, False, False, False, 10, shoes_train2,␣
 ↪shoes_test2, shoes_val2, df_shoe_brand2,num_classes2)
```

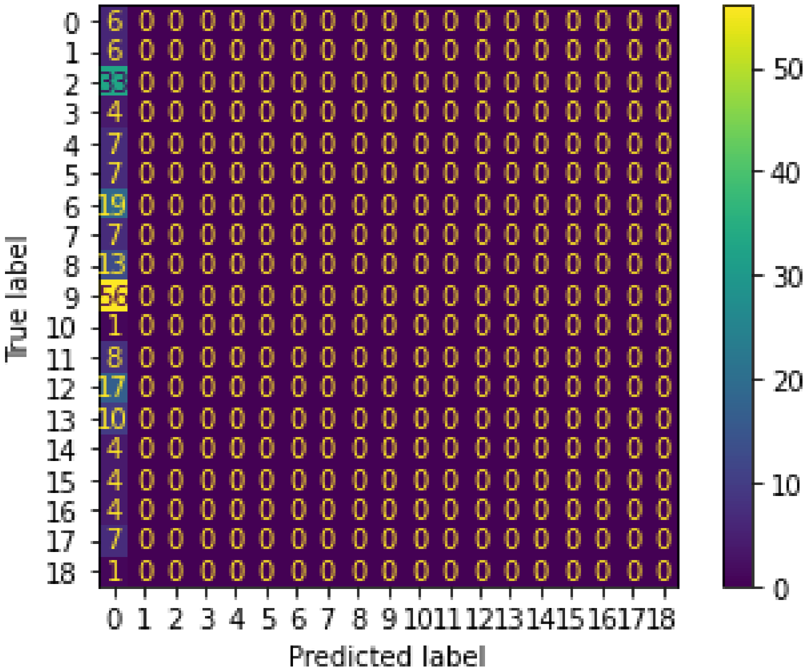
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
74/74 [==============================] - 91s 1s/step - loss: 3.1273 - accuracy:
0.1644 - val_loss: 2.8141 - val_accuracy: 0.2250
Epoch 2/10
74/74 [==============================] - 88s 1s/step - loss: 2.6989 - accuracy:
0.1780 - val_loss: 2.8321 - val_accuracy: 0.2250
Epoch 3/10
74/74 [==============================] - 88s 1s/step - loss: 2.6204 - accuracy:
0.1807 - val_loss: 4.7316 - val_accuracy: 0.2250
Epoch 4/10
74/74 [==============================] - 89s 1s/step - loss: 2.5055 - accuracy:
0.2188 - val_loss: 5.2323 - val_accuracy: 0.2250
Epoch 5/10
74/74 [==============================] - 88s 1s/step - loss: 2.4087 - accuracy:
0.2446 - val_loss: 6.6873 - val_accuracy: 0.1417
Epoch 6/10
74/74 [==============================] - 88s 1s/step - loss: 2.1812 - accuracy:
0.3247 - val_loss: 6.5034 - val_accuracy: 0.1417
Epoch 7/10
```

```
74/74 [==============================] - 89s 1s/step - loss: 2.0013 - accuracy:
0.3967 - val_loss: 5.9147 - val_accuracy: 0.1417
Epoch 8/10
74/74 [==============================] - 89s 1s/step - loss: 1.8786 - accuracy:
0.4212 - val_loss: 7.3811 - val_accuracy: 0.1417
Epoch 9/10
74/74 [==============================] - 89s 1s/step - loss: 1.6903 - accuracy:
0.4769 - val_loss: 7.9985 - val_accuracy: 0.0583
Epoch 10/10
74/74 [==============================] - 88s 1s/step - loss: 1.6178 - accuracy:
0.5041 - val_loss: 7.2885 - val_accuracy: 0.0583
```





```
22/22 [==============================] - 6s 266ms/step
Test evaluation:
22/22 [==============================] - 6s 267ms/step - loss: 8.3252 -
accuracy: 0.0280
[8.325196266174316, 0.028037382289767265]
% of correct brand in the first 3 positions:
69
0.32242990654205606
% of brand predicted with percentage >= 0.25
0.32242990654205606
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



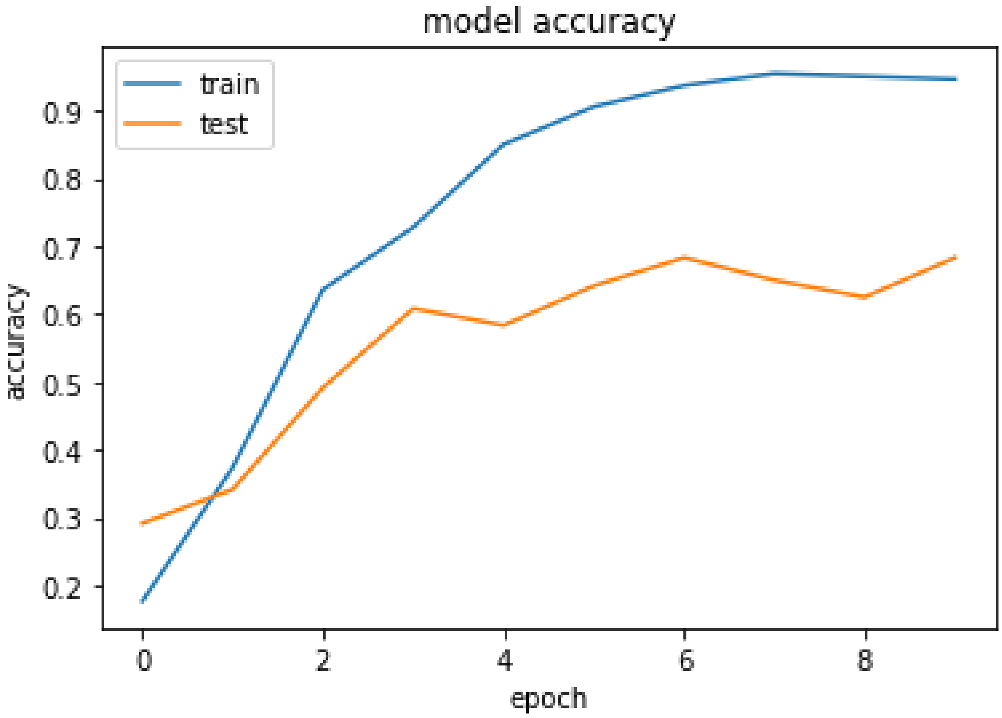
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

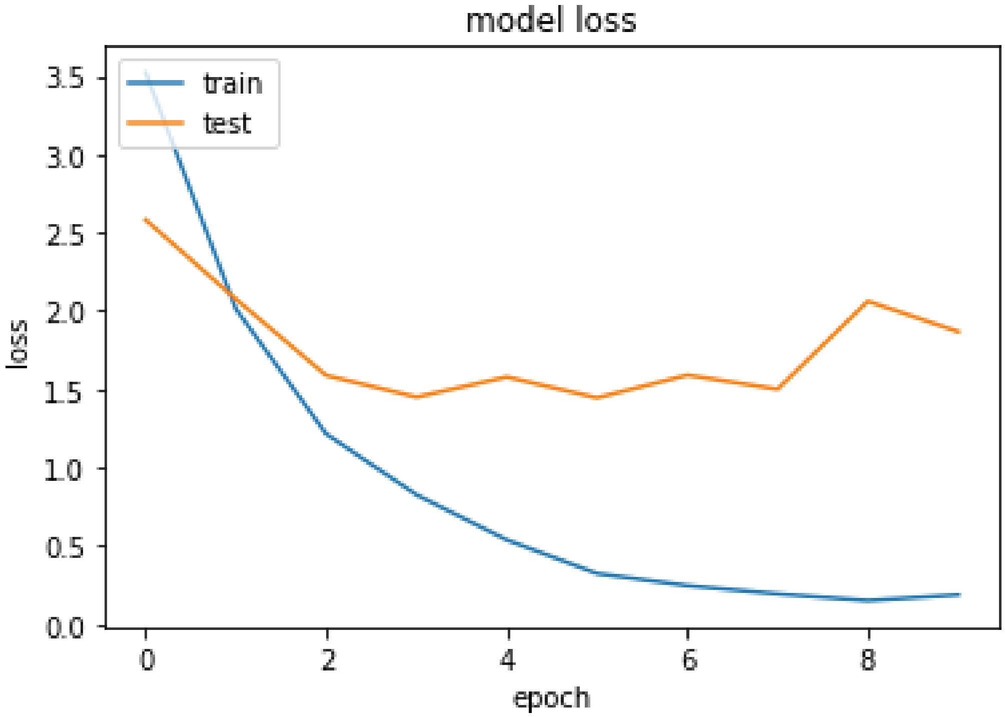
[232]:

```
model_test31=executeModelData(False, True, True, True, 10, shoes_train2,␣
↪shoes_test2, shoes_val2, df_shoe_brand2,num_classes2)
```

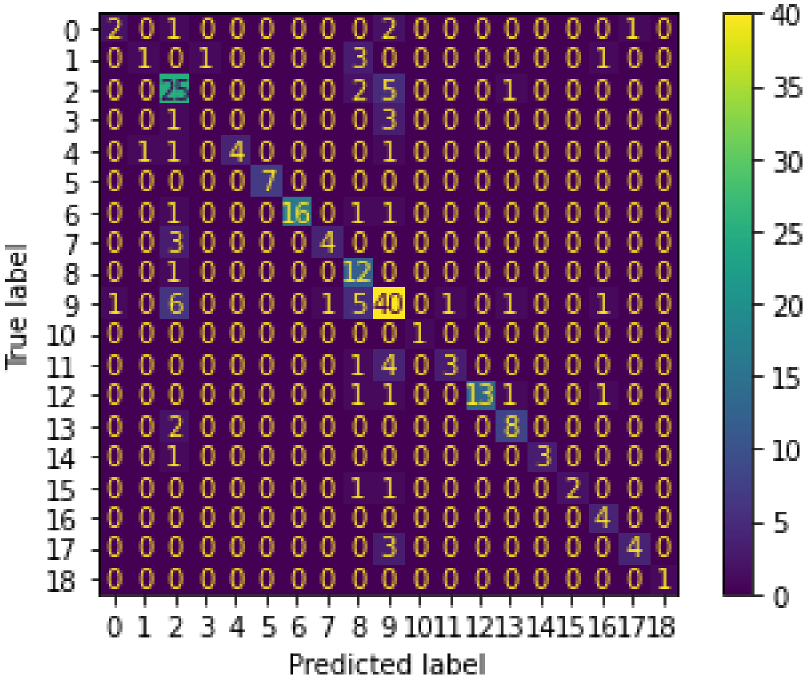
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
74/74 [==============================] - 83s 1s/step - loss: 3.5222 - accuracy:
0.1766 - val_loss: 2.5816 - val_accuracy: 0.2917
Epoch 2/10
74/74 [==============================] - 85s 1s/step - loss: 2.0134 - accuracy:
0.3736 - val_loss: 2.0762 - val_accuracy: 0.3417
Epoch 3/10
74/74 [==============================] - 88s 1s/step - loss: 1.2148 - accuracy:
0.6359 - val_loss: 1.5886 - val_accuracy: 0.4917
Epoch 4/10
74/74 [==============================] - 78s 1s/step - loss: 0.8268 - accuracy:
0.7283 - val_loss: 1.4501 - val_accuracy: 0.6083
Epoch 5/10
74/74 [==============================] - 81s 1s/step - loss: 0.5385 - accuracy:
0.8505 - val_loss: 1.5785 - val_accuracy: 0.5833
Epoch 6/10
74/74 [==============================] - 85s 1s/step - loss: 0.3236 - accuracy:
0.9062 - val_loss: 1.4453 - val_accuracy: 0.6417
Epoch 7/10
```

```
74/74 [==============================] - 76s 1s/step - loss: 0.2462 - accuracy:
0.9375 - val_loss: 1.5904 - val_accuracy: 0.6833
Epoch 8/10
74/74 [==============================] - 81s 1s/step - loss: 0.1935 - accuracy:
0.9552 - val_loss: 1.5006 - val_accuracy: 0.6500
Epoch 9/10
74/74 [==============================] - 83s 1s/step - loss: 0.1506 - accuracy:
0.9511 - val_loss: 2.0624 - val_accuracy: 0.6250
Epoch 10/10
74/74 [==============================] - 82s 1s/step - loss: 0.1877 - accuracy:
0.9470 - val_loss: 1.8681 - val_accuracy: 0.6833
```





```
22/22 [==============================] - 5s 232ms/step
Test evaluation:
22/22 [==============================] - 6s 276ms/step - loss: 1.3484 -
accuracy: 0.7009
[1.3483635187149048, 0.7009345889091492]
% of correct brand in the first 3 positions:
196
0.9158878504672897
% of brand predicted with percentage >= 0.25
0.1542056074766355
% of brand predicted with percentage >= 0.5
0.1542056074766355
% of brand predicted with percentage >= 0.75
0.1542056074766355
Matriz de confusión:
```

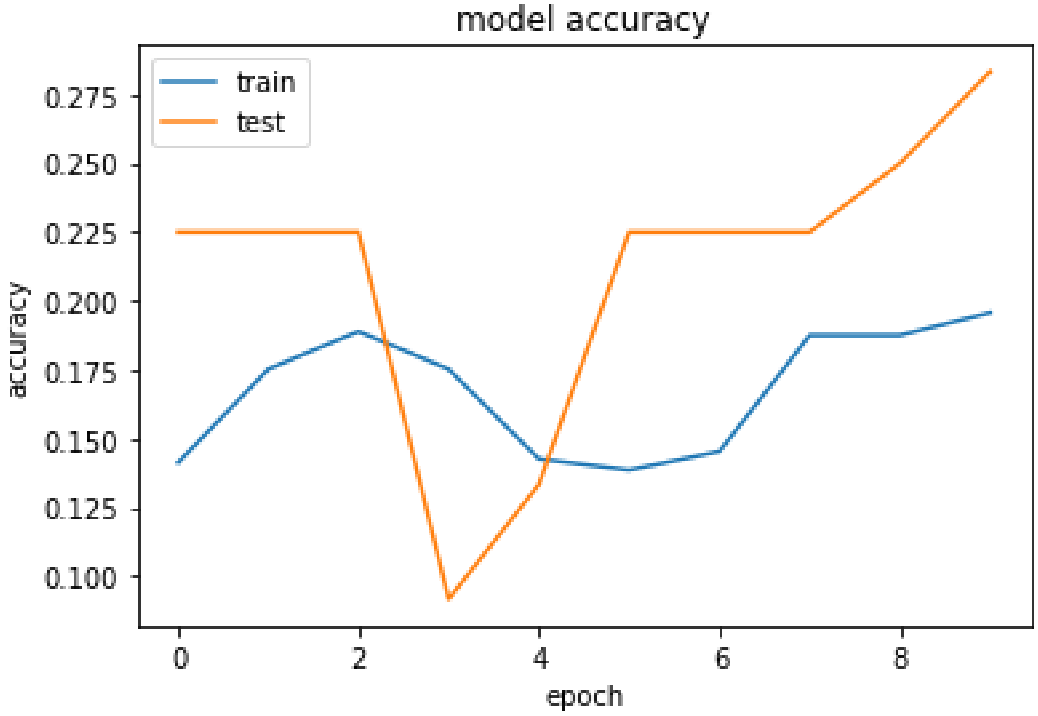


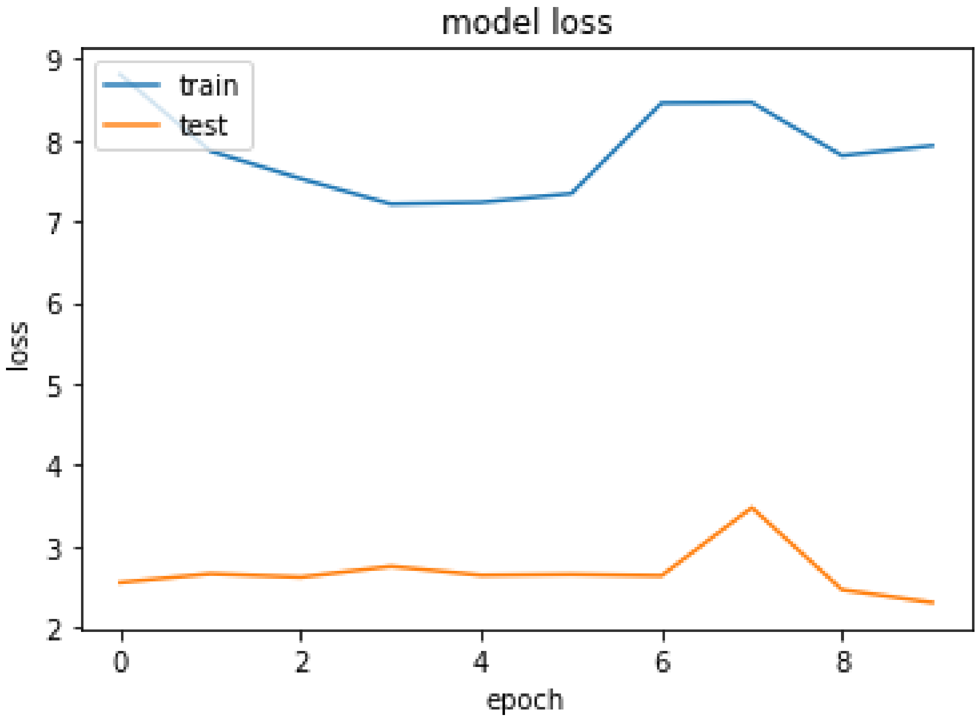
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 1 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 1 | 0 | 0 | 0 | 16 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 1 | 5 | 40 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 13 | 1 | 0 | 0 | 1 | 0 | 0 |
| 13 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

```
[63]: model_test32=executeModelData(True, True, True, True, 10, shoes_train2,␣
      ↪shoes_test2, shoes_val2, df_shoe_brand2,num_classes2)
```

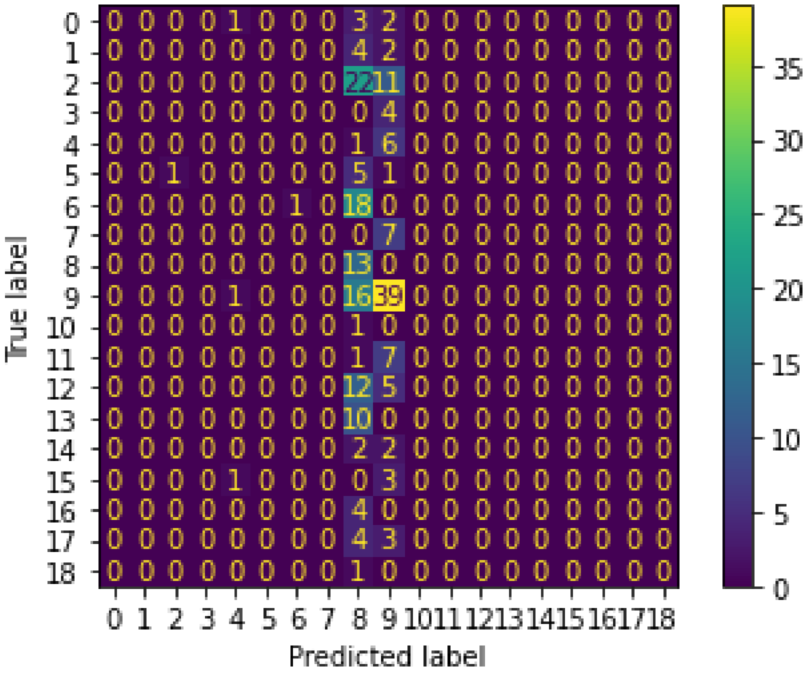
```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
74/74 [==============================] - 83s 1s/step - loss: 8.8096 - accuracy:
0.1413 - val_loss: 2.5498 - val_accuracy: 0.2250
Epoch 2/10
74/74 [==============================] - 82s 1s/step - loss: 7.8674 - accuracy:
0.1753 - val_loss: 2.6580 - val_accuracy: 0.2250
Epoch 3/10
74/74 [==============================] - 82s 1s/step - loss: 7.5274 - accuracy:
0.1889 - val_loss: 2.6154 - val_accuracy: 0.2250
Epoch 4/10
74/74 [==============================] - 82s 1s/step - loss: 7.2148 - accuracy:
0.1753 - val_loss: 2.7495 - val_accuracy: 0.0917
Epoch 5/10
74/74 [==============================] - 82s 1s/step - loss: 7.2358 - accuracy:
0.1427 - val_loss: 2.6391 - val_accuracy: 0.1333
Epoch 6/10
74/74 [==============================] - 81s 1s/step - loss: 7.3436 - accuracy:
0.1386 - val_loss: 2.6498 - val_accuracy: 0.2250
Epoch 7/10
```

```
74/74 [==============================] - 82s 1s/step - loss: 8.4591 - accuracy:
0.1454 - val_loss: 2.6334 - val_accuracy: 0.2250
Epoch 8/10
74/74 [==============================] - 83s 1s/step - loss: 8.4673 - accuracy:
0.1875 - val_loss: 3.4731 - val_accuracy: 0.2250
Epoch 9/10
74/74 [==============================] - 89s 1s/step - loss: 7.8115 - accuracy:
0.1875 - val_loss: 2.4604 - val_accuracy: 0.2500
Epoch 10/10
74/74 [==============================] - 83s 1s/step - loss: 7.9341 - accuracy:
0.1957 - val_loss: 2.3028 - val_accuracy: 0.2833
```





```
22/22 [==============================] - 6s 251ms/step
Test evaluation:
22/22 [==============================] - 6s 267ms/step - loss: 2.3681 -
accuracy: 0.2477
[2.368114471435547, 0.24766355752944946]
% of correct brand in the first 3 positions:
98
0.45794392523364486
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



| True label \ Predicted label | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 16 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[64]:
```
num_classes1, df_shoe_brand1,shoes_train1, shoes_test1, shoes_val1 =␣
↪returnDataByMinSample(1)
```

```
                  x   y
0            Adidas  12
1          Airspeed   1
2           Airwalk   1
3              Aldo   1
4    American Eagle   1
5           Arizona   1
6             Asics  13
7              BAGO   1
8              BASS   1
9       Birkenstock   1
10           Brooks   2
11      CalvinKlain   1
12         Champion   3
13           Clarks   1
14         Columbus   1
15         Converse   7
16           Cooeli   1
17    Court classic   1
18           Dansko   1
19       Deer Stags   1
20          Dockers   1
```

```
21              Ecco   2
22           Elcanto   1
23        Fadedglory   1
24            Feiyue   1
25              Fila   1
26       G.H.Bass&Co   1
27              Guho   1
28           HeyBear   1
29           K-swiss   1
30              Keen   3
31            Landya   1
32          Namuhana   2
33        Newbalance   4
34              Nike  24
35          Ninewest   1
37                OP   1
38              Ofem   1
39          Prospecs   2
40              Puma   1
41             Robin   1
42           Saucony   6
43            Shoedy   1
44           Shoopen   3
45       Simply vera   1
46          Skechers   8
47              Soma   1
48            Sonoma   1
49             Sorel   2
50            Sperry   7
51             Stone   1
52             Sugar   1
53               T2R   2
54              Teva   3
55          Truesoft   1
56       Under Amour   1
57              Vans   2
58            Vibram   1
59             Yonex   1
Brands with at least 1 samples: 59
Brands with only 1 register: 0
(1470, 3)
```

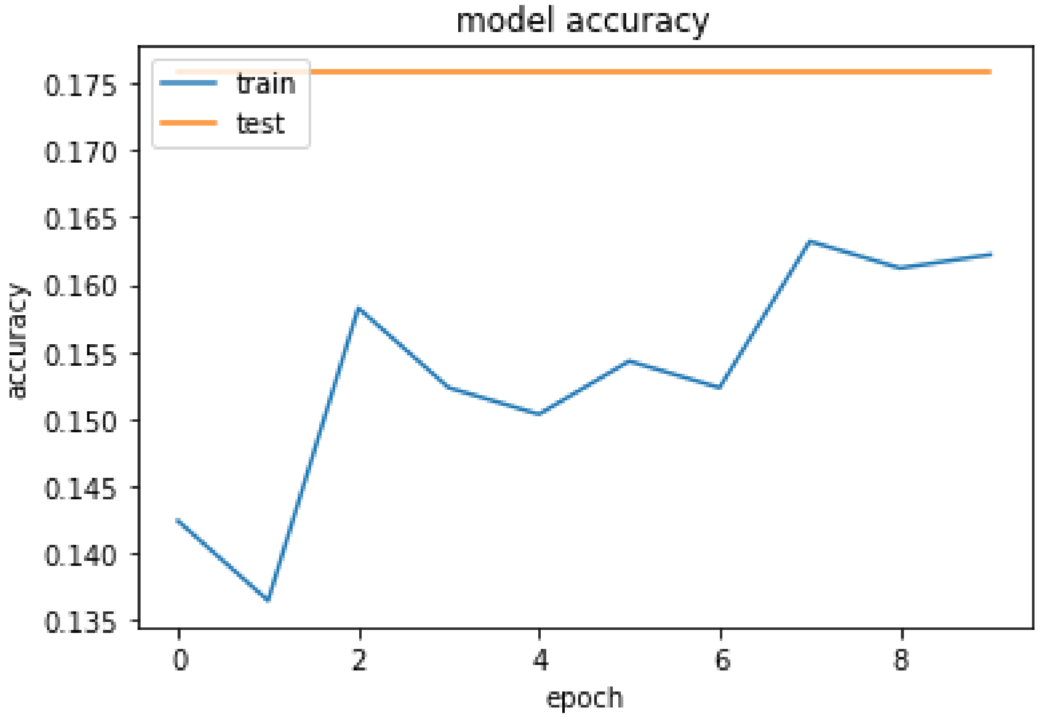
```
<ipython-input-15-6f4ddfca829a>:22: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

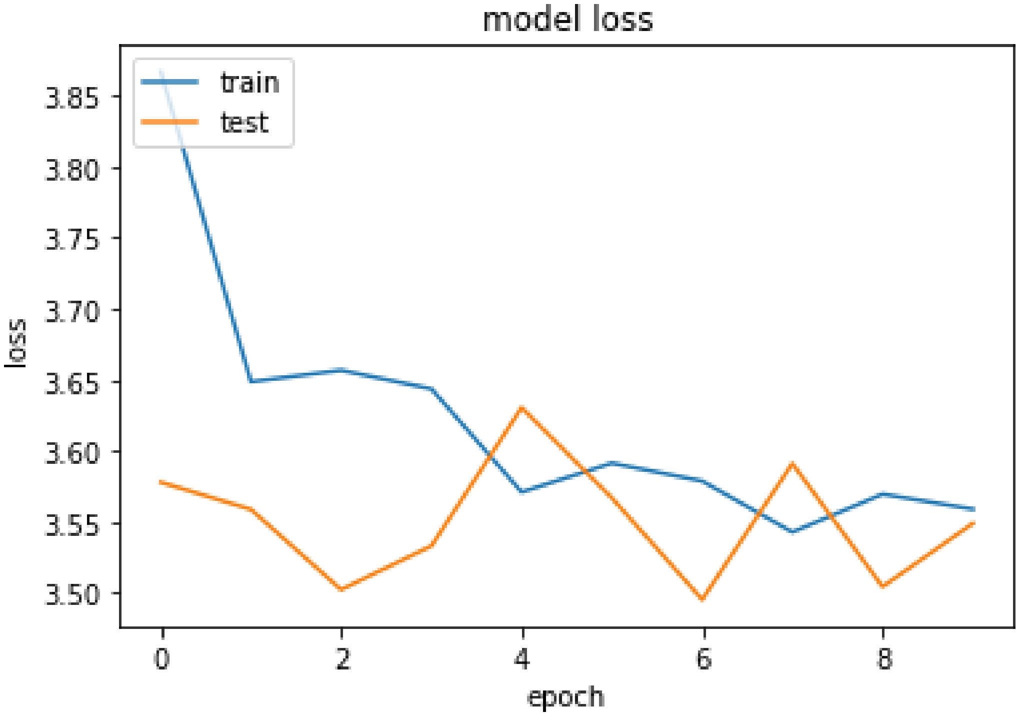
```
  df_shoe_brand['factor_brand'] =
pd.Categorical(pd.factorize(df_shoe_brand['y'])[0].astype(np.float32))
```

[239]:

```
model_test33=executeModelData(False, False, False, False, 10, shoes_train1,␣
↪shoes_test1, shoes_val1, df_shoe_brand1,num_classes1)
```

```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
102/102 [==============================] - 136s 1s/step - loss: 3.8670 -
accuracy: 0.1424 - val_loss: 3.5780 - val_accuracy: 0.1758
Epoch 2/10
102/102 [==============================] - 220s 2s/step - loss: 3.6487 -
accuracy: 0.1365 - val_loss: 3.5589 - val_accuracy: 0.1758
Epoch 3/10
102/102 [==============================] - 217s 2s/step - loss: 3.6568 -
accuracy: 0.1583 - val_loss: 3.5024 - val_accuracy: 0.1758
Epoch 4/10
102/102 [==============================] - 212s 2s/step - loss: 3.6437 -
accuracy: 0.1523 - val_loss: 3.5332 - val_accuracy: 0.1758
Epoch 5/10
102/102 [==============================] - 200s 2s/step - loss: 3.5711 -
accuracy: 0.1503 - val_loss: 3.6305 - val_accuracy: 0.1758
Epoch 6/10
102/102 [==============================] - 286s 3s/step - loss: 3.5915 -
accuracy: 0.1543 - val_loss: 3.5670 - val_accuracy: 0.1758
Epoch 7/10
102/102 [==============================] - 236s 2s/step - loss: 3.5789 -
accuracy: 0.1523 - val_loss: 3.4954 - val_accuracy: 0.1758
Epoch 8/10
102/102 [==============================] - 265s 3s/step - loss: 3.5429 -
accuracy: 0.1632 - val_loss: 3.5912 - val_accuracy: 0.1758
Epoch 9/10
102/102 [==============================] - 214s 2s/step - loss: 3.5697 -
accuracy: 0.1612 - val_loss: 3.5044 - val_accuracy: 0.1758
Epoch 10/10
102/102 [==============================] - 218s 2s/step - loss: 3.5591 -
accuracy: 0.1622 - val_loss: 3.5491 - val_accuracy: 0.1758
```


model accuracy
train
test
accuracy
0.175
0.170
0.165
0.160
0.155
0.150
0.145
0.140
0.135
0
2
4
6
8
epoch

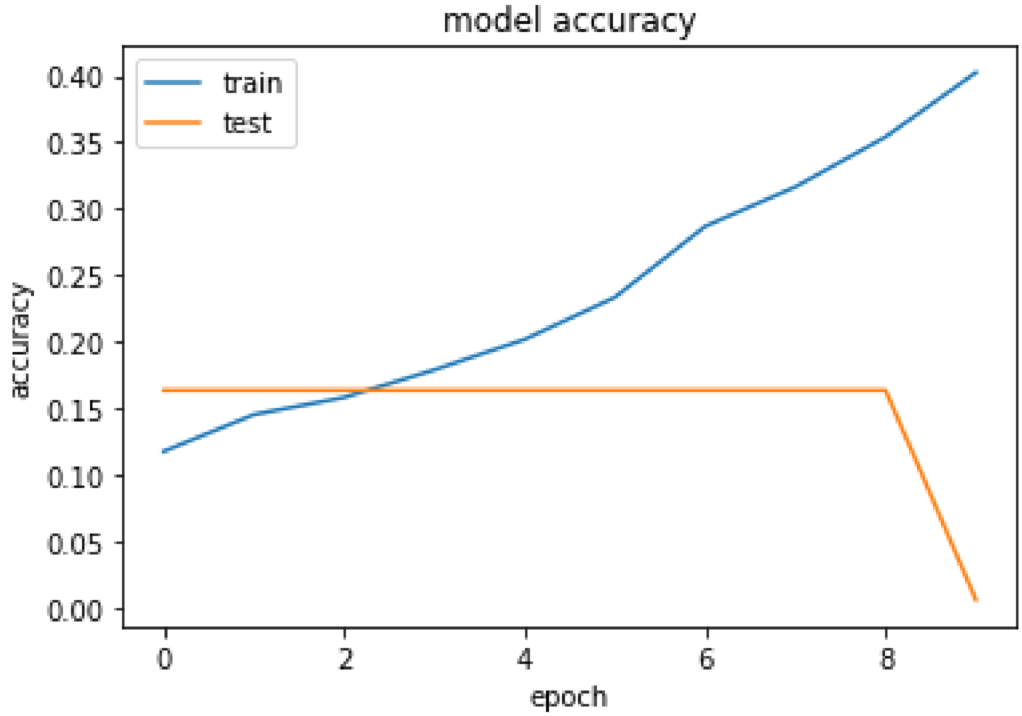

model loss
train
test
loss
3.85
3.80
3.75
3.70
3.65
3.60
3.55
3.50
0
2
4
6
8
epoch

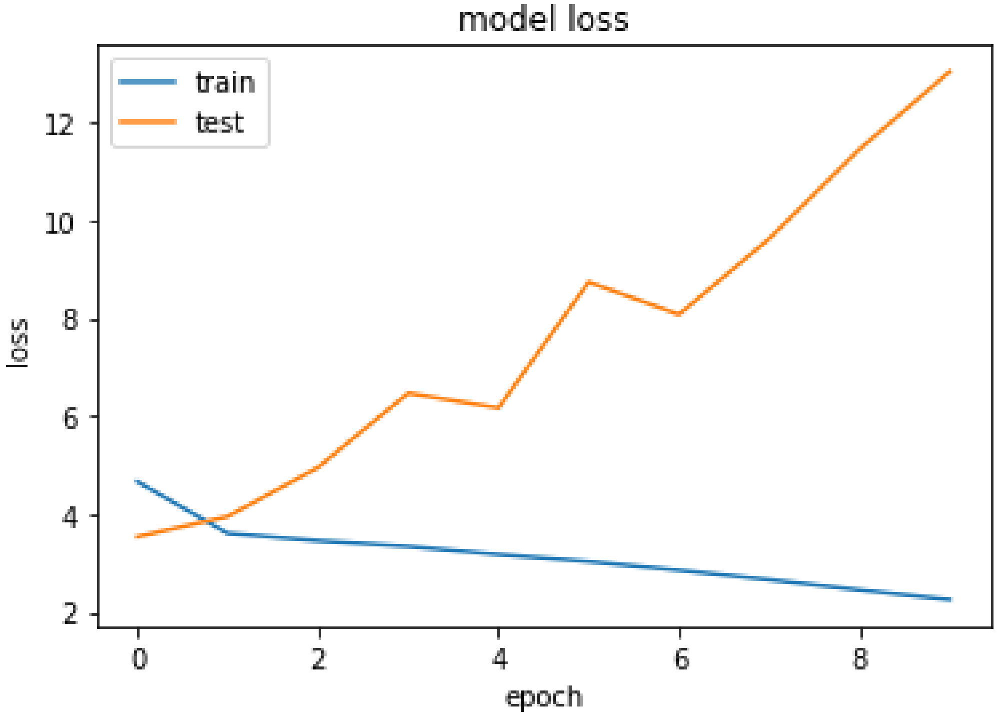
```
30/30 [==============================] - 15s 489ms/step
Test evaluation:
30/30 [==============================] - 16s 530ms/step - loss: 3.6018 -
accuracy: 0.1565
[3.601834774017334, 0.15646257996559143]
% of correct brand in the first 3 positions:
98
0.3333333333333333
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
```

```
[65]: model_test34=executeModelData(True, False, False, False, 10, shoes_train1,␣
       ↪shoes_test1, shoes_val1, df_shoe_brand1,num_classes1)
```

```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
102/102 [==============================] - 126s 1s/step - loss: 4.6684 -
accuracy: 0.1177 - val_loss: 3.5402 - val_accuracy: 0.1636
Epoch 2/10
102/102 [==============================] - 122s 1s/step - loss: 3.6103 -
accuracy: 0.1454 - val_loss: 3.9533 - val_accuracy: 0.1636
Epoch 3/10
102/102 [==============================] - 121s 1s/step - loss: 3.4582 -
accuracy: 0.1583 - val_loss: 4.9559 - val_accuracy: 0.1636
Epoch 4/10
102/102 [==============================] - 122s 1s/step - loss: 3.3429 -
accuracy: 0.1790 - val_loss: 6.4668 - val_accuracy: 0.1636
Epoch 5/10
102/102 [==============================] - 122s 1s/step - loss: 3.1782 -
accuracy: 0.2018 - val_loss: 6.1674 - val_accuracy: 0.1636
Epoch 6/10
102/102 [==============================] - 122s 1s/step - loss: 3.0340 -
accuracy: 0.2334 - val_loss: 8.7387 - val_accuracy: 0.1636
Epoch 7/10
102/102 [==============================] - 121s 1s/step - loss: 2.8561 -
accuracy: 0.2868 - val_loss: 8.0752 - val_accuracy: 0.1636
Epoch 8/10
102/102 [==============================] - 121s 1s/step - loss: 2.6624 -
accuracy: 0.3165 - val_loss: 9.6229 - val_accuracy: 0.1636
Epoch 9/10
102/102 [==============================] - 125s 1s/step - loss: 2.4529 -
accuracy: 0.3541 - val_loss: 11.4523 - val_accuracy: 0.1636
```

```
Epoch 10/10
102/102 [==============================] - 123s 1s/step - loss: 2.2548 -
accuracy: 0.4026 - val_loss: 13.0359 - val_accuracy: 0.0061
```



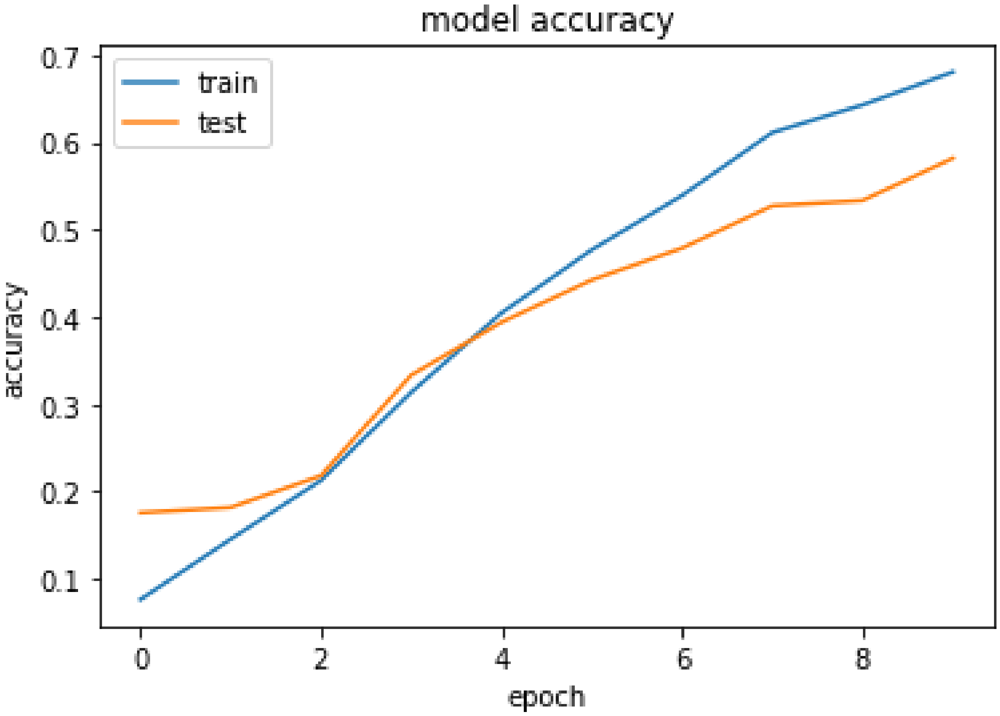


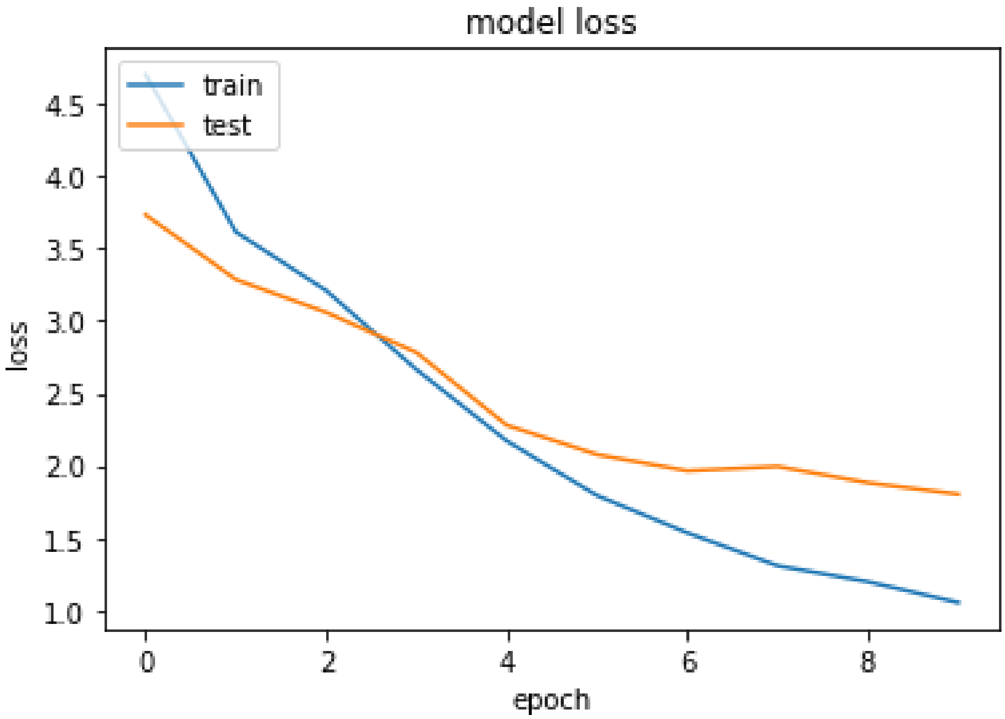
```
30/30 [==============================] - 8s 269ms/step
Test evaluation:
30/30 [==============================] - 8s 275ms/step - loss: 13.3836 -
accuracy: 0.0102
[13.38359546661377, 0.010204081423580647]
% of correct brand in the first 3 positions:
53
0.18027210884353742
% of brand predicted with percentage >= 0.25
0.01020408163265306
% of brand predicted with percentage >= 0.5
0.01020408163265306
% of brand predicted with percentage >= 0.75
0.01020408163265306
```

[241]:
```
model_test35=executeModelData(False, True, True, True, 10, shoes_train1,␣
↪shoes_test1, shoes_val1, df_shoe_brand1,num_classes1)
```

```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
102/102 [==============================] - 155s 2s/step - loss: 4.7010 -
accuracy: 0.0762 - val_loss: 3.7318 - val_accuracy: 0.1758
Epoch 2/10
102/102 [==============================] - 156s 2s/step - loss: 3.6134 -
accuracy: 0.1454 - val_loss: 3.2858 - val_accuracy: 0.1818
Epoch 3/10
102/102 [==============================] - 151s 1s/step - loss: 3.2100 -
accuracy: 0.2127 - val_loss: 3.0592 - val_accuracy: 0.2182
Epoch 4/10
102/102 [==============================] - 152s 1s/step - loss: 2.6628 -
accuracy: 0.3136 - val_loss: 2.7814 - val_accuracy: 0.3333
Epoch 5/10
102/102 [==============================] - 152s 1s/step - loss: 2.1699 -
accuracy: 0.4045 - val_loss: 2.2784 - val_accuracy: 0.3939
Epoch 6/10
102/102 [==============================] - 152s 1s/step - loss: 1.7935 -
accuracy: 0.4768 - val_loss: 2.0763 - val_accuracy: 0.4424
Epoch 7/10
102/102 [==============================] - 136s 1s/step - loss: 1.5352 -
accuracy: 0.5391 - val_loss: 1.9642 - val_accuracy: 0.4788
Epoch 8/10
102/102 [==============================] - 151s 1s/step - loss: 1.3078 -
accuracy: 0.6113 - val_loss: 1.9943 - val_accuracy: 0.5273
Epoch 9/10
```

```
102/102 [==============================] - 148s 1s/step - loss: 1.1976 -
accuracy: 0.6429 - val_loss: 1.8819 - val_accuracy: 0.5333
Epoch 10/10
102/102 [==============================] - 160s 2s/step - loss: 1.0534 -
accuracy: 0.6805 - val_loss: 1.8024 - val_accuracy: 0.5818
```



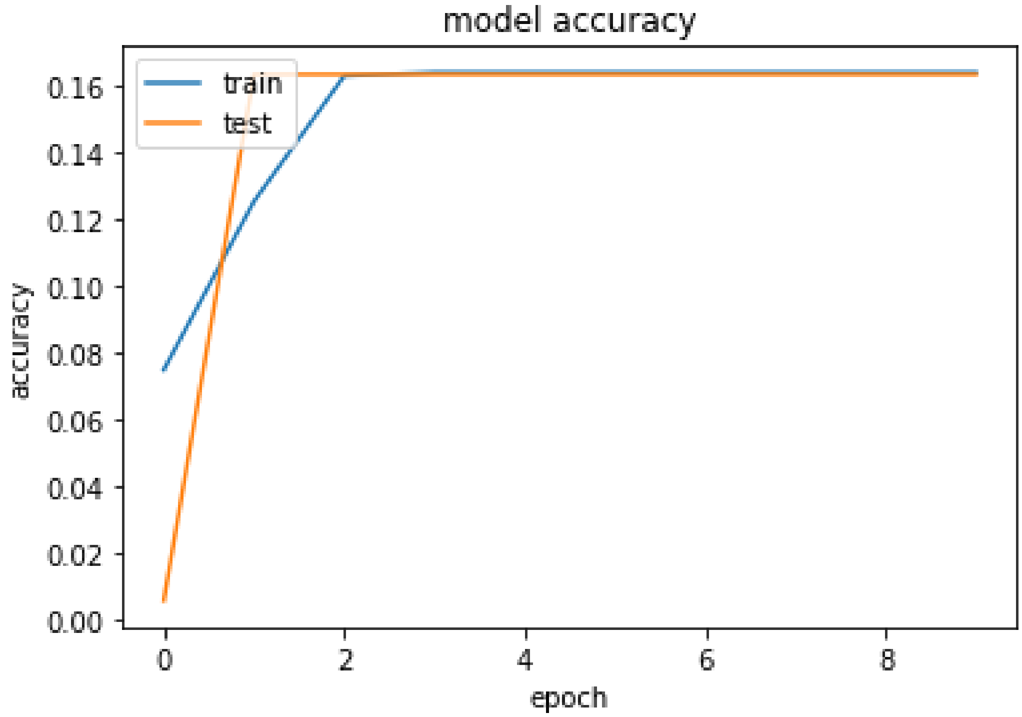


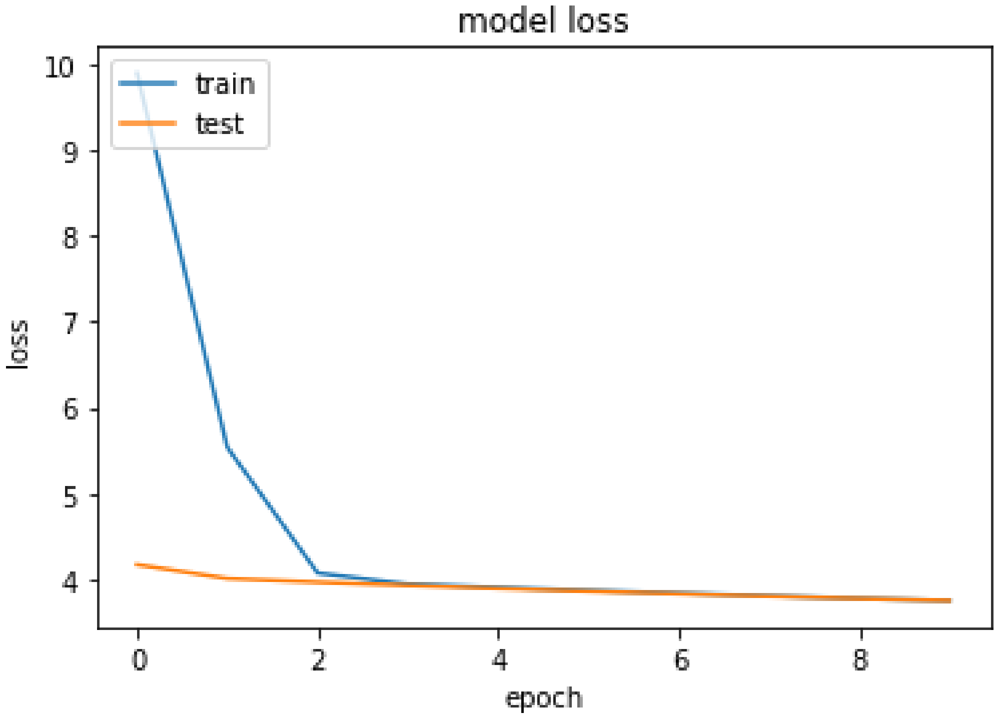
```
30/30 [==============================] - 14s 442ms/step
Test evaluation:
30/30 [==============================] - 13s 439ms/step - loss: 1.8061 -
accuracy: 0.5374
[1.8061199188232422, 0.5374149680137634]
% of correct brand in the first 3 positions:
223
0.7585034013605442
% of brand predicted with percentage >= 0.25
0.1564625850340136
% of brand predicted with percentage >= 0.5
0.1564625850340136
% of brand predicted with percentage >= 0.75
0.1564625850340136
```

[66]:
```
model_test36=executeModelData(True, True, True, True, 10, shoes_train1,␣
 ↪shoes_test1, shoes_val1, df_shoe_brand1,num_classes1)
```

```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
102/102 [==============================] - 114s 1s/step - loss: 9.8988 -
accuracy: 0.0752 - val_loss: 4.1699 - val_accuracy: 0.0061
```

```
Epoch 2/10
102/102 [==============================] - 112s 1s/step - loss: 5.5382 -
accuracy: 0.1256 - val_loss: 4.0087 - val_accuracy: 0.1636
Epoch 3/10
102/102 [==============================] - 111s 1s/step - loss: 4.0720 -
accuracy: 0.1632 - val_loss: 3.9656 - val_accuracy: 0.1636
Epoch 4/10
102/102 [==============================] - 112s 1s/step - loss: 3.9427 -
accuracy: 0.1642 - val_loss: 3.9279 - val_accuracy: 0.1636
Epoch 5/10
102/102 [==============================] - 113s 1s/step - loss: 3.9043 -
accuracy: 0.1642 - val_loss: 3.8921 - val_accuracy: 0.1636
Epoch 6/10
102/102 [==============================] - 112s 1s/step - loss: 3.8691 -
accuracy: 0.1642 - val_loss: 3.8602 - val_accuracy: 0.1636
Epoch 7/10
102/102 [==============================] - 111s 1s/step - loss: 3.8361 -
accuracy: 0.1642 - val_loss: 3.8297 - val_accuracy: 0.1636
Epoch 8/10
102/102 [==============================] - 111s 1s/step - loss: 3.8059 -
accuracy: 0.1642 - val_loss: 3.8012 - val_accuracy: 0.1636
Epoch 9/10
102/102 [==============================] - 113s 1s/step - loss: 3.7768 -
accuracy: 0.1642 - val_loss: 3.7754 - val_accuracy: 0.1636
Epoch 10/10
102/102 [==============================] - 112s 1s/step - loss: 3.7502 -
accuracy: 0.1642 - val_loss: 3.7502 - val_accuracy: 0.1636
```


model accuracy
train
test
accuracy
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0
2
4
6
8
epoch


model loss
train
test
loss
4
5
6
7
8
9
10
0
2
4
6
8
epoch

```
30/30 [==============================] - 8s 272ms/step
Test evaluation:
30/30 [==============================] - 8s 272ms/step - loss: 3.7887 -
accuracy: 0.1599
[3.7886502742767334, 0.15986394882202148]
% of correct brand in the first 3 positions:
91
0.30952380952380953
% of brand predicted with percentage >= 0.25
0.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
```

[67]:

```
num_classes10, df_shoe_brand10,shoes_train10, shoes_test10, shoes_val10 =␣
↪returnDataByMinSample(10)
```

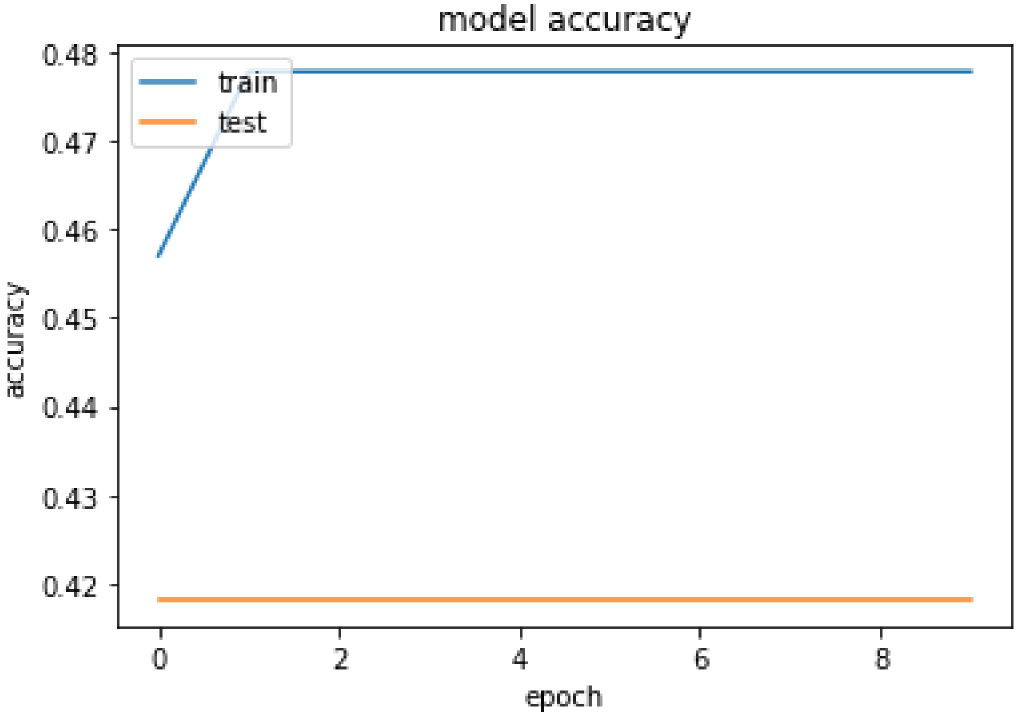
```
         x   y
0   Adidas  12
6    Asics  13
34    Nike  24
Brands with at least 10 samples: 3
Brands with only 1 register: 56
(490, 3)
```

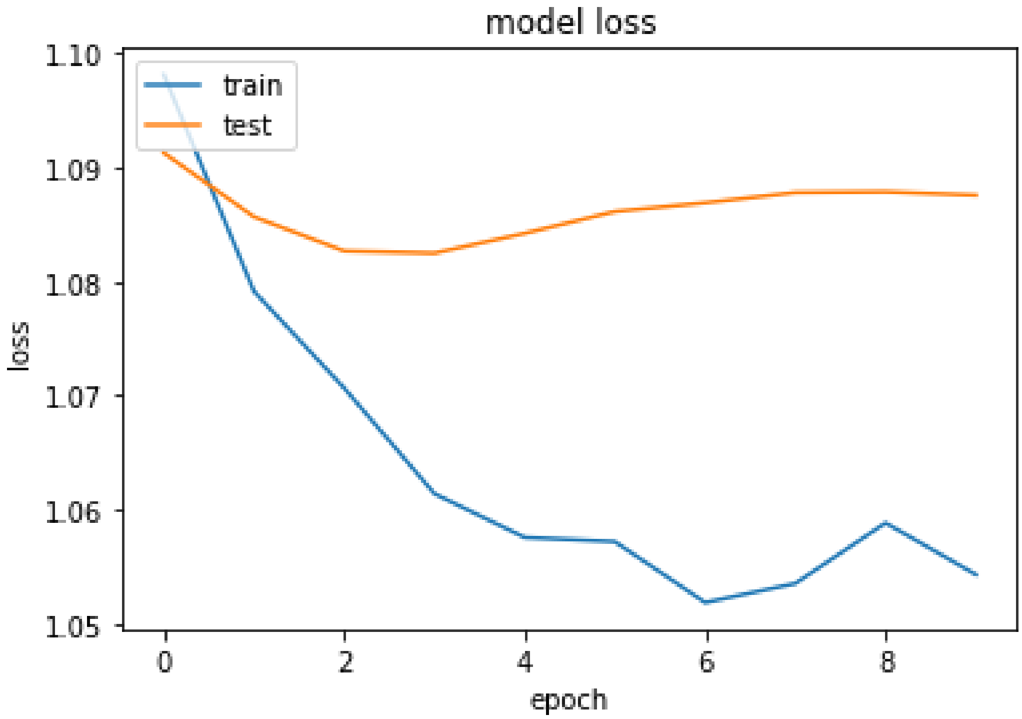
[244]:

```
model_test37=executeModelData(False, False, False, False, 10, shoes_train10,␣
↪shoes_test10, shoes_val10, df_shoe_brand10,num_classes10)
```

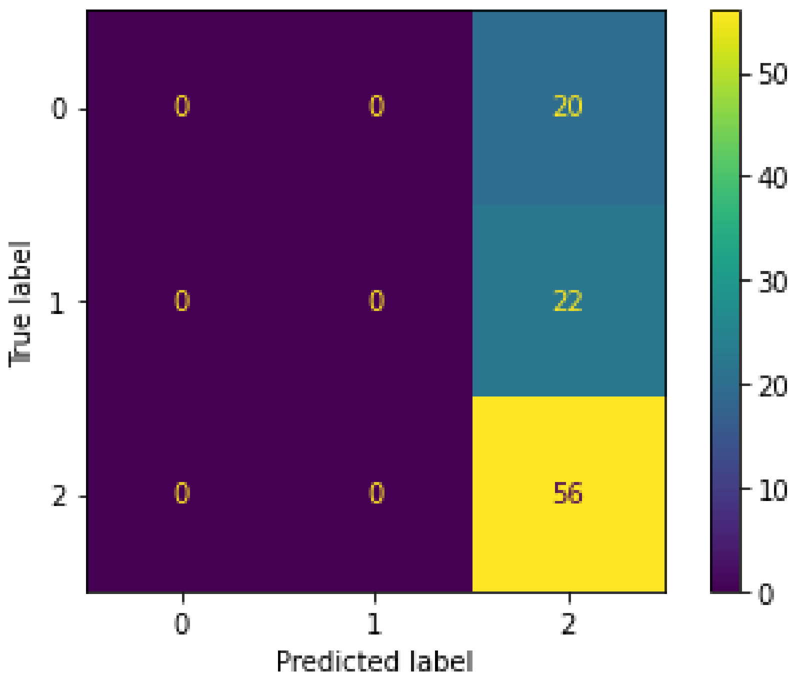
```
Training model with aumentation:False, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
34/34 [==============================] - 44s 1s/step - loss: 1.0982 - accuracy:
0.4570 - val_loss: 1.0913 - val_accuracy: 0.4182
Epoch 2/10
34/34 [==============================] - 41s 1s/step - loss: 1.0792 - accuracy:
0.4777 - val_loss: 1.0857 - val_accuracy: 0.4182
Epoch 3/10
34/34 [==============================] - 41s 1s/step - loss: 1.0707 - accuracy:
0.4777 - val_loss: 1.0827 - val_accuracy: 0.4182
Epoch 4/10
34/34 [==============================] - 37s 1s/step - loss: 1.0614 - accuracy:
0.4777 - val_loss: 1.0825 - val_accuracy: 0.4182
Epoch 5/10
34/34 [==============================] - 39s 1s/step - loss: 1.0576 - accuracy:
0.4777 - val_loss: 1.0842 - val_accuracy: 0.4182
Epoch 6/10
34/34 [==============================] - 44s 1s/step - loss: 1.0572 - accuracy:
```

```
0.4777 - val_loss: 1.0861 - val_accuracy: 0.4182
Epoch 7/10
34/34 [==============================] - 45s 1s/step - loss: 1.0518 - accuracy:
0.4777 - val_loss: 1.0869 - val_accuracy: 0.4182
Epoch 8/10
34/34 [==============================] - 43s 1s/step - loss: 1.0535 - accuracy:
0.4777 - val_loss: 1.0878 - val_accuracy: 0.4182
Epoch 9/10
34/34 [==============================] - 42s 1s/step - loss: 1.0588 - accuracy:
0.4777 - val_loss: 1.0879 - val_accuracy: 0.4182
Epoch 10/10
34/34 [==============================] - 43s 1s/step - loss: 1.0543 - accuracy:
0.4777 - val_loss: 1.0876 - val_accuracy: 0.4182
```





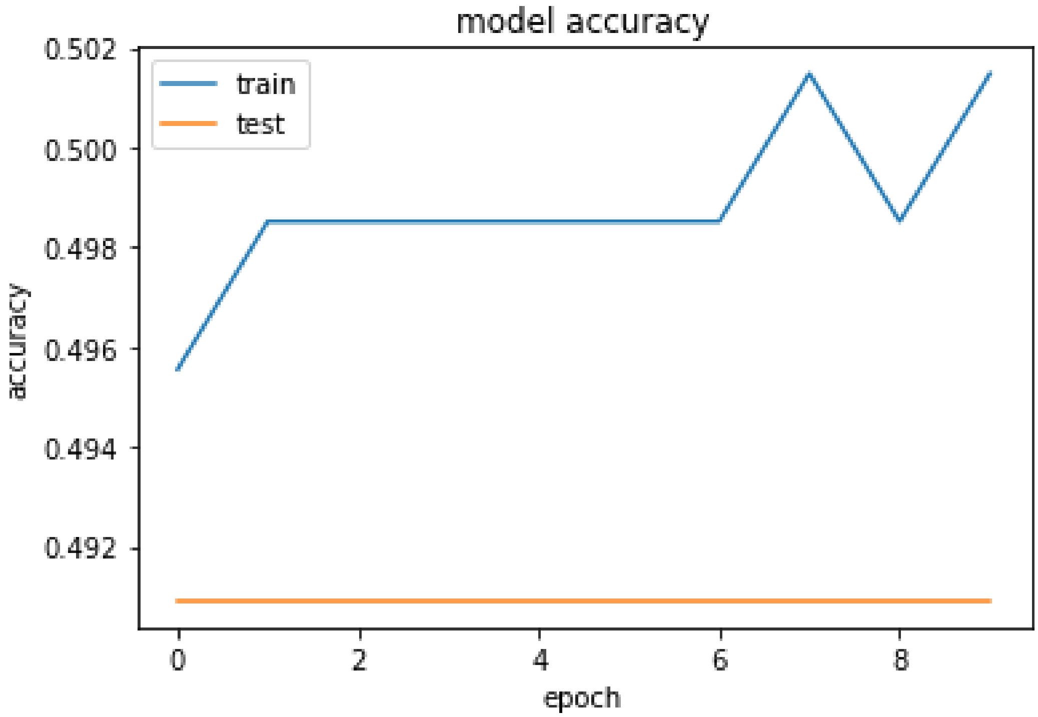
```
10/10 [==============================] - 3s 285ms/step
Test evaluation:
10/10 [==============================] - 3s 291ms/step - loss: 1.0016 -
accuracy: 0.5714
[1.0015724897384644, 0.5714285969734192]
% of correct brand in the first 3 positions:
98
1.0
% of brand predicted with percentage >= 0.25
1.0
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

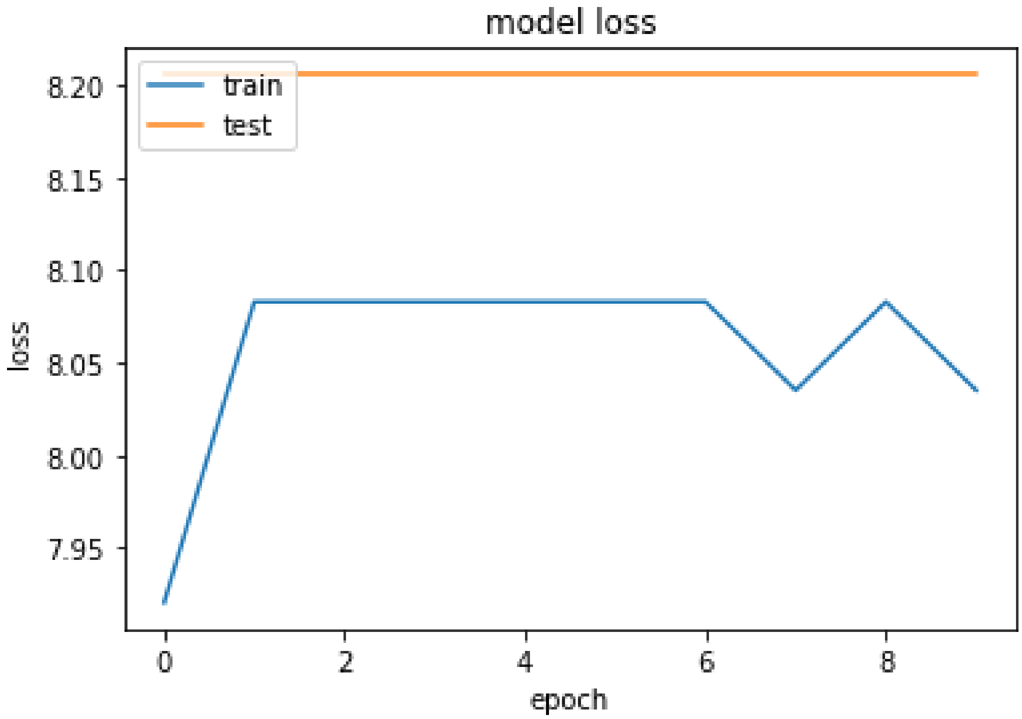


```
[68]: model_test38=executeModelData(True, False, False, False, 10, shoes_train10,␣
       ↪shoes_test10, shoes_val10, df_shoe_brand10,num_classes10)
```

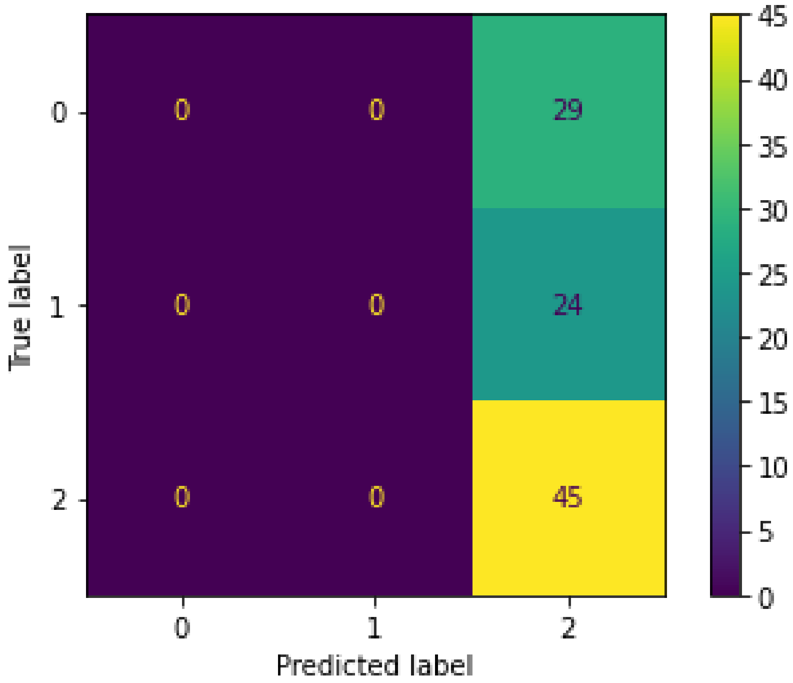
```
Training model with aumentation:True, gray:False, binary:False, crop:False and
epochs = 10
Epoch 1/10
34/34 [==============================] - 43s 1s/step - loss: 7.9205 - accuracy:
0.4955 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 2/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 3/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 4/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 5/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 6/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 7/10
```

```
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 8/10
34/34 [==============================] - 41s 1s/step - loss: 8.0351 - accuracy:
0.5015 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 9/10
34/34 [==============================] - 41s 1s/step - loss: 8.0830 - accuracy:
0.4985 - val_loss: 8.2056 - val_accuracy: 0.4909
Epoch 10/10
34/34 [==============================] - 41s 1s/step - loss: 8.0351 - accuracy:
0.5015 - val_loss: 8.2056 - val_accuracy: 0.4909
```





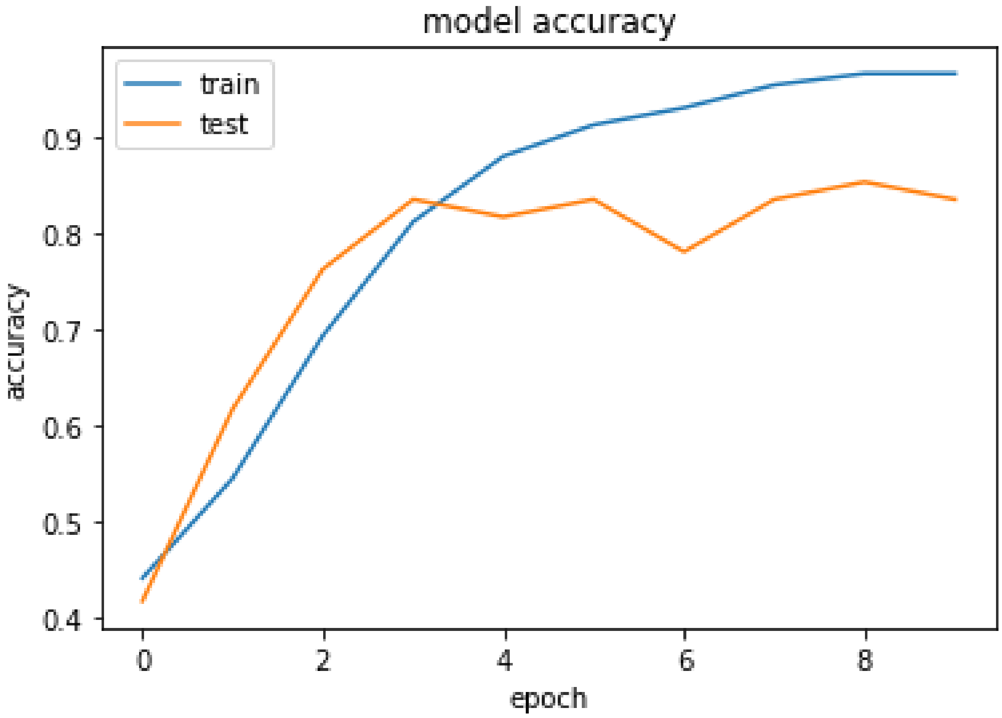
```
10/10 [==============================] - 3s 247ms/step
Test evaluation:
10/10 [==============================] - 3s 266ms/step - loss: 8.7169 -
accuracy: 0.4592
[8.71692943572998, 0.4591836631298065]
% of correct brand in the first 3 positions:
98
1.0
% of brand predicted with percentage >= 0.25
0.45918367346938777
% of brand predicted with percentage >= 0.5
0.45918367346938777
% of brand predicted with percentage >= 0.75
0.45918367346938777
Matriz de confusión:
```

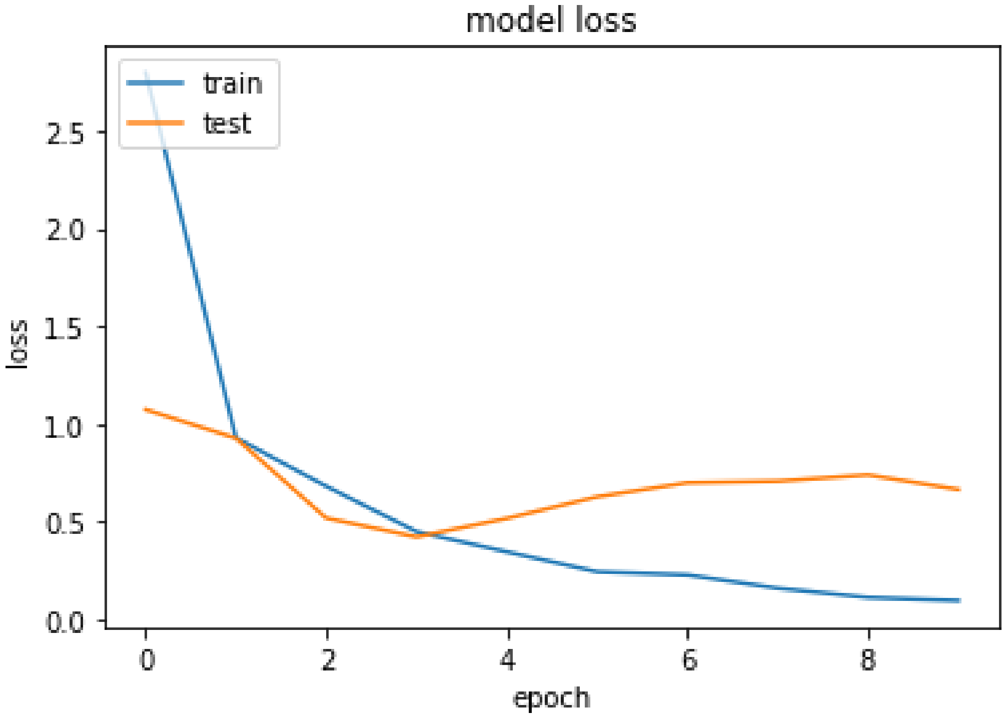


[246]:
```
model_test39=executeModelData(False, True, True, True, 10, shoes_train10,␣
↪shoes_test10, shoes_val10, df_shoe_brand10,num_classes10)
```

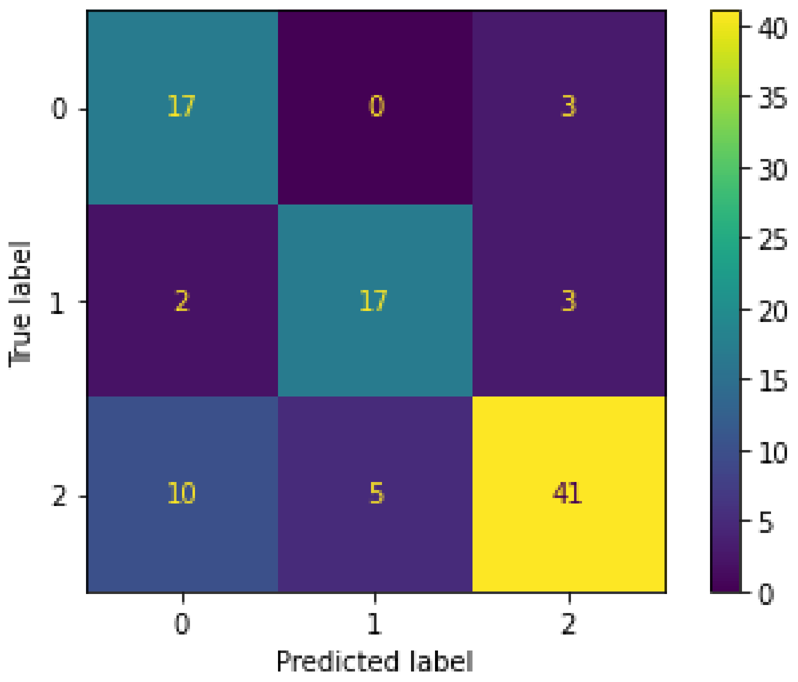
```
Training model with aumentation:False, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
34/34 [==============================] - 41s 1s/step - loss: 2.7961 - accuracy:
0.4421 - val_loss: 1.0735 - val_accuracy: 0.4182
Epoch 2/10
34/34 [==============================] - 42s 1s/step - loss: 0.9298 - accuracy:
0.5460 - val_loss: 0.9274 - val_accuracy: 0.6182
Epoch 3/10
34/34 [==============================] - 40s 1s/step - loss: 0.6826 - accuracy:
0.6944 - val_loss: 0.5198 - val_accuracy: 0.7636
Epoch 4/10
34/34 [==============================] - 39s 1s/step - loss: 0.4502 - accuracy:
0.8131 - val_loss: 0.4233 - val_accuracy: 0.8364
Epoch 5/10
34/34 [==============================] - 42s 1s/step - loss: 0.3470 - accuracy:
0.8813 - val_loss: 0.5179 - val_accuracy: 0.8182
Epoch 6/10
34/34 [==============================] - 39s 1s/step - loss: 0.2452 - accuracy:
0.9139 - val_loss: 0.6282 - val_accuracy: 0.8364
Epoch 7/10
```

```
34/34 [==============================] - 40s 1s/step - loss: 0.2288 - accuracy:
0.9318 - val_loss: 0.7002 - val_accuracy: 0.7818
Epoch 8/10
34/34 [==============================] - 40s 1s/step - loss: 0.1610 - accuracy:
0.9555 - val_loss: 0.7082 - val_accuracy: 0.8364
Epoch 9/10
34/34 [==============================] - 39s 1s/step - loss: 0.1138 - accuracy:
0.9674 - val_loss: 0.7406 - val_accuracy: 0.8545
Epoch 10/10
34/34 [==============================] - 40s 1s/step - loss: 0.0976 - accuracy:
0.9674 - val_loss: 0.6658 - val_accuracy: 0.8364
```





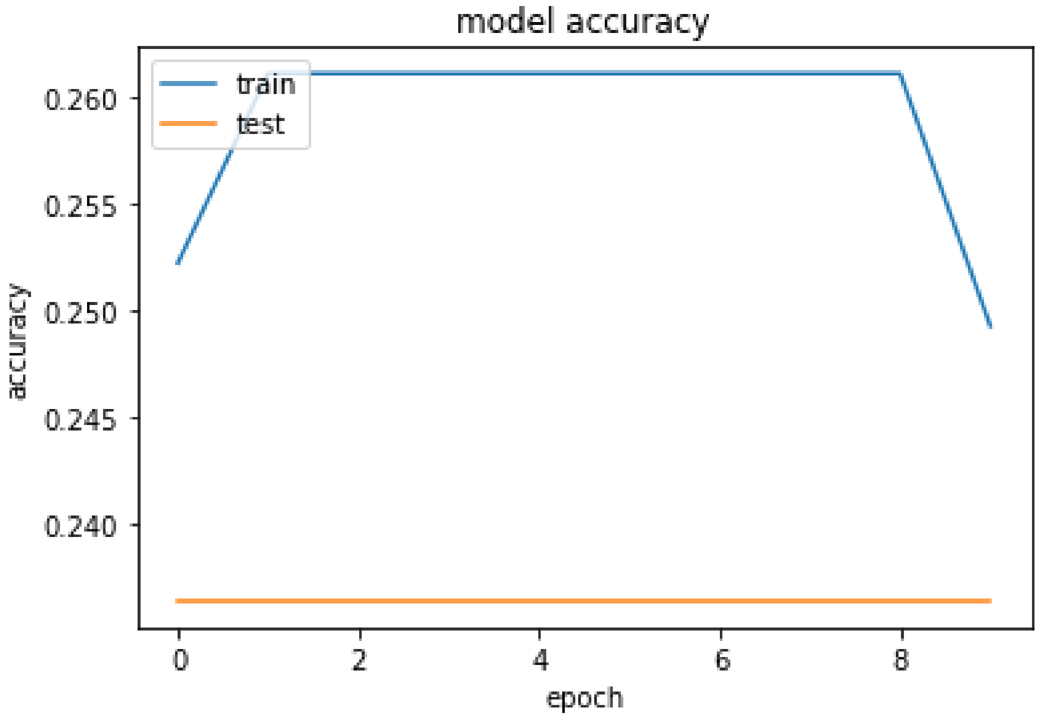
```
10/10 [==============================] - 3s 257ms/step
Test evaluation:
10/10 [==============================] - 3s 281ms/step - loss: 0.9397 -
accuracy: 0.7653
[0.9397358298301697, 0.7653061151504517]
% of correct brand in the first 3 positions:
98
1.0
% of brand predicted with percentage >= 0.25
0.5714285714285714
% of brand predicted with percentage >= 0.5
0.5714285714285714
% of brand predicted with percentage >= 0.75
0.5714285714285714
Matriz de confusión:
```

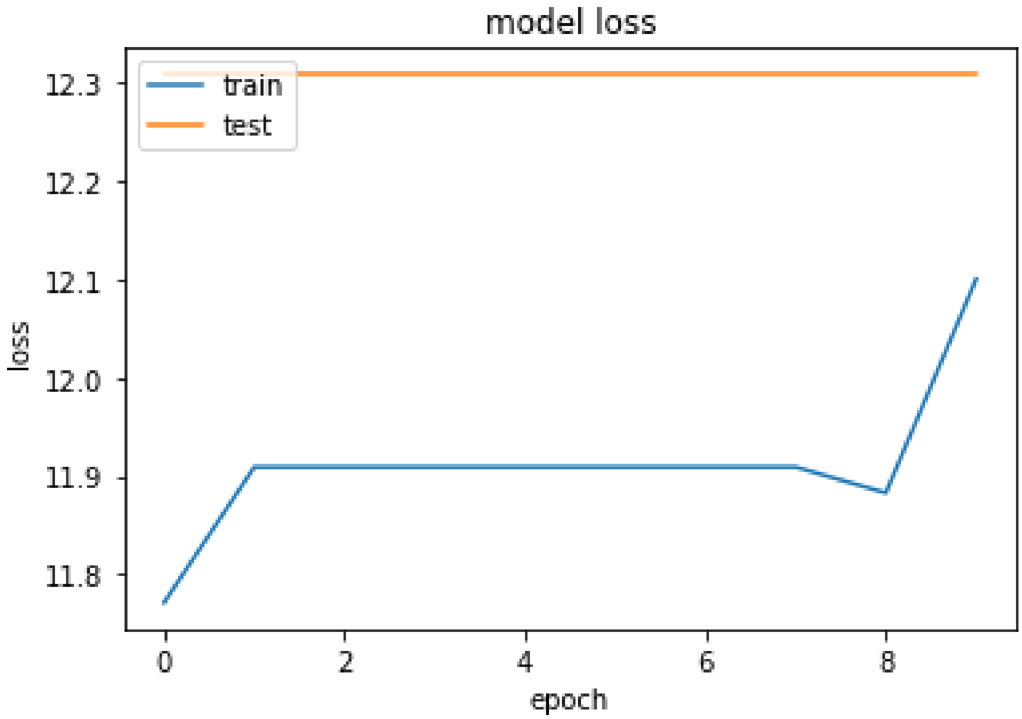


[69]:
```
model_test40=executeModelData(True, True, True, True, 10, shoes_train10,␣
 ↪shoes_test10, shoes_val10, df_shoe_brand10,num_classes10)
```

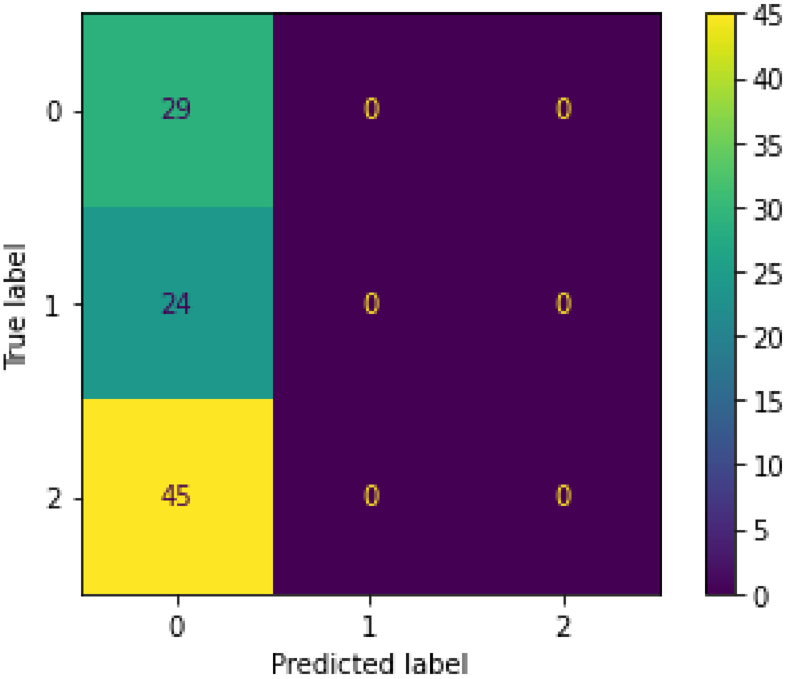
```
Training model with aumentation:True, gray:True, binary:True, crop:True and
epochs = 10
Epoch 1/10
34/34 [==============================] - 39s 1s/step - loss: 11.7713 - accuracy:
0.2522 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 2/10
34/34 [==============================] - 38s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 3/10
34/34 [==============================] - 38s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 4/10
34/34 [==============================] - 38s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 5/10
34/34 [==============================] - 37s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 6/10
34/34 [==============================] - 38s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 7/10
```

```
34/34 [==============================] - 37s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 8/10
34/34 [==============================] - 37s 1s/step - loss: 11.9092 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 9/10
34/34 [==============================] - 37s 1s/step - loss: 11.8829 - accuracy:
0.2611 - val_loss: 12.3084 - val_accuracy: 0.2364
Epoch 10/10
34/34 [==============================] - 37s 1s/step - loss: 12.1007 - accuracy:
0.2493 - val_loss: 12.3084 - val_accuracy: 0.2364
```





```
10/10 [==============================] - 3s 234ms/step
Test evaluation:
10/10 [==============================] - 3s 244ms/step - loss: 11.3485 -
accuracy: 0.2959
[11.348454475402832, 0.29591837525367737]
% of correct brand in the first 3 positions:
98
1.0
% of brand predicted with percentage >= 0.25
0.29591836734693877
% of brand predicted with percentage >= 0.5
0.29591836734693877
% of brand predicted with percentage >= 0.75
0.29591836734693877
Matriz de confusión:
```



## 4.2 Variaciones en las capas

En este apartado se analizan los resultados al utilizar más o menos capas en el modelo para comprender la utilizadad de cada una de ellas.

Para estos experimentos se usan las imágenes con tamaño 280x832, epoch = 10, preprocesado a blanco y negro sin espacios en blanco y con o sin aumentación. En total, dos experimentos por variación. Las variaciones se van a realizar eliminando una o varias capas del modelo presentado como solución para ver si influye en el resultado.

Ls capas utilizadas son las siguientes:

- Conv2D

- MaxPooling2D

- Flatten

- Dense relu
- Dense softmax
- Dropout

[70]:

```python
from tensorflow.keras import models
from tensorflow.keras import optimizers
from tensorflow.keras.layers import Conv2D, MaxPooling2D, UpSampling2D, Dense,␣
 ↪Flatten, Softmax, Rescaling, Dropout
```

```
import tensorflow as tf
import cv2

def createCustomModel(n, withActivation='relu',withMax = True, extraLayers =␣
↪True, withFlatten=True, withDense=True,
                      withDropout = True , dropout_value = 0.5, withSoftmax␣
↪=True):

    print("Activation: "+withActivation+", maxPooling2D: "+str(withMax)+
         ", extraLayers: "+str(extraLayers)+", withFlatten: "+ str(withFlatten)+
         ", withDense: "+str(withDense)+", withDropout: "+str(withDropout)+
         ", Dropout value: "+str(dropout_value)+", withSoftmax:␣
↪"+str(withSoftmax))

    modelC = models.Sequential()
    modelC.add(Conv2D(16, 3, padding='same', activation=withActivation,␣
↪input_shape=(280,832,1)))
    #if withMax == True:
    modelC.add(MaxPooling2D())
    if extraLayers == True:
        modelC.add(Conv2D(32, 3, padding='same', activation=withActivation))
        if withMax == True:
            modelC.add(MaxPooling2D())
        modelC.add(Conv2D(64, 3, padding='same', activation=withActivation))
        if withMax == True:
            modelC.add(MaxPooling2D())

    if withFlatten == True:
        modelC.add(Flatten())
    if withDense==True:
        modelC.add(Dense(128, activation = "relu"))
    if withDropout == True:
        modelC.add(Dropout(dropout_value))
    if withSoftmax == True:
        modelC.add(Dense(n, activation='softmax'))
    if withFlatten==True:
        modelC.add(Flatten())

    return modelC
```

[71]:

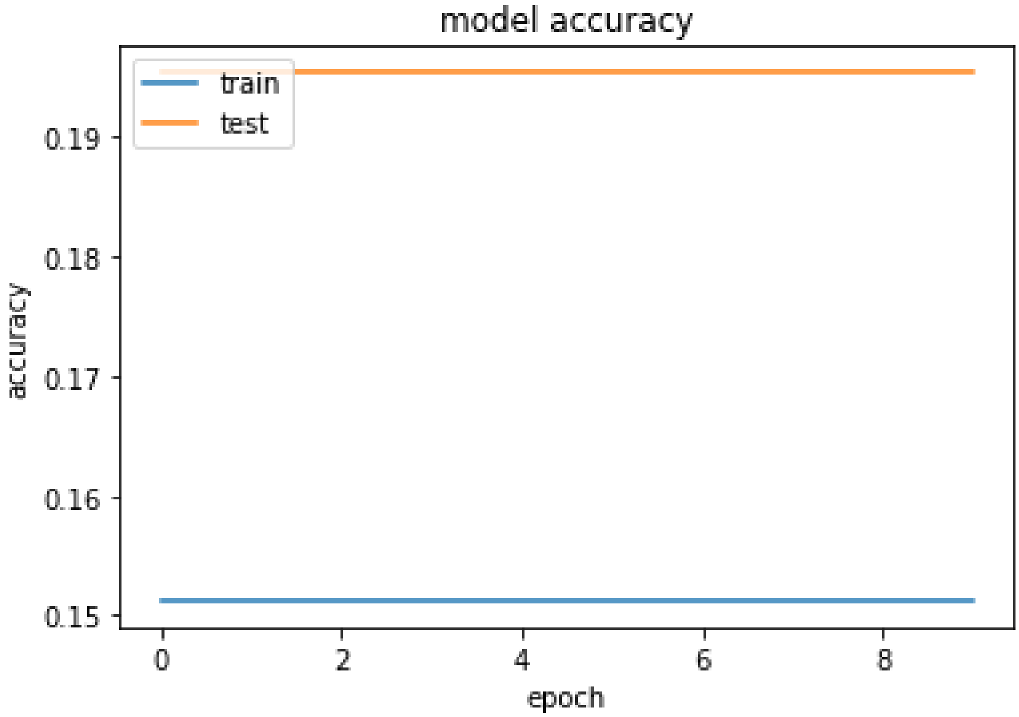
```
def testCustomModel(n, withActivation='relu',withMax = True, extraLayers =␣
↪True, withFlatten=True, withDense=True,
                      withDropout = True , dropout_value = 0.5, withSoftmax␣
↪=True, aumentation = False):
    print("Aumentation: "+str(aumentation))
    start = datetime.now()
    model = createCustomModel(num_classes,withActivation, withMax, extraLayers,␣
↪withFlatten, withDense,
                              withDropout, dropout_value, withSoftmax)
    model.compile(optimizer='adam',
              loss=tf.keras.losses.
↪SparseCategoricalCrossentropy(from_logits=False),
              metrics=['accuracy'])

    trainGenerator=DataGenerator2dFootwear(shoes_train['X'].
↪tolist(),df_shoe_brand, aumentation, "images/", True, True, True)
    testGenerator=DataGenerator2dFootwear(shoes_test['X'].
↪tolist(),df_shoe_brand, False, "images/", True, True, True)
    valGenerator=DataGenerator2dFootwear(shoes_val['X'].tolist(),df_shoe_brand,␣
↪False, "images/", True, True, True)
    model.summary()
    history = model.fit(trainGenerator,validation_data=valGenerator, epochs=10)

    end= datetime.now()
    print("Time used: "+str(end-start))

    plot_history(history)

    checkModel(model, testGenerator, shoes_test, num_classes)
    return history, model
```

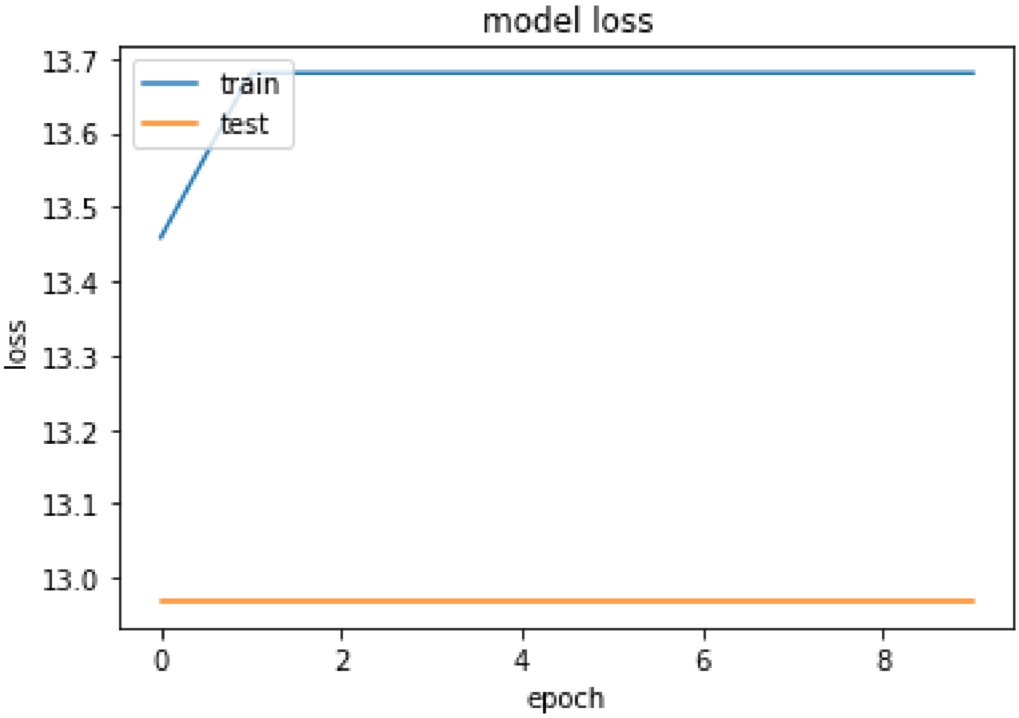
### 4.2.1 Sin Dropout

[76]:

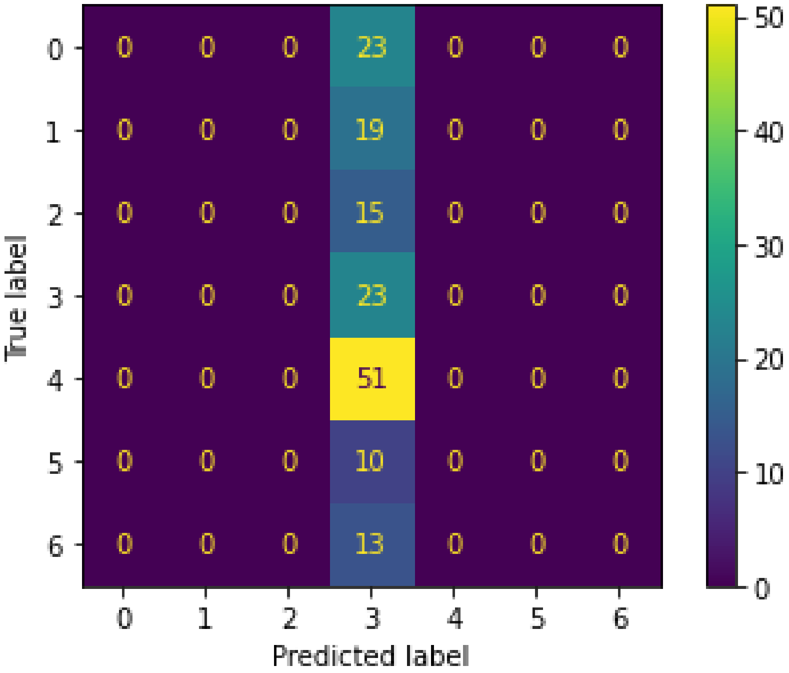
```
model_1 = testCustomModel(num_classes,'relu', True, True, True, True, False)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: False, Dropout value: 0.5, withSoftmax: True
Model: "sequential_17"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_51 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_41 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_52 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_42 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_53 (Conv2D)          (None, 70, 208, 64)       18496
 max_pooling2d_43 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_26 (Flatten)        (None, 232960)            0

 dense_31 (Dense)            (None, 128)               29819008

 dense_32 (Dense)            (None, 7)                 903

 flatten_27 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 69s 1s/step - loss: 13.4589 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 2/10
53/53 [==============================] - 66s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 3/10
53/53 [==============================] - 65s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 4/10
53/53 [==============================] - 65s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 5/10
53/53 [==============================] - 63s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 6/10
53/53 [==============================] - 61s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 7/10
53/53 [==============================] - 57s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 8/10
53/53 [==============================] - 62s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 9/10
53/53 [==============================] - 70s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Epoch 10/10
53/53 [==============================] - 75s 1s/step - loss: 13.6806 - accuracy:
0.1512 - val_loss: 12.9686 - val_accuracy: 0.1954
Time used: 0:10:53.507221
```


model accuracy
train
test
0.19
0.18
0.17
0.16
0.15
accuracy
0
2
4
6
8
epoch


model loss
train
test
13.7
13.6
13.5
13.4
13.3
13.2
13.1
13.0
loss
0
2
4
6
8
epoch

```
16/16 [==============================] - 6s 360ms/step
Test evaluation:
16/16 [==============================] - 7s 416ms/step - loss: 13.7108 -
accuracy: 0.1494
[13.710846900939941, 0.14935064315795898]
% of correct brand in the first 3 positions:
59
0.38311688311688313
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```



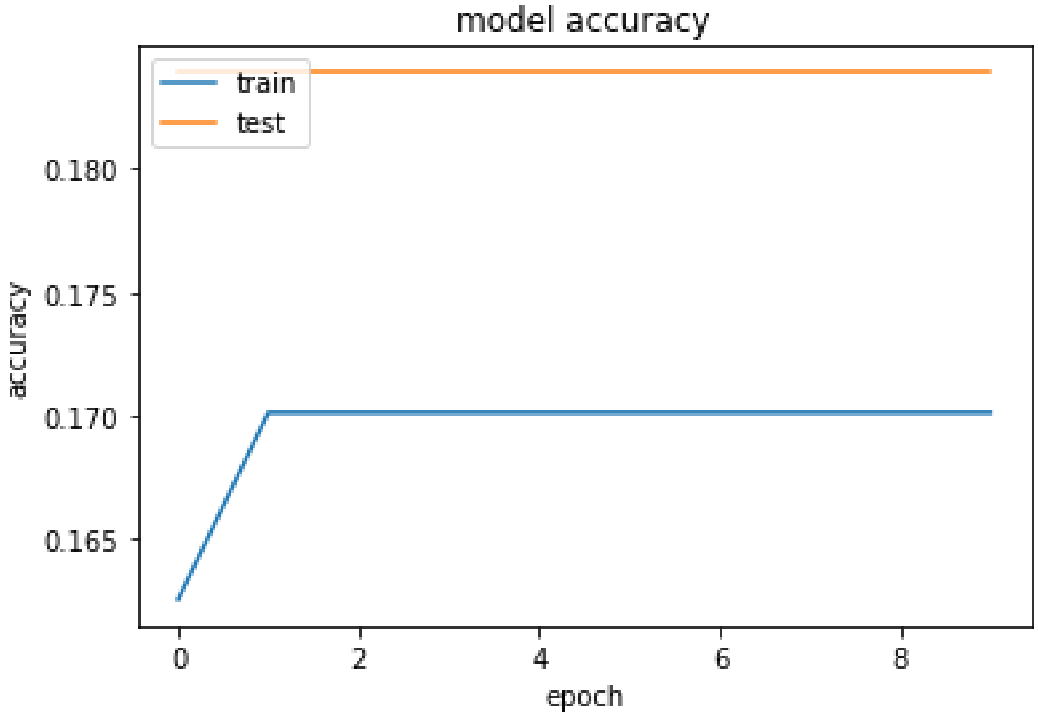
[72]:

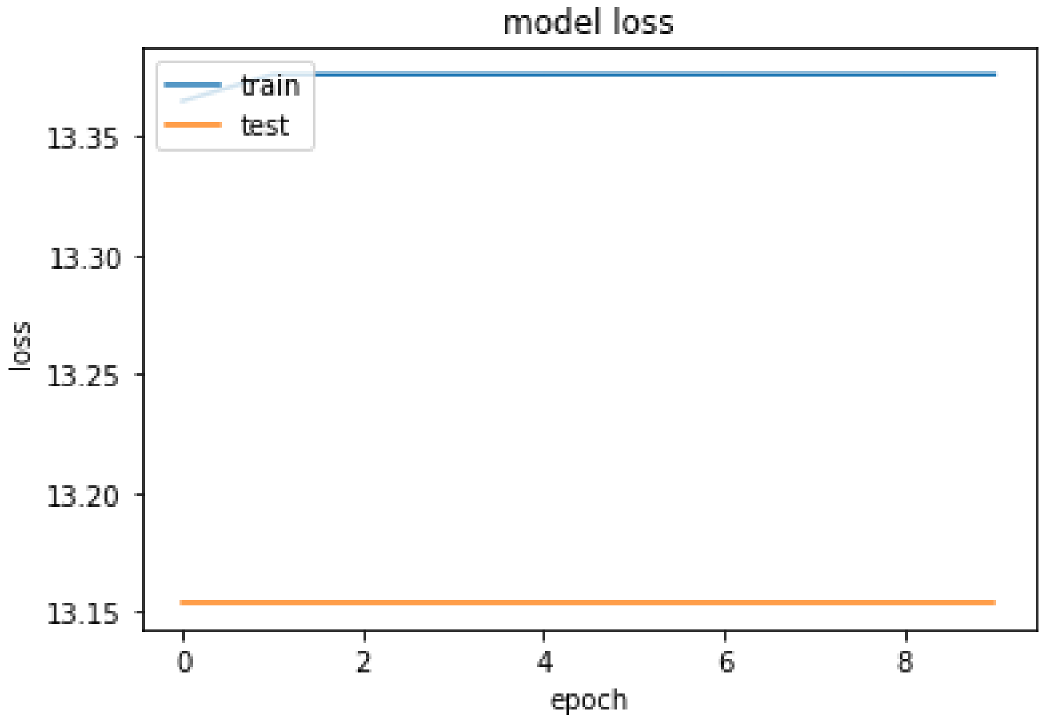
```
model_1a = testCustomModel(num_classes,'relu', True, True, True, True, False, 0.
↪5 , True, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: False, Dropout value: 0.5, withSoftmax: True
Model: "sequential_21"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

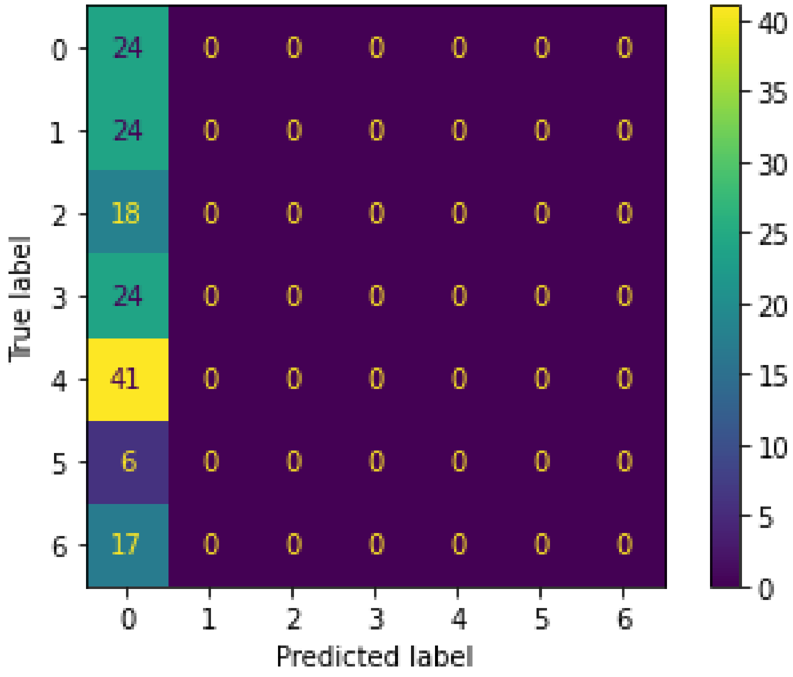
```
=================================================================
 conv2d_63 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_63 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_64 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_64 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_65 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_65 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_42 (Flatten)        (None, 232960)            0

 dense_42 (Dense)            (None, 128)               29819008

 dense_43 (Dense)            (None, 7)                 903

 flatten_43 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 60s 1s/step - loss: 13.3648 - accuracy:
0.1626 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 2/10
53/53 [==============================] - 59s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 3/10
53/53 [==============================] - 59s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 4/10
53/53 [==============================] - 59s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 5/10
53/53 [==============================] - 59s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 6/10
53/53 [==============================] - 59s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 7/10
```

```
53/53 [==============================] - 58s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 8/10
53/53 [==============================] - 58s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 9/10
53/53 [==============================] - 58s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 10/10
53/53 [==============================] - 58s 1s/step - loss: 13.3759 - accuracy:
0.1701 - val_loss: 13.1538 - val_accuracy: 0.1839
Time used: 0:09:46.563419
```





```
16/16 [==============================] - 4s 239ms/step
Test evaluation:
16/16 [==============================] - 4s 246ms/step - loss: 13.6062 -
accuracy: 0.1558
[13.606184959411621, 0.15584415197372437]
% of correct brand in the first 3 positions:
66
0.42857142857142855
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```

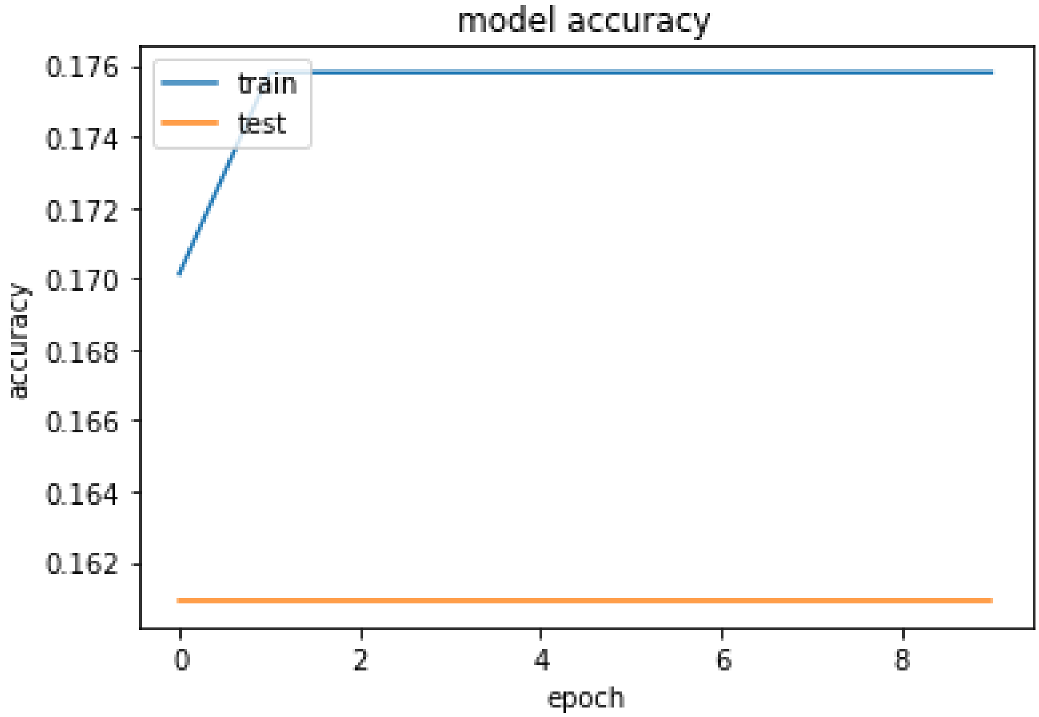


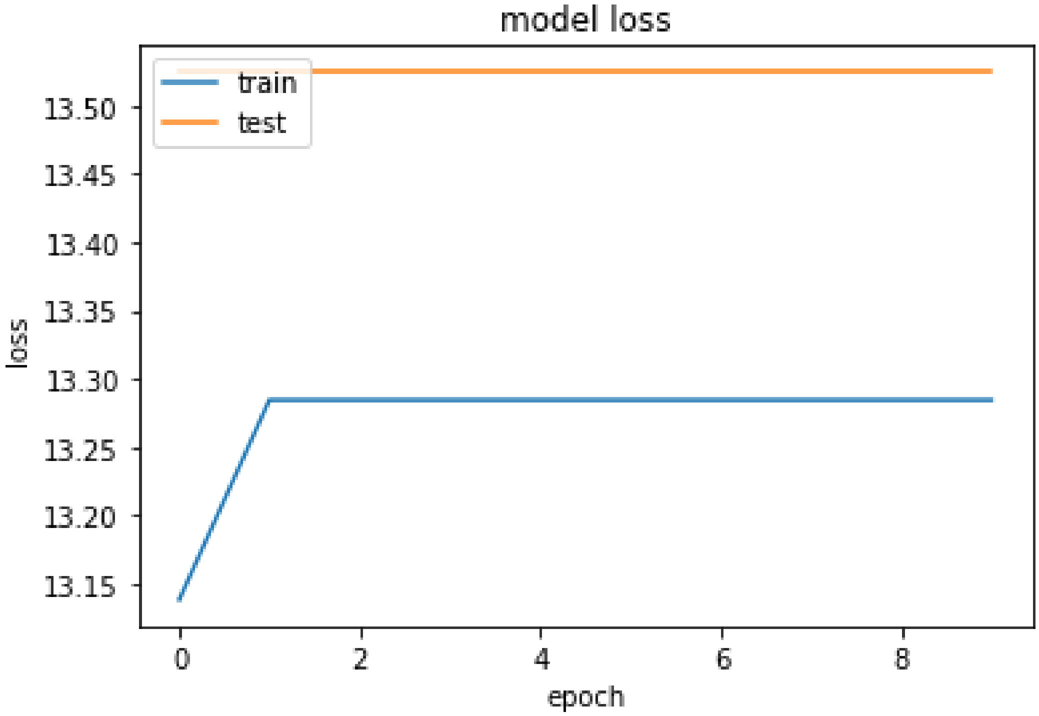
### 4.2.2 Dropout del 0.1

[78]:

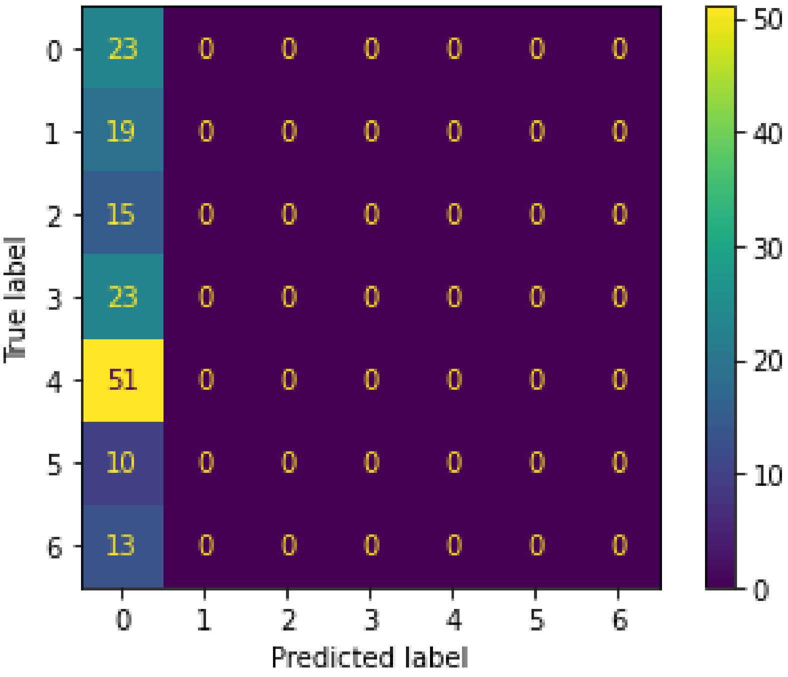
```
model_2 = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.1)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.1, withSoftmax: True
Model: "sequential_19"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_57 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_47 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_58 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_48 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_59 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_49 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_30 (Flatten)        (None, 232960)            0

 dense_35 (Dense)            (None, 128)               29819008

 dropout_12 (Dropout)        (None, 128)               0

 dense_36 (Dense)            (None, 7)                 903

 flatten_31 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 75s 1s/step - loss: 13.1383 - accuracy:
0.1701 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 2/10
53/53 [==============================] - 67s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 3/10
53/53 [==============================] - 74s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 4/10
53/53 [==============================] - 73s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 5/10
53/53 [==============================] - 68s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 6/10
53/53 [==============================] - 68s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 7/10
53/53 [==============================] - 67s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 8/10
53/53 [==============================] - 69s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 9/10
53/53 [==============================] - 63s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 10/10
53/53 [==============================] - 64s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Time used: 0:11:29.758197
```


model accuracy
accuracy
0.176
0.174
0.172
0.170
0.168
0.166
0.164
0.162
train
test
0
2
4
6
8
epoch


model loss
loss
13.50
13.45
13.40
13.35
13.30
13.25
13.20
13.15
train
test
0
2
4
6
8
epoch

```
16/16 [==============================] - 5s 296ms/step
Test evaluation:
16/16 [==============================] - 5s 283ms/step - loss: 13.7108 -
accuracy: 0.1494
[13.710848808288574, 0.14935064315795898]
% of correct brand in the first 3 positions:
57
0.37012987012987014
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```

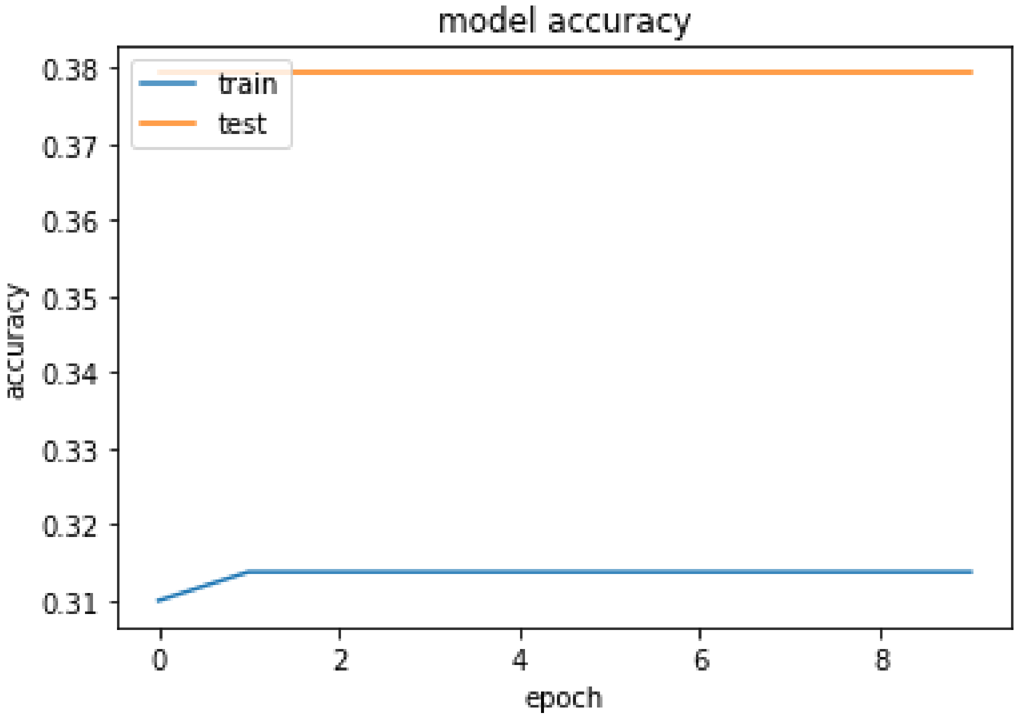


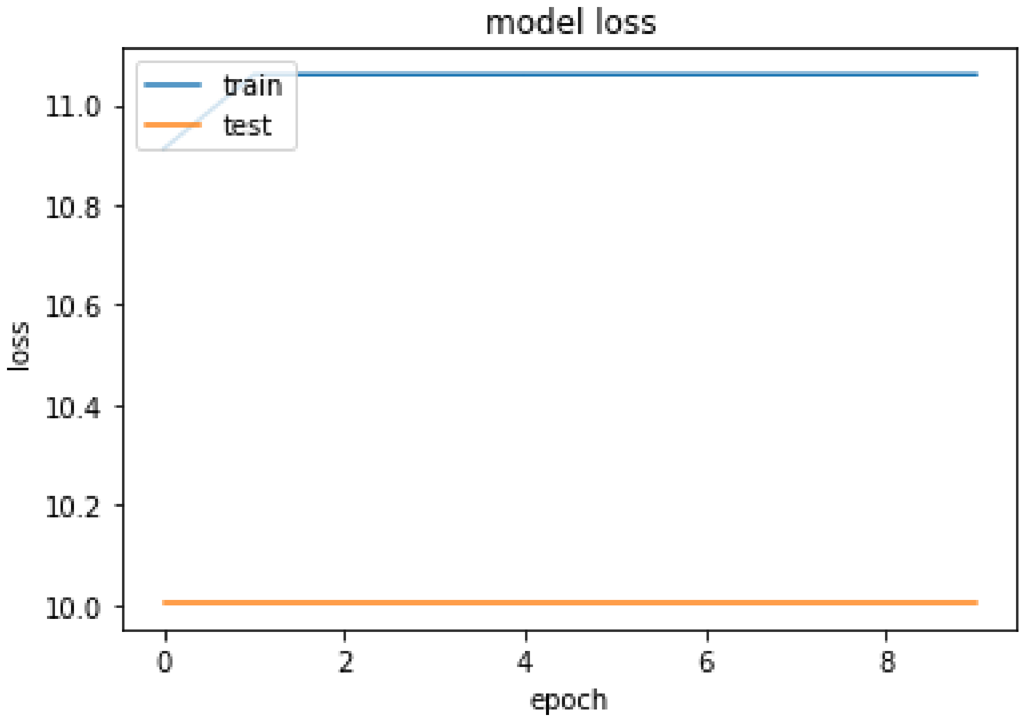
```
[73]: model_2a = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.
      ↪1 , True, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.1, withSoftmax: True
Model: "sequential_22"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

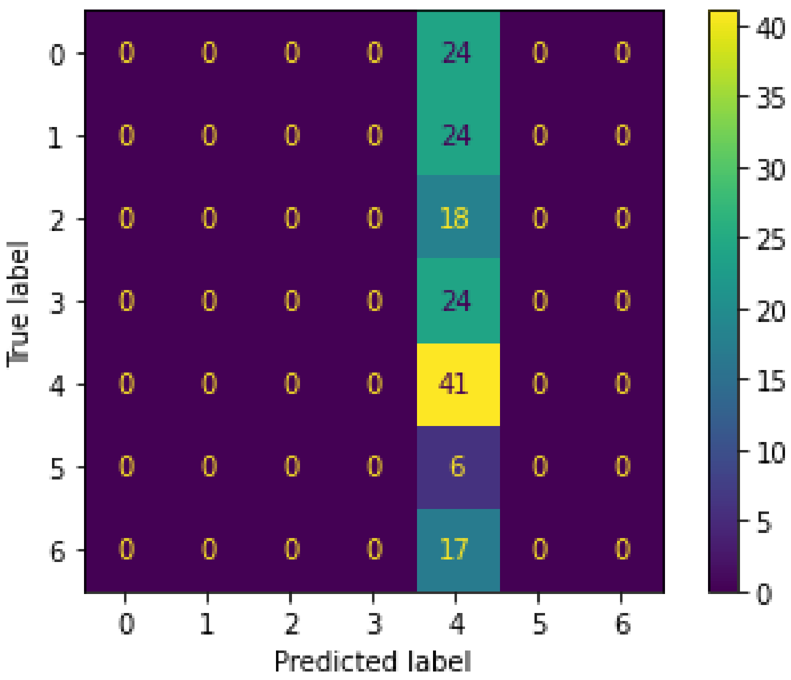
```
=================================================================
 conv2d_66 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_66 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_67 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_67 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_68 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_68 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_44 (Flatten)        (None, 232960)            0

 dense_44 (Dense)            (None, 128)               29819008

 dropout_21 (Dropout)        (None, 128)               0

 dense_45 (Dense)            (None, 7)                 903

 flatten_45 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 60s 1s/step - loss: 10.9119 - accuracy:
0.3100 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 2/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 58s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 6/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
```

```
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 7/10
53/53 [==============================] - 58s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 8/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 9/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 10/10
53/53 [==============================] - 59s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Time used: 0:09:50.678957
```





```
16/16 [==============================] - 4s 241ms/step
Test evaluation:
16/16 [==============================] - 4s 246ms/step - loss: 11.8269 -
accuracy: 0.2662
[11.826915740966797, 0.26623377203941345]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.2662337662337662
Matriz de confusión:
```

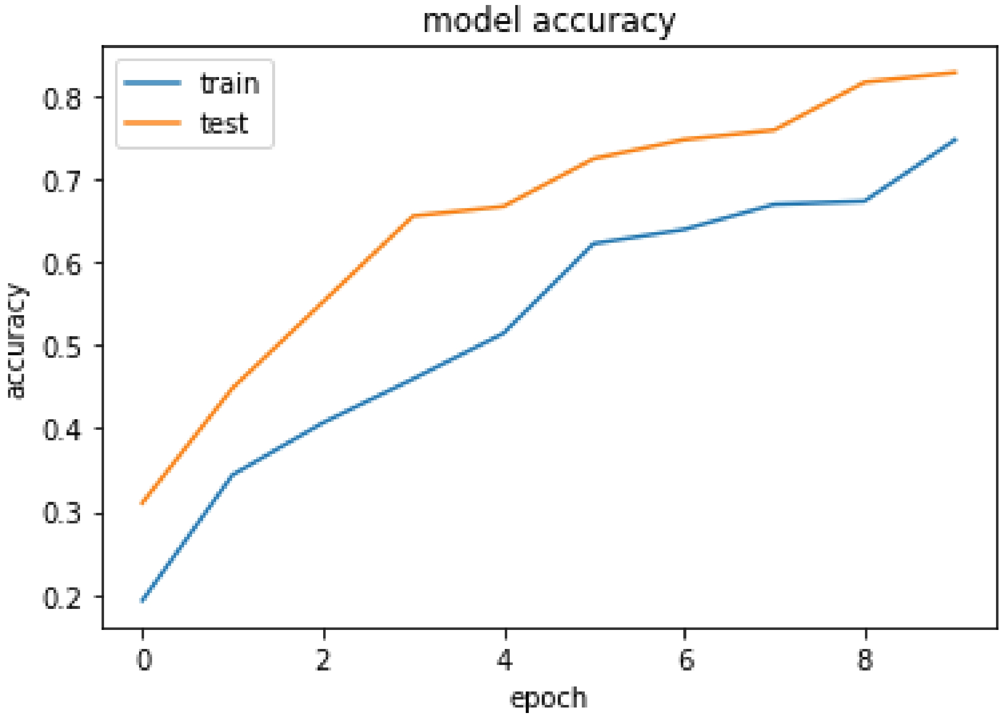


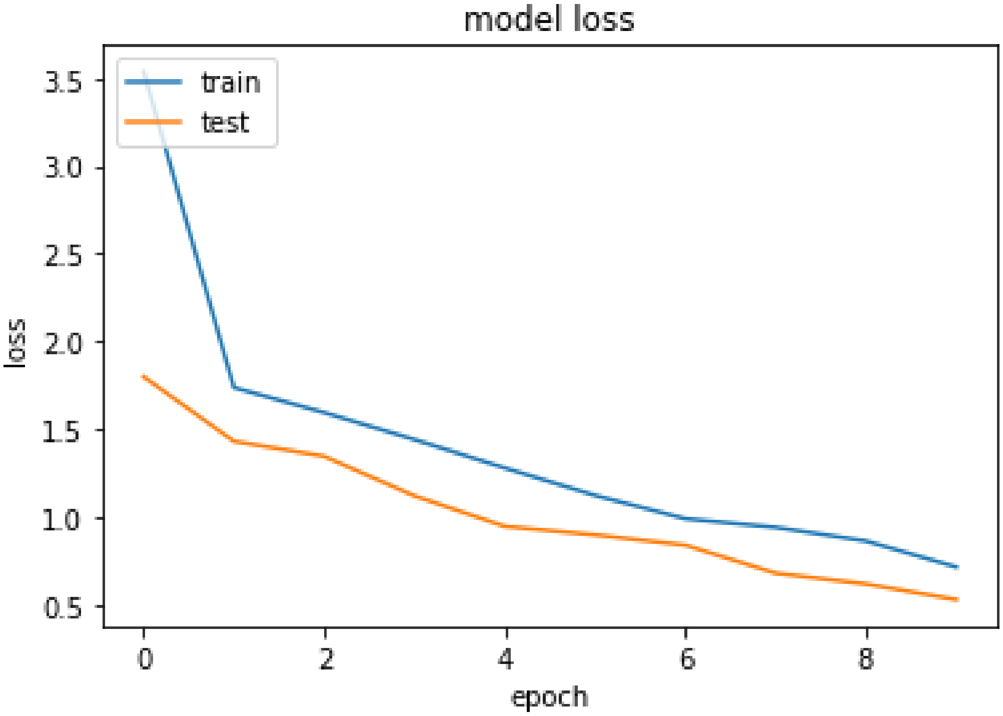
### 4.2.3 Dropout del 0.8

[80]:

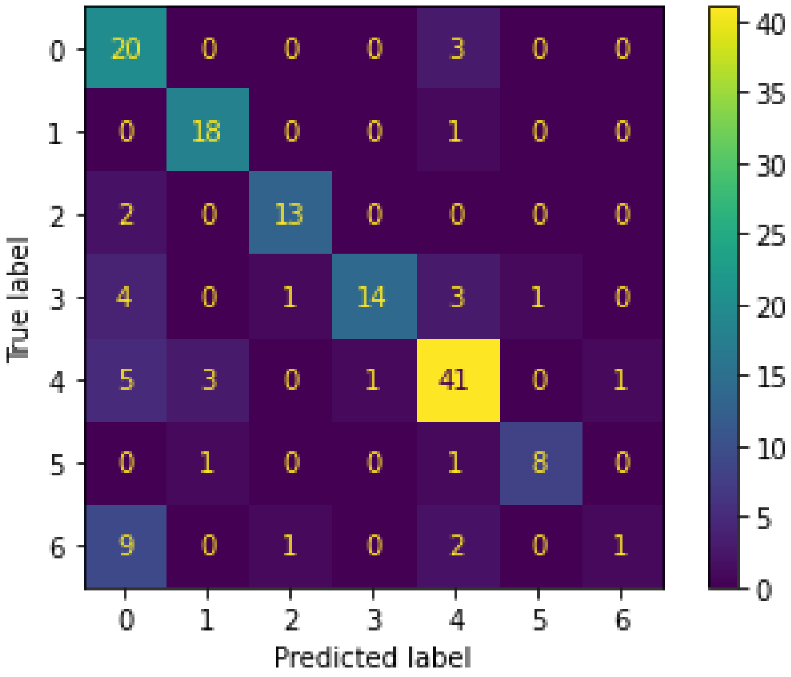
```
model_3 = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.8)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.8, withSoftmax: True
Model: "sequential_21"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_63 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_53 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_64 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_54 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_65 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_55 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_34 (Flatten)        (None, 232960)            0

 dense_39 (Dense)            (None, 128)               29819008

 dropout_14 (Dropout)        (None, 128)               0

 dense_40 (Dense)            (None, 7)                 903

 flatten_35 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 62s 1s/step - loss: 3.5372 - accuracy:
0.1928 - val_loss: 1.7982 - val_accuracy: 0.3103
Epoch 2/10
53/53 [==============================] - 58s 1s/step - loss: 1.7366 - accuracy:
0.3440 - val_loss: 1.4303 - val_accuracy: 0.4483
Epoch 3/10
53/53 [==============================] - 57s 1s/step - loss: 1.5942 - accuracy:
0.4064 - val_loss: 1.3458 - val_accuracy: 0.5517
Epoch 4/10
53/53 [==============================] - 58s 1s/step - loss: 1.4401 - accuracy:
0.4594 - val_loss: 1.1199 - val_accuracy: 0.6552
Epoch 5/10
53/53 [==============================] - 58s 1s/step - loss: 1.2792 - accuracy:
0.5142 - val_loss: 0.9462 - val_accuracy: 0.6667
Epoch 6/10
53/53 [==============================] - 58s 1s/step - loss: 1.1228 - accuracy:
0.6219 - val_loss: 0.8975 - val_accuracy: 0.7241
Epoch 7/10
53/53 [==============================] - 59s 1s/step - loss: 0.9897 - accuracy:
0.6389 - val_loss: 0.8390 - val_accuracy: 0.7471
Epoch 8/10
53/53 [==============================] - 60s 1s/step - loss: 0.9405 - accuracy:
0.6692 - val_loss: 0.6791 - val_accuracy: 0.7586
Epoch 9/10
53/53 [==============================] - 62s 1s/step - loss: 0.8627 - accuracy:
0.6730 - val_loss: 0.6177 - val_accuracy: 0.8161
Epoch 10/10
53/53 [==============================] - 63s 1s/step - loss: 0.7145 - accuracy:
0.7467 - val_loss: 0.5288 - val_accuracy: 0.8276
Time used: 0:09:53.758722
```


model accuracy
train
test
0.8
0.7
0.6
0.5
0.4
0.3
0.2
accuracy
0
2
4
6
8
epoch


model loss
train
test
3.5
3.0
2.5
2.0
1.5
1.0
0.5
loss
0
2
4
6
8
epoch

```
16/16 [==============================] - 4s 250ms/step
Test evaluation:
16/16 [==============================] - 4s 259ms/step - loss: 0.6280 -
accuracy: 0.7468
[0.628024697303772, 0.7467532753944397]
% of correct brand in the first 3 positions:
149
0.9675324675324676
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```

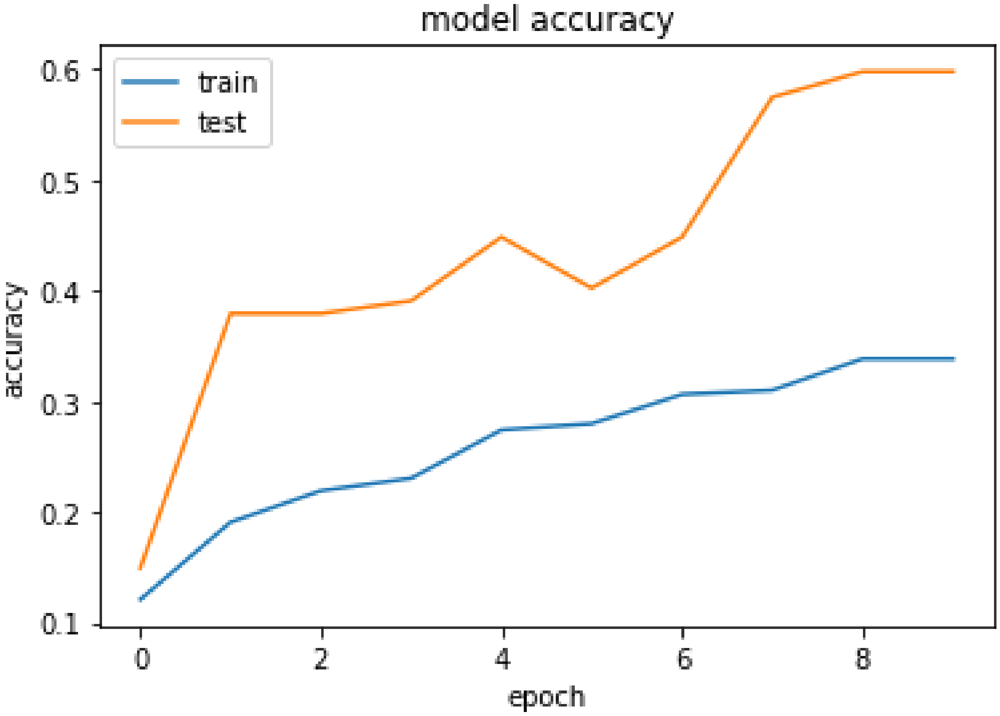


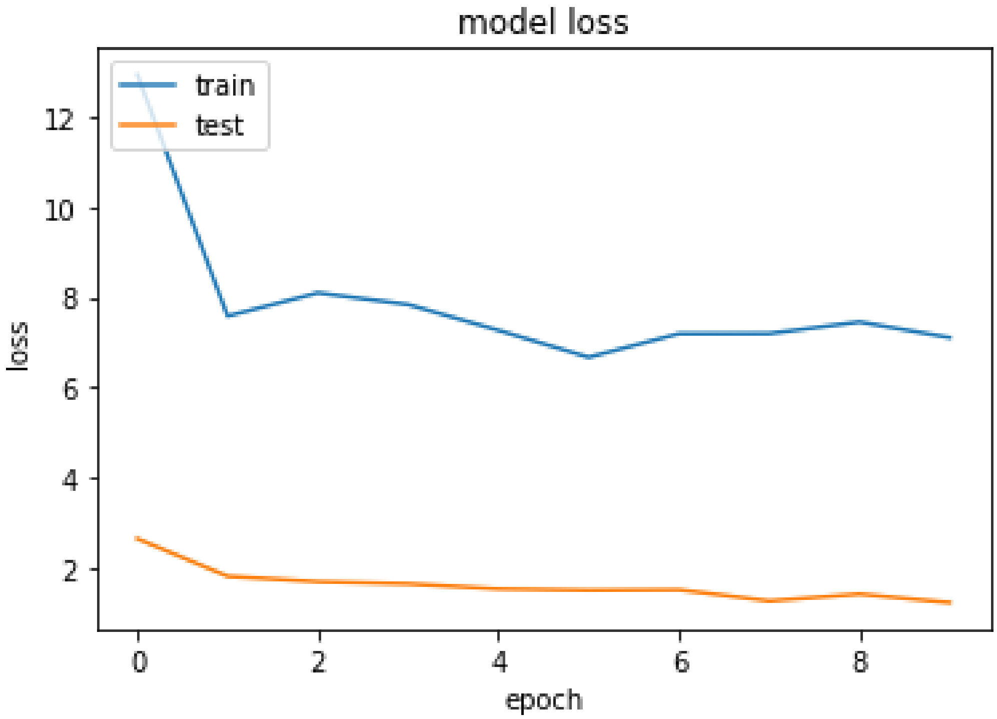
```
[74]: model_3a = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.1 , True, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.1, withSoftmax: True
Model: "sequential_23"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

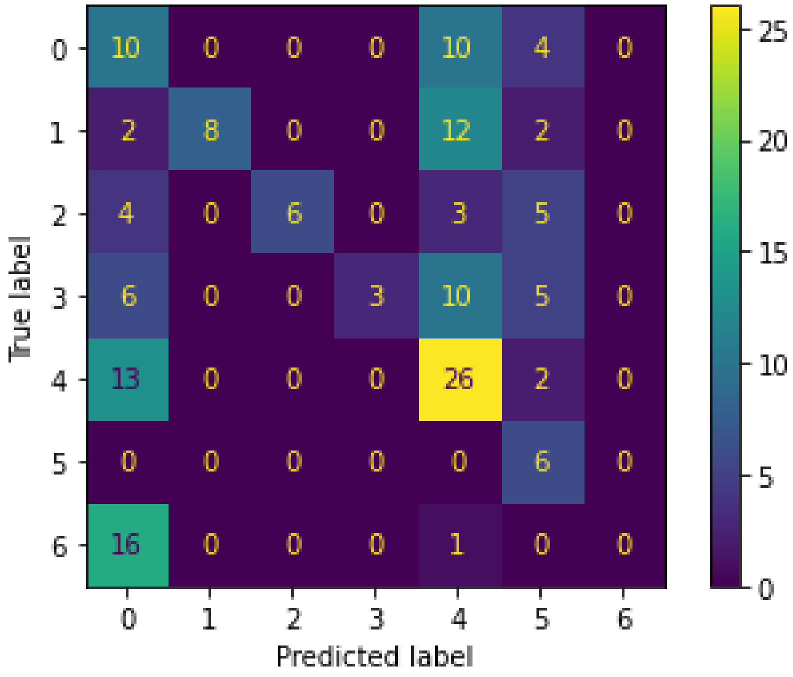
```
=================================================================
 conv2d_69 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_69 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_70 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_70 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_71 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_71 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_46 (Flatten)        (None, 232960)            0

 dense_46 (Dense)            (None, 128)               29819008

 dropout_22 (Dropout)        (None, 128)               0

 dense_47 (Dense)            (None, 7)                 903

 flatten_47 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 60s 1s/step - loss: 12.9229 - accuracy:
0.1210 - val_loss: 2.6626 - val_accuracy: 0.1494
Epoch 2/10
53/53 [==============================] - 59s 1s/step - loss: 7.5854 - accuracy:
0.1909 - val_loss: 1.8305 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 58s 1s/step - loss: 8.0977 - accuracy:
0.2193 - val_loss: 1.7104 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 58s 1s/step - loss: 7.8395 - accuracy:
0.2306 - val_loss: 1.6639 - val_accuracy: 0.3908
Epoch 5/10
53/53 [==============================] - 58s 1s/step - loss: 7.2691 - accuracy:
0.2741 - val_loss: 1.5506 - val_accuracy: 0.4483
Epoch 6/10
53/53 [==============================] - 58s 1s/step - loss: 6.6728 - accuracy:
```

```
0.2798 - val_loss: 1.5229 - val_accuracy: 0.4023
Epoch 7/10
53/53 [==============================] - 58s 1s/step - loss: 7.1935 - accuracy:
0.3062 - val_loss: 1.5315 - val_accuracy: 0.4483
Epoch 8/10
53/53 [==============================] - 58s 1s/step - loss: 7.1967 - accuracy:
0.3100 - val_loss: 1.2854 - val_accuracy: 0.5747
Epoch 9/10
53/53 [==============================] - 58s 1s/step - loss: 7.4542 - accuracy:
0.3384 - val_loss: 1.4353 - val_accuracy: 0.5977
Epoch 10/10
53/53 [==============================] - 60s 1s/step - loss: 7.1078 - accuracy:
0.3384 - val_loss: 1.2485 - val_accuracy: 0.5977
Time used: 0:09:47.152657
```





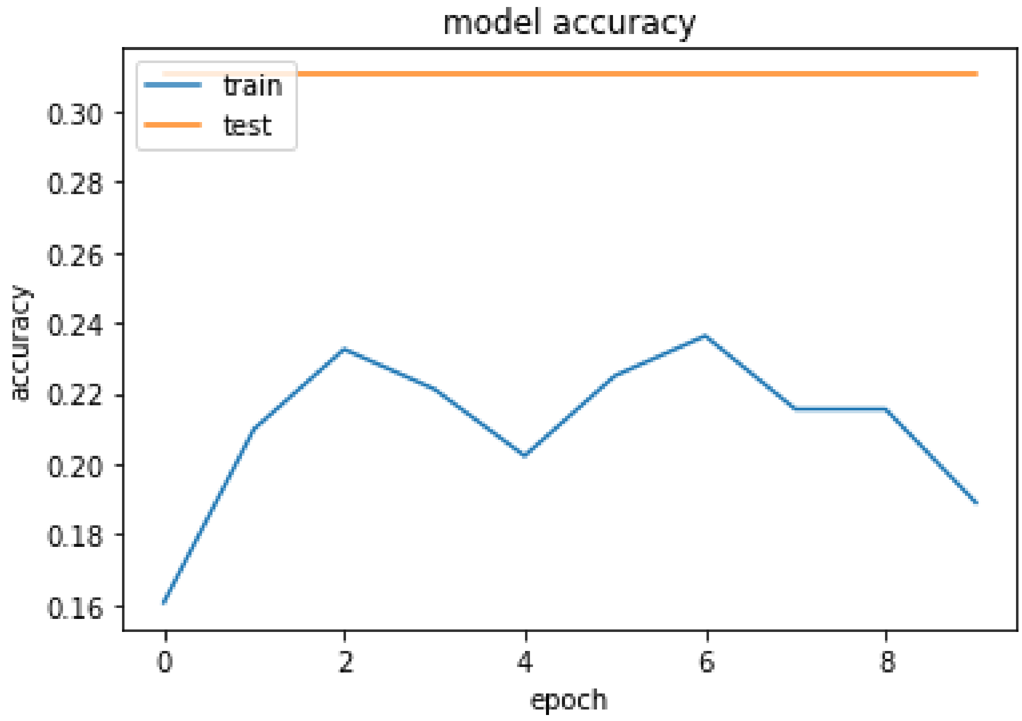
```
16/16 [==============================] - 4s 258ms/step
Test evaluation:
16/16 [==============================] - 4s 268ms/step - loss: 1.6604 -
accuracy: 0.3831
[1.6603707075119019, 0.38311687111854553]
% of correct brand in the first 3 positions:
121
0.7857142857142857
% of brand predicted with percentage >= 0.25
0.3116883116883117
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```

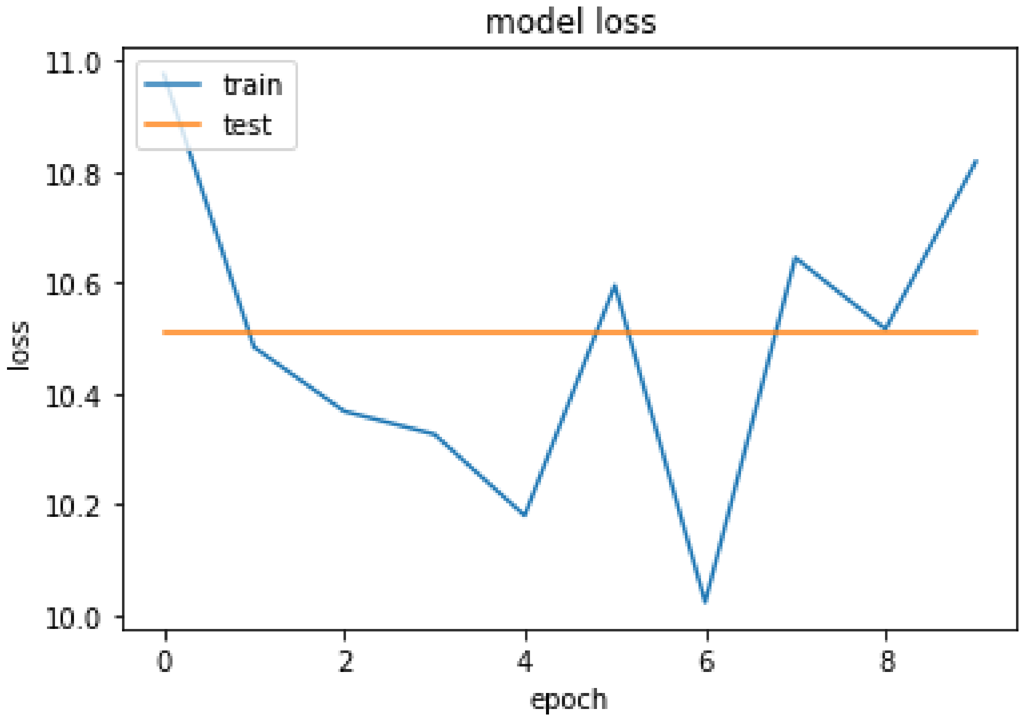


### 4.2.4 Sin Softmax

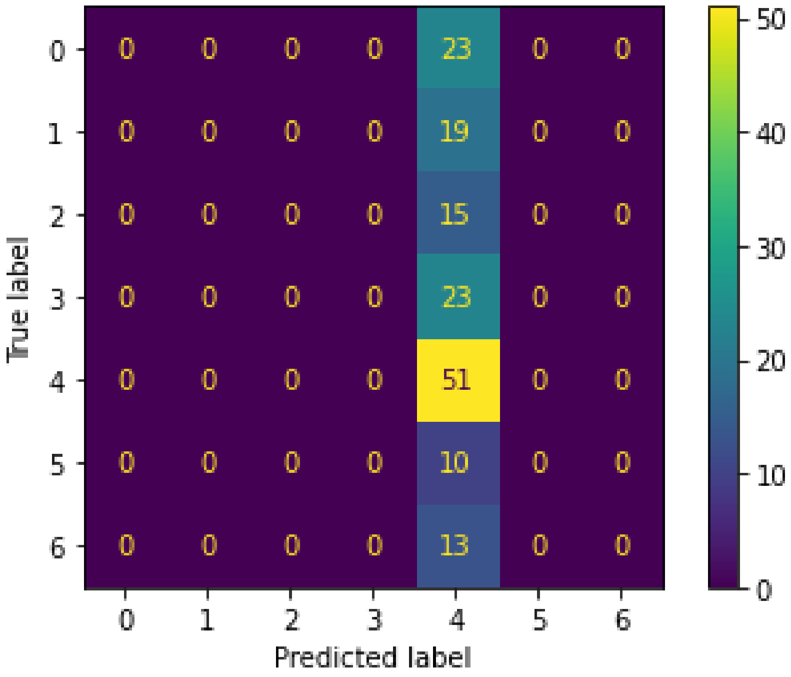
[86]:
```
model_4 = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.
↪5, False)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: False
Model: "sequential_26"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_74 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_64 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_75 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_65 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_76 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_66 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_44 (Flatten)        (None, 232960)            0

 dense_48 (Dense)            (None, 128)               29819008

 dropout_19 (Dropout)        (None, 128)               0

 flatten_45 (Flatten)        (None, 128)               0

=================================================================
Total params: 29,842,304
Trainable params: 29,842,304
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 58s 1s/step - loss: 10.9753 - accuracy:
0.1607 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 2/10
53/53 [==============================] - 52s 985ms/step - loss: 10.4838 -
accuracy: 0.2098 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 3/10
53/53 [==============================] - 54s 1s/step - loss: 10.3681 - accuracy:
0.2325 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 4/10
53/53 [==============================] - 54s 1s/step - loss: 10.3265 - accuracy:
0.2212 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 5/10
53/53 [==============================] - 54s 1s/step - loss: 10.1803 - accuracy:
0.2023 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 6/10
53/53 [==============================] - 54s 1s/step - loss: 10.5952 - accuracy:
0.2250 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 7/10
53/53 [==============================] - 56s 1s/step - loss: 10.0244 - accuracy:
0.2363 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 8/10
53/53 [==============================] - 55s 1s/step - loss: 10.6446 - accuracy:
0.2155 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 9/10
53/53 [==============================] - 55s 1s/step - loss: 10.5162 - accuracy:
0.2155 - val_loss: 10.5122 - val_accuracy: 0.3103
Epoch 10/10
53/53 [==============================] - 55s 1s/step - loss: 10.8179 - accuracy:
0.1890 - val_loss: 10.5122 - val_accuracy: 0.3103
Time used: 0:09:06.140455
```


model accuracy
train
test
accuracy
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0
2
4
6
8
epoch


model loss
train
test
loss
11.0
10.8
10.6
10.4
10.2
10.0
0
2
4
6
8
epoch

```
16/16 [==============================] - 3s 204ms/step
Test evaluation:
16/16 [==============================] - 3s 209ms/step - loss: 10.1128 -
accuracy: 0.3312
[10.11281967163086, 0.3311688303947449]
% of correct brand in the first 3 positions:
87
0.564935064935065
% of brand predicted with percentage >= 0.25
0.4155844155844156
% of brand predicted with percentage >= 0.5
0.4155844155844156
% of brand predicted with percentage >= 0.75
0.4155844155844156
Matriz de confusión:
```



|   | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 15 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 23 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 51 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 13 | 0 | 0 |

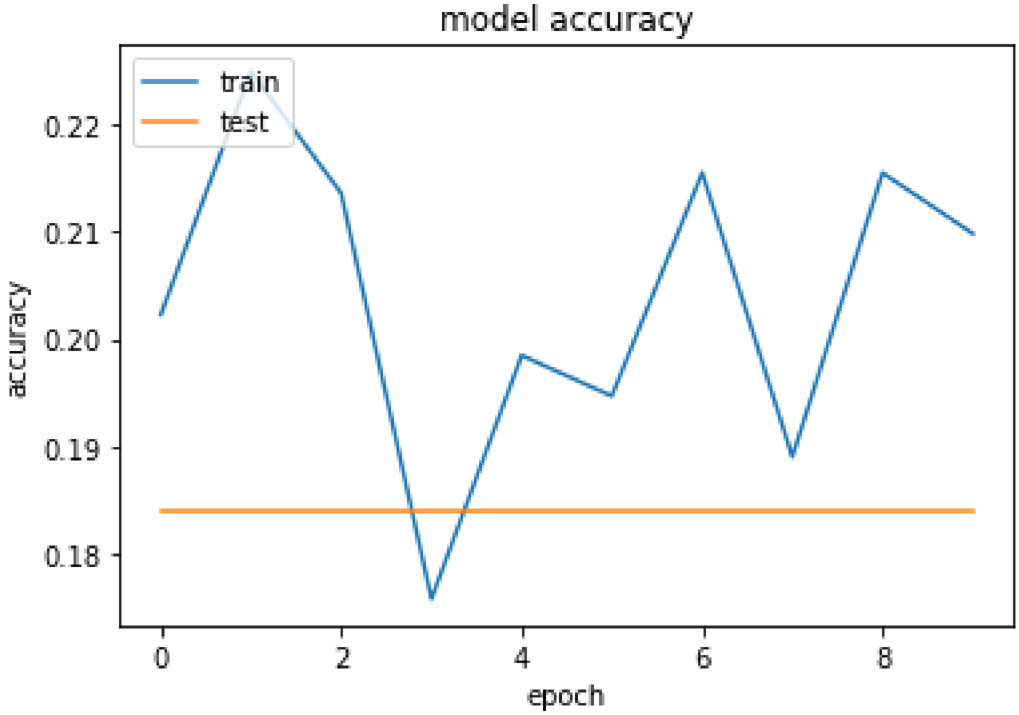
[75]:

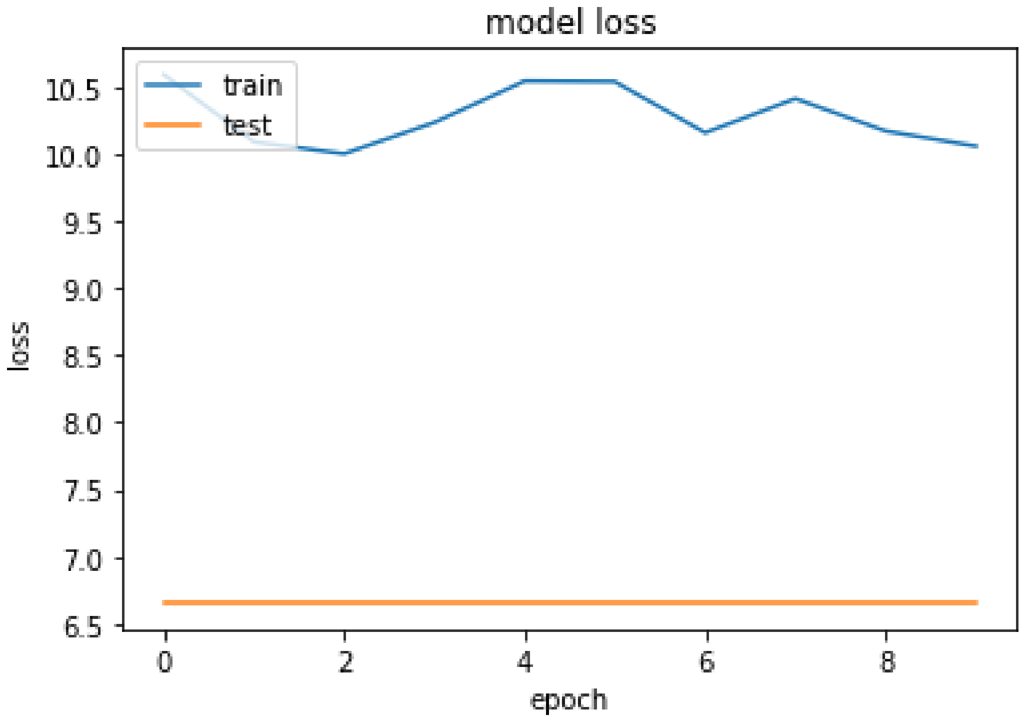
```
model_4a = testCustomModel(num_classes,'relu', True, True, True, True, True, 0.
 ↪5, False, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: False
Model: "sequential_24"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

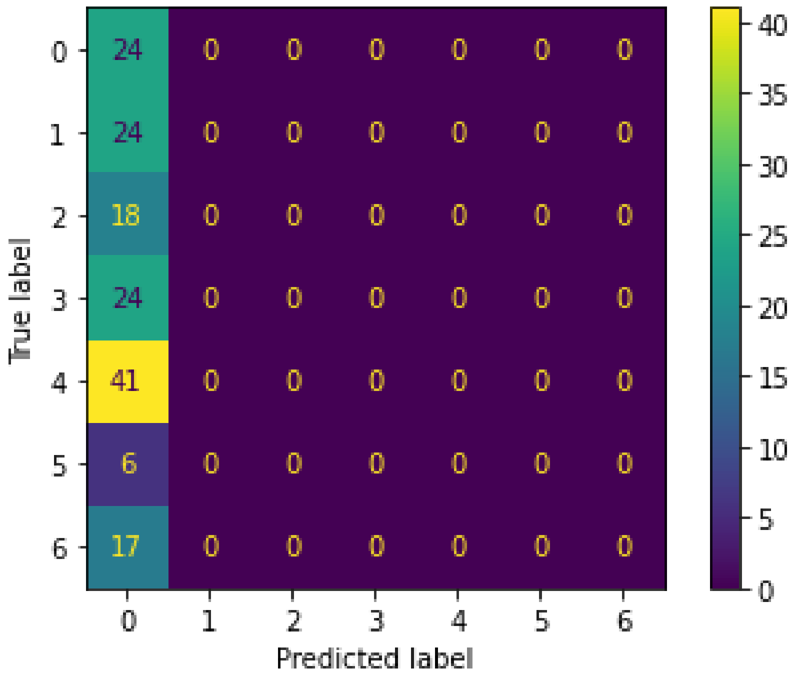
```
=================================================================
 conv2d_72 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_72 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_73 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_73 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_74 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_74 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_48 (Flatten)        (None, 232960)            0

 dense_48 (Dense)            (None, 128)               29819008

 dropout_23 (Dropout)        (None, 128)               0

 flatten_49 (Flatten)        (None, 128)               0

=================================================================
Total params: 29,842,304
Trainable params: 29,842,304
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 64s 1s/step - loss: 10.5925 - accuracy:
0.2023 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 2/10
53/53 [==============================] - 54s 1s/step - loss: 10.0916 - accuracy:
0.2250 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 3/10
53/53 [==============================] - 54s 1s/step - loss: 10.0028 - accuracy:
0.2136 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 4/10
53/53 [==============================] - 54s 1s/step - loss: 10.2367 - accuracy:
0.1758 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 5/10
53/53 [==============================] - 54s 1s/step - loss: 10.5447 - accuracy:
0.1985 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 6/10
53/53 [==============================] - 54s 1s/step - loss: 10.5403 - accuracy:
0.1947 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 7/10
```

```
53/53 [==============================] - 54s 1s/step - loss: 10.1599 - accuracy:
0.2155 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 8/10
53/53 [==============================] - 54s 1s/step - loss: 10.4139 - accuracy:
0.1890 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 9/10
53/53 [==============================] - 54s 1s/step - loss: 10.1726 - accuracy:
0.2155 - val_loss: 6.6566 - val_accuracy: 0.1839
Epoch 10/10
53/53 [==============================] - 55s 1s/step - loss: 10.0594 - accuracy:
0.2098 - val_loss: 6.6566 - val_accuracy: 0.1839
Time used: 0:09:12.566183
```





```
16/16 [==============================] - 4s 207ms/step
Test evaluation:
16/16 [==============================] - 3s 205ms/step - loss: 9.7857 -
accuracy: 0.1558
[9.785683631896973, 0.15584415197372437]
% of correct brand in the first 3 positions:
71
0.461038961038961
% of brand predicted with percentage >= 0.25
0.461038961038961
% of brand predicted with percentage >= 0.5
0.461038961038961
% of brand predicted with percentage >= 0.75
0.461038961038961
Matriz de confusión:
```



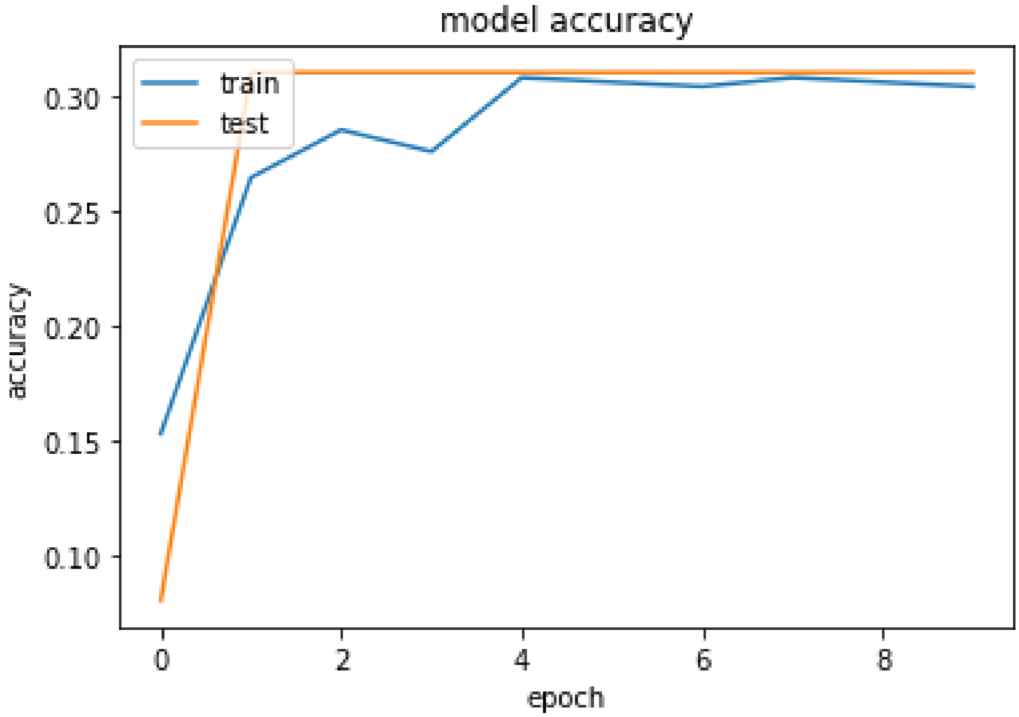
### 4.2.5 Sin extra Layers

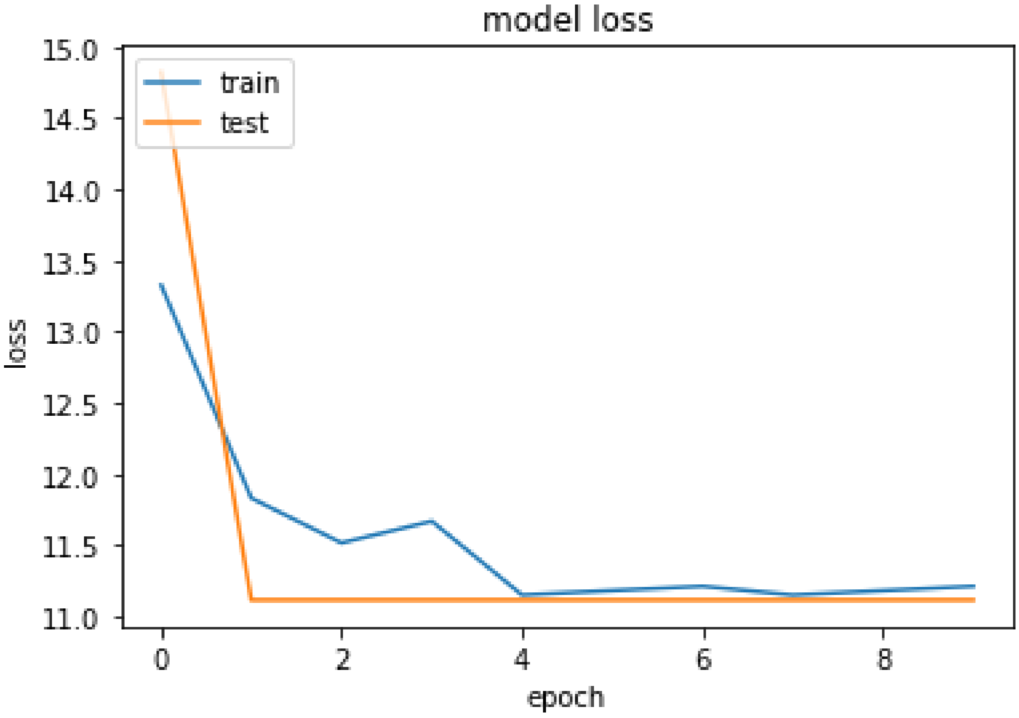
[83]:

```
model_5 = testCustomModel(num_classes,'relu', True, False)
```

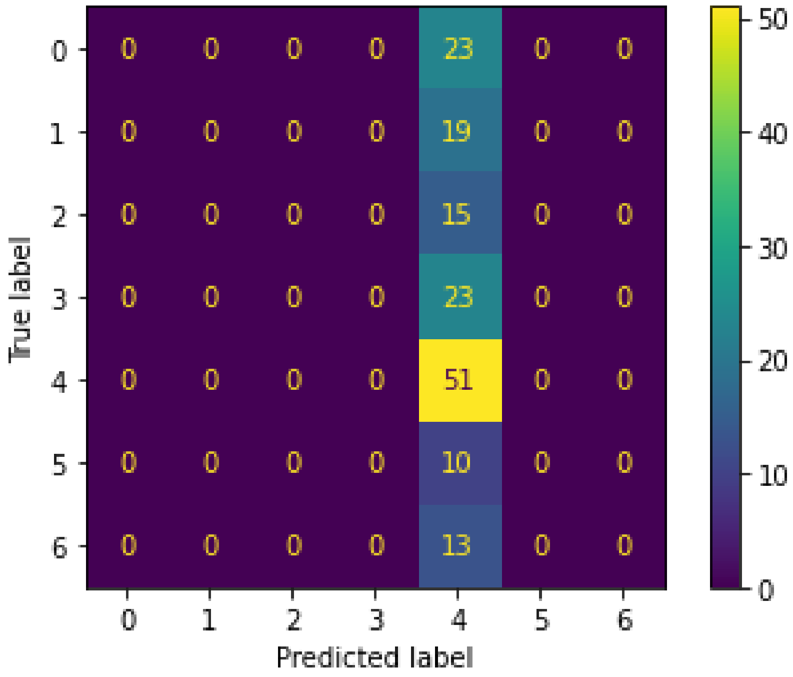
```
Activation: relu, maxPooling2D: True, extraLayers: False, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_24"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_72 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_62 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 flatten_40 (Flatten)        (None, 931840)            0

 dense_44 (Dense)            (None, 128)               119275648

 dropout_17 (Dropout)        (None, 128)               0

 dense_45 (Dense)            (None, 7)                 903

 flatten_41 (Flatten)        (None, 7)                 0
```

```
=================================================================
Total params: 119,276,711
Trainable params: 119,276,711
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 77s 1s/step - loss: 13.3273 - accuracy:
0.1531 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 2/10
53/53 [==============================] - 72s 1s/step - loss: 11.8322 - accuracy:
0.2647 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 3/10
53/53 [==============================] - 71s 1s/step - loss: 11.5173 - accuracy:
0.2854 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 4/10
53/53 [==============================] - 71s 1s/step - loss: 11.6696 - accuracy:
0.2760 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 5/10
53/53 [==============================] - 71s 1s/step - loss: 11.1517 - accuracy:
0.3081 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 6/10
53/53 [==============================] - 72s 1s/step - loss: 11.1826 - accuracy:
0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 7/10
53/53 [==============================] - 72s 1s/step - loss: 11.2126 - accuracy:
0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 8/10
53/53 [==============================] - 71s 1s/step - loss: 11.1517 - accuracy:
0.3081 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 9/10
53/53 [==============================] - 72s 1s/step - loss: 11.1821 - accuracy:
0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 10/10
53/53 [==============================] - 73s 1s/step - loss: 11.2126 - accuracy:
0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Time used: 0:12:01.413035
```


model accuracy
train
test
accuracy
0.30
0.25
0.20
0.15
0.10
0
2
4
6
8
epoch


model loss
train
test
loss
15.0
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
0
2
4
6
8
epoch

```
16/16 [==============================] - 4s 215ms/step
Test evaluation:
16/16 [==============================] - 4s 211ms/step - loss: 10.7803 -
accuracy: 0.3312
[10.780284881591797, 0.3311688303947449]
% of correct brand in the first 3 positions:
93
0.6038961038961039
% of brand predicted with percentage >= 0.25
0.33116883116883117
% of brand predicted with percentage >= 0.5
0.33116883116883117
% of brand predicted with percentage >= 0.75
0.33116883116883117
Matriz de confusión:
```

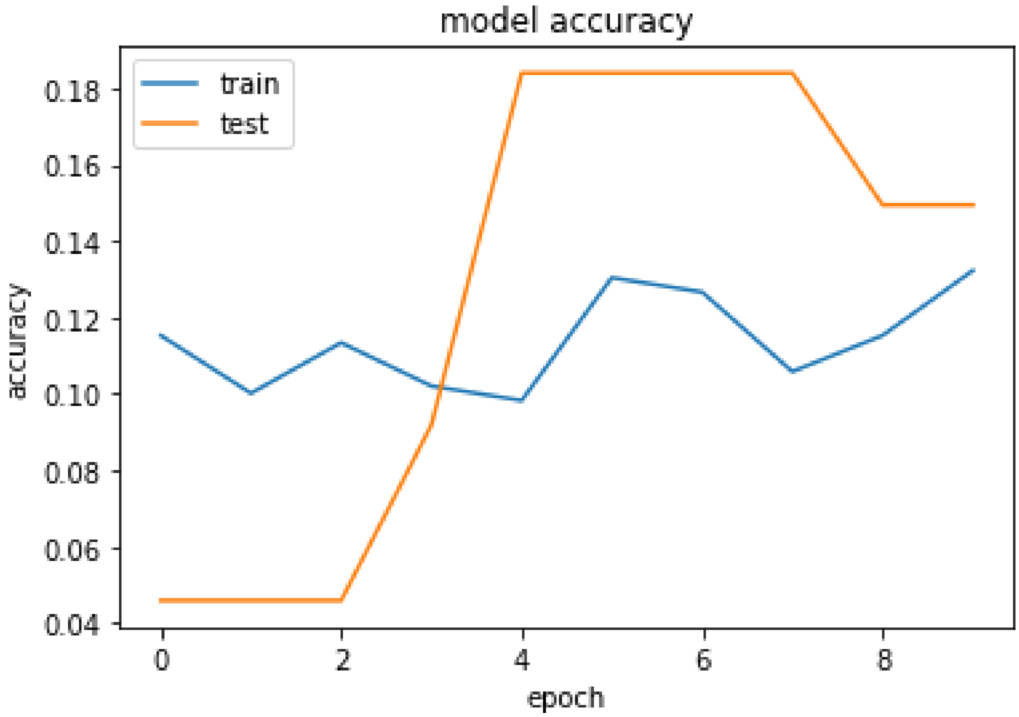


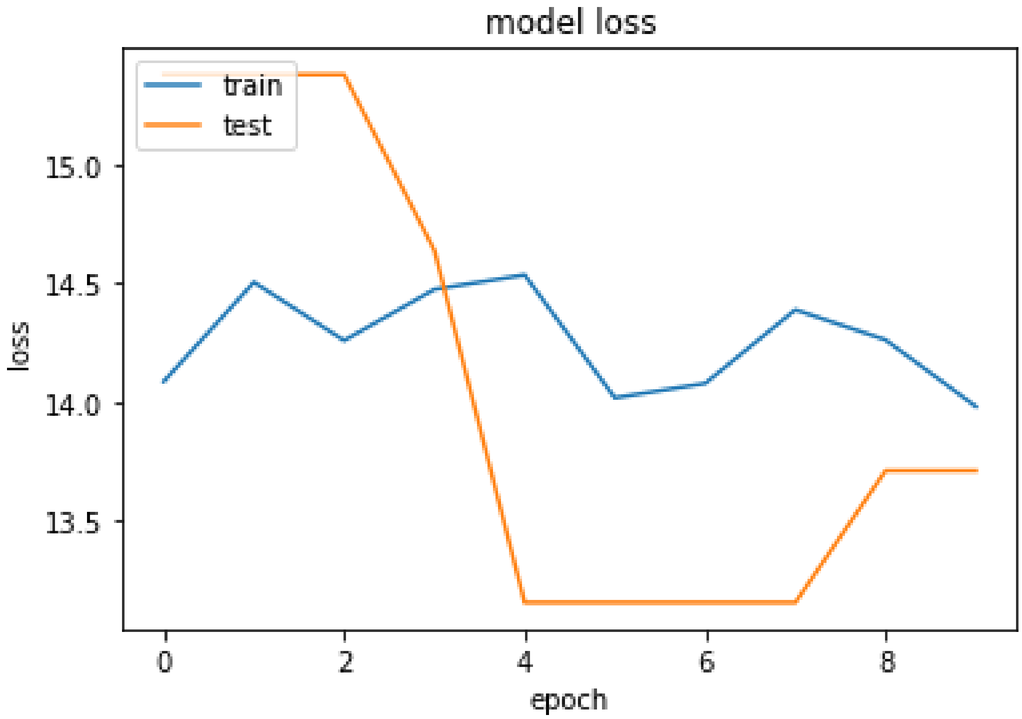
[76]:
```
#sinextra con aumentación
model_5a=testCustomModel(num_classes, 'relu',True, False,True, True, True, 0.
 ↪5,True, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: False, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_25"
_________________________________________________________________
```

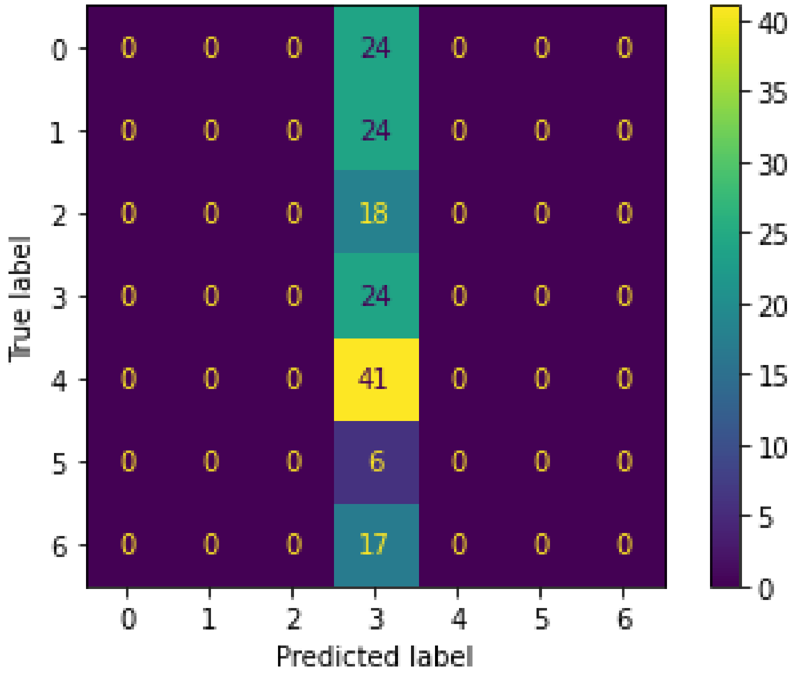
```
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_75 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_75 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 flatten_50 (Flatten)        (None, 931840)            0

 dense_49 (Dense)            (None, 128)               119275648

 dropout_24 (Dropout)        (None, 128)               0

 dense_50 (Dense)            (None, 7)                 903

 flatten_51 (Flatten)        (None, 7)                 0

=================================================================
Total params: 119,276,711
Trainable params: 119,276,711
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 69s 1s/step - loss: 14.0848 - accuracy:
0.1153 - val_loss: 15.3770 - val_accuracy: 0.0460
Epoch 2/10
53/53 [==============================] - 67s 1s/step - loss: 14.5032 - accuracy:
0.1002 - val_loss: 15.3770 - val_accuracy: 0.0460
Epoch 3/10
53/53 [==============================] - 66s 1s/step - loss: 14.2574 - accuracy:
0.1134 - val_loss: 15.3770 - val_accuracy: 0.0460
Epoch 4/10
53/53 [==============================] - 68s 1s/step - loss: 14.4733 - accuracy:
0.1021 - val_loss: 14.6360 - val_accuracy: 0.0920
Epoch 5/10
53/53 [==============================] - 68s 1s/step - loss: 14.5337 - accuracy:
0.0983 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 6/10
53/53 [==============================] - 68s 1s/step - loss: 14.0157 - accuracy:
0.1304 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 7/10
53/53 [==============================] - 68s 1s/step - loss: 14.0767 - accuracy:
0.1267 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 8/10
53/53 [==============================] - 67s 1s/step - loss: 14.3871 - accuracy:
0.1059 - val_loss: 13.1538 - val_accuracy: 0.1839
Epoch 9/10
53/53 [==============================] - 66s 1s/step - loss: 14.2602 - accuracy:
```

```
0.1153 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 10/10
53/53 [==============================] - 67s 1s/step - loss: 13.9791 - accuracy:
0.1323 - val_loss: 13.7096 - val_accuracy: 0.1494
Time used: 0:11:14.643553
```





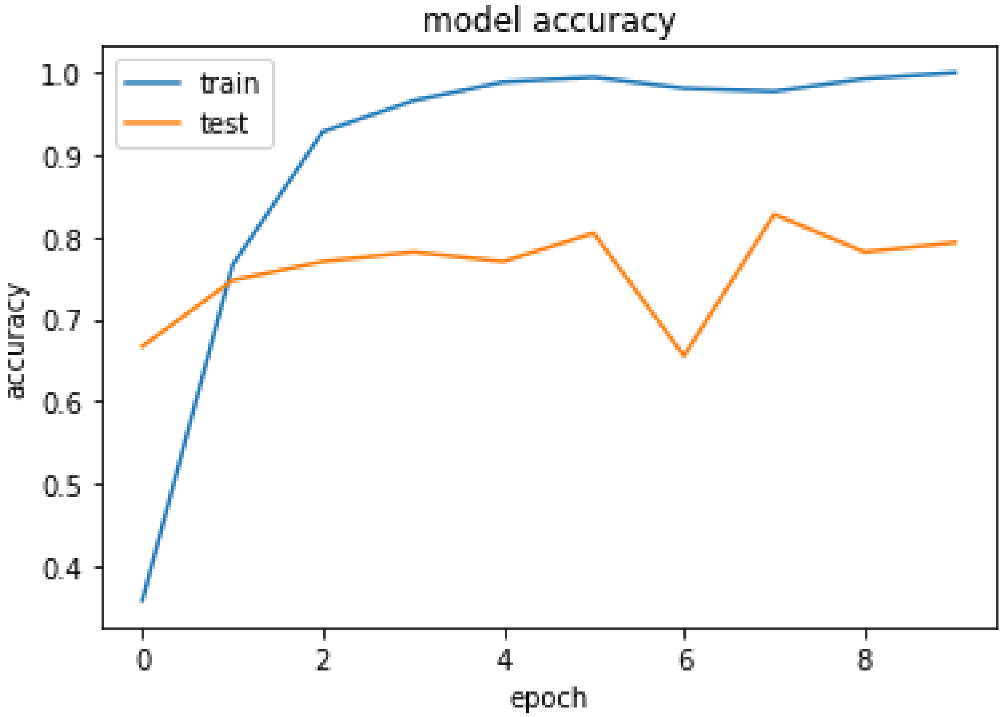
```
16/16 [==============================] - 3s 178ms/step
Test evaluation:
16/16 [==============================] - 3s 181ms/step - loss: 13.6062 -
accuracy: 0.1558
[13.606184959411621, 0.15584415197372437]
% of correct brand in the first 3 positions:
72
0.4675324675324675
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```

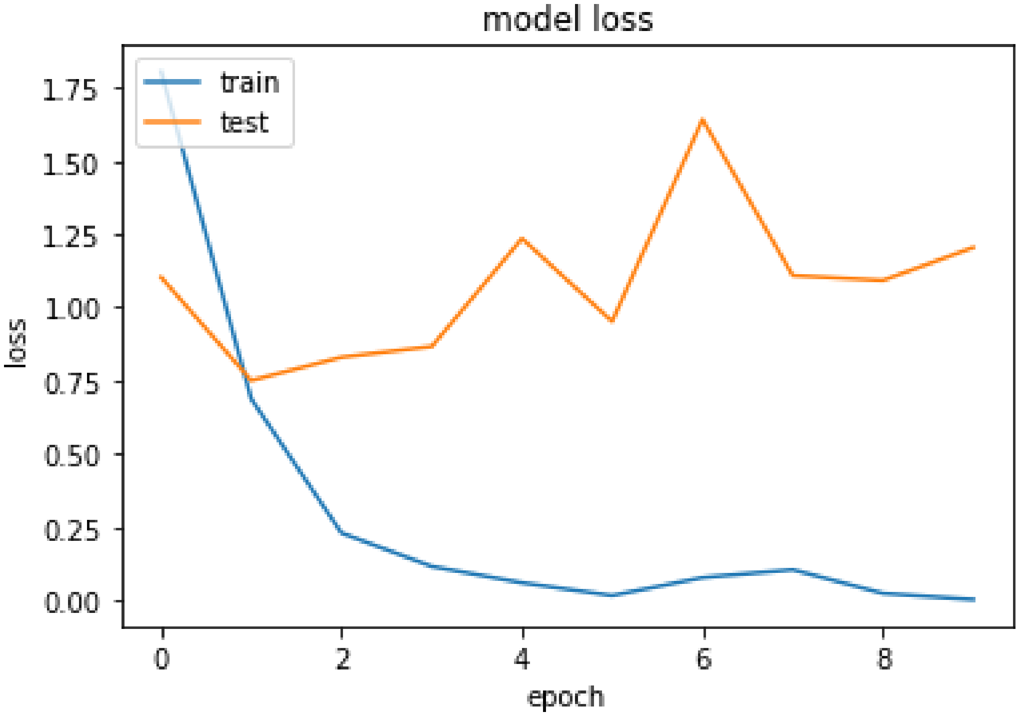


### 4.2.6 Sin Dense

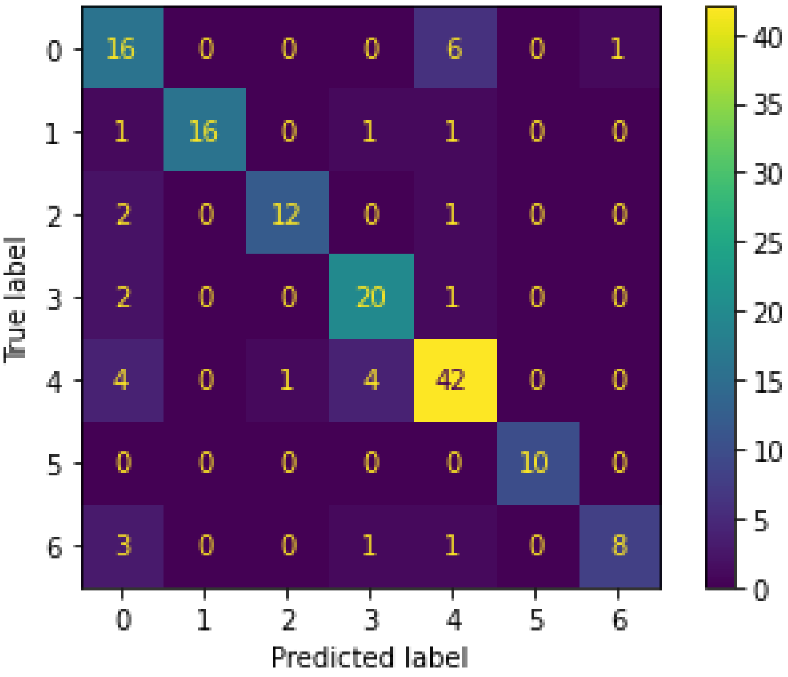
[82]:
```python
model_6 = testCustomModel(num_classes,'relu', True, True, True, False)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: False, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_23"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_69 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_59 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_70 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_60 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_71 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_61 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_38 (Flatten)        (None, 232960)            0

 dropout_16 (Dropout)        (None, 232960)            0

 dense_43 (Dense)            (None, 7)                 1630727

 flatten_39 (Flatten)        (None, 7)                 0

=================================================================
Total params: 1,654,023
Trainable params: 1,654,023
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 52s 963ms/step - loss: 1.8052 -
accuracy: 0.3573 - val_loss: 1.1032 - val_accuracy: 0.6667
Epoch 2/10
53/53 [==============================] - 51s 965ms/step - loss: 0.6868 -
accuracy: 0.7656 - val_loss: 0.7500 - val_accuracy: 0.7471
Epoch 3/10
53/53 [==============================] - 50s 948ms/step - loss: 0.2292 -
accuracy: 0.9282 - val_loss: 0.8295 - val_accuracy: 0.7701
Epoch 4/10
53/53 [==============================] - 51s 969ms/step - loss: 0.1147 -
accuracy: 0.9660 - val_loss: 0.8663 - val_accuracy: 0.7816
Epoch 5/10
53/53 [==============================] - 50s 944ms/step - loss: 0.0589 -
accuracy: 0.9887 - val_loss: 1.2350 - val_accuracy: 0.7701
Epoch 6/10
53/53 [==============================] - 52s 971ms/step - loss: 0.0153 -
accuracy: 0.9943 - val_loss: 0.9520 - val_accuracy: 0.8046
Epoch 7/10
53/53 [==============================] - 56s 1s/step - loss: 0.0767 - accuracy:
0.9811 - val_loss: 1.6417 - val_accuracy: 0.6552
Epoch 8/10
53/53 [==============================] - 56s 1s/step - loss: 0.1037 - accuracy:
0.9773 - val_loss: 1.1088 - val_accuracy: 0.8276
Epoch 9/10
53/53 [==============================] - 50s 932ms/step - loss: 0.0229 -
accuracy: 0.9924 - val_loss: 1.0922 - val_accuracy: 0.7816
Epoch 10/10
53/53 [==============================] - 49s 927ms/step - loss: 0.0016 -
accuracy: 1.0000 - val_loss: 1.2042 - val_accuracy: 0.7931
Time used: 0:08:37.719498
```


model accuracy
train
test
accuracy
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0
2
4
6
8
epoch


model loss
train
test
loss
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
2
4
6
8
epoch

```
16/16 [==============================] - 5s 282ms/step
Test evaluation:
16/16 [==============================] - 5s 306ms/step - loss: 0.7921 -
accuracy: 0.8052
[0.7921475768089294, 0.8051947951316833]
% of correct brand in the first 3 positions:
149
0.9675324675324676
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```

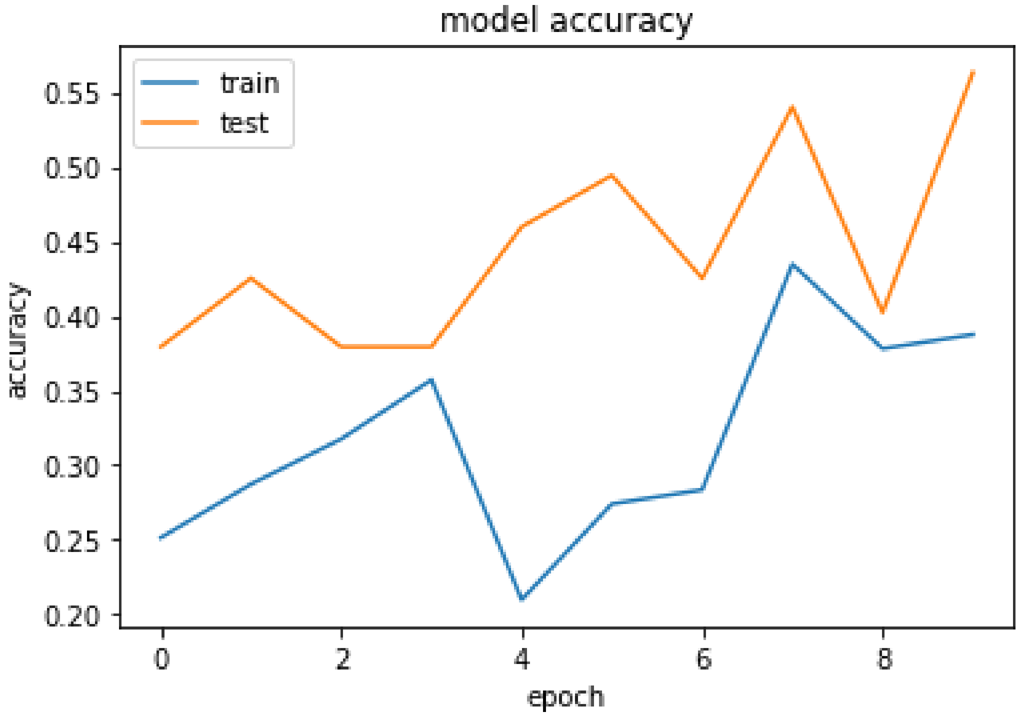


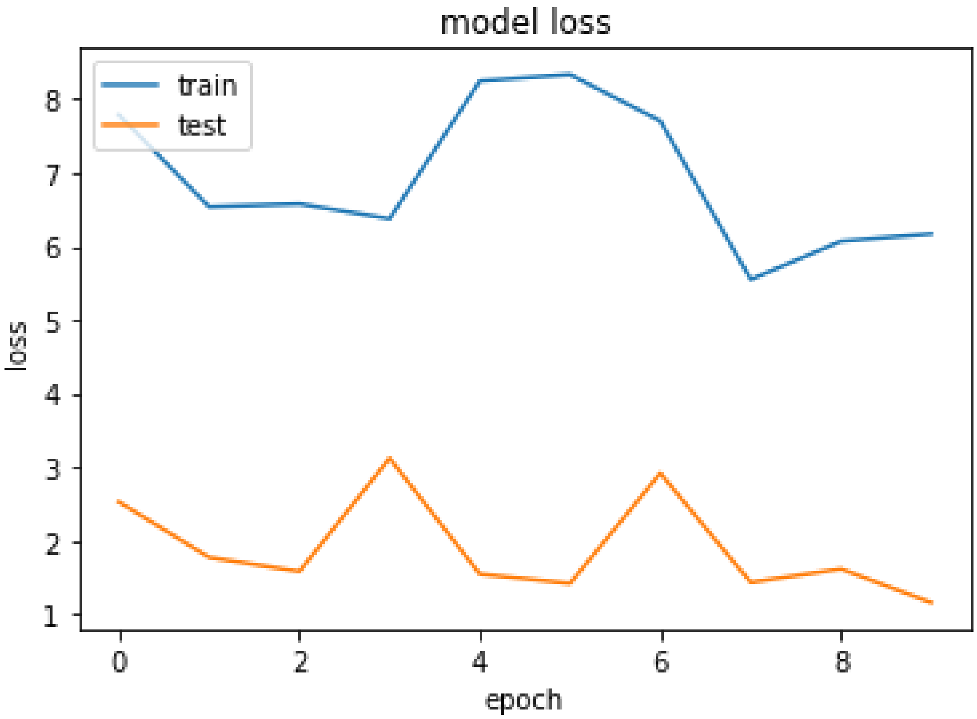
```
[77]: model_6a = testCustomModel(num_classes, 'relu',True, True, True, False, True, 0.
      ↪5, True, True)
```

```
Aumentation: True
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: False, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_26"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

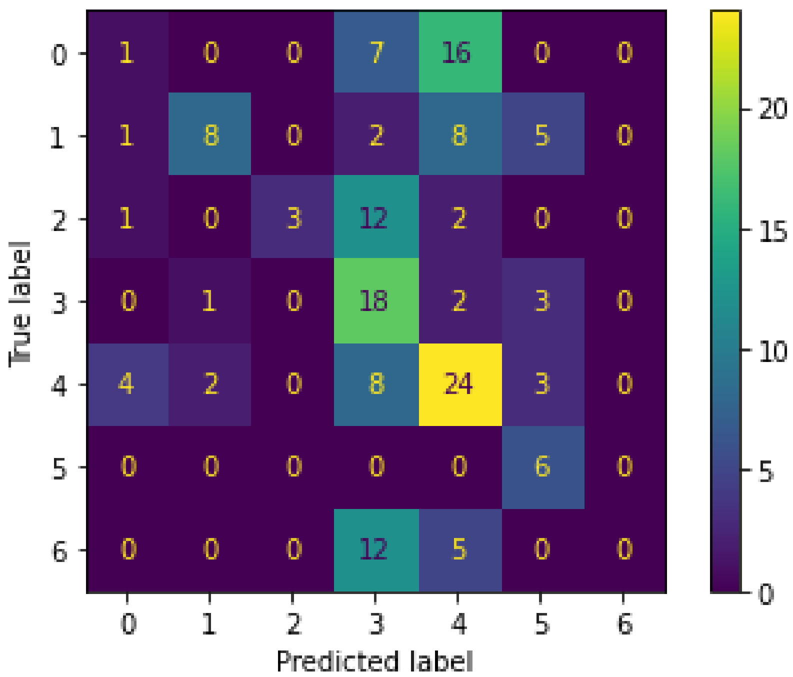
```
=================================================================
 conv2d_76 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_76 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_77 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_77 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_78 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_78 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_52 (Flatten)        (None, 232960)            0

 dropout_25 (Dropout)        (None, 232960)            0

 dense_51 (Dense)            (None, 7)                 1630727

 flatten_53 (Flatten)        (None, 7)                 0

=================================================================
Total params: 1,654,023
Trainable params: 1,654,023
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 46s 840ms/step - loss: 7.7896 -
accuracy: 0.2514 - val_loss: 2.5278 - val_accuracy: 0.3793
Epoch 2/10
53/53 [==============================] - 44s 824ms/step - loss: 6.5391 -
accuracy: 0.2873 - val_loss: 1.7712 - val_accuracy: 0.4253
Epoch 3/10
53/53 [==============================] - 43s 816ms/step - loss: 6.5784 -
accuracy: 0.3176 - val_loss: 1.5795 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 43s 807ms/step - loss: 6.3757 -
accuracy: 0.3573 - val_loss: 3.1212 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 43s 810ms/step - loss: 8.2495 -
accuracy: 0.2098 - val_loss: 1.5440 - val_accuracy: 0.4598
Epoch 6/10
53/53 [==============================] - 43s 799ms/step - loss: 8.3354 -
accuracy: 0.2741 - val_loss: 1.4170 - val_accuracy: 0.4943
Epoch 7/10
```

```
53/53 [==============================] - 43s 805ms/step - loss: 7.7073 -
accuracy: 0.2836 - val_loss: 2.9178 - val_accuracy: 0.4253
Epoch 8/10
53/53 [==============================] - 43s 816ms/step - loss: 5.5496 -
accuracy: 0.4348 - val_loss: 1.4313 - val_accuracy: 0.5402
Epoch 9/10
53/53 [==============================] - 43s 807ms/step - loss: 6.0704 -
accuracy: 0.3781 - val_loss: 1.6139 - val_accuracy: 0.4023
Epoch 10/10
53/53 [==============================] - 43s 802ms/step - loss: 6.1711 -
accuracy: 0.3875 - val_loss: 1.1560 - val_accuracy: 0.5632
Time used: 0:07:14.104045
```





```
16/16 [==============================] - 3s 203ms/step
Test evaluation:
16/16 [==============================] - 3s 205ms/step - loss: 1.3660 -
accuracy: 0.3896
[1.366049885749817, 0.3896103799343109]
% of correct brand in the first 3 positions:
122
0.7922077922077922
% of brand predicted with percentage >= 0.25
0.42207792207792205
% of brand predicted with percentage >= 0.5
0.0
% of brand predicted with percentage >= 0.75
0.0
Matriz de confusión:
```



### 4.2.7 Sin segunda capa Flatten

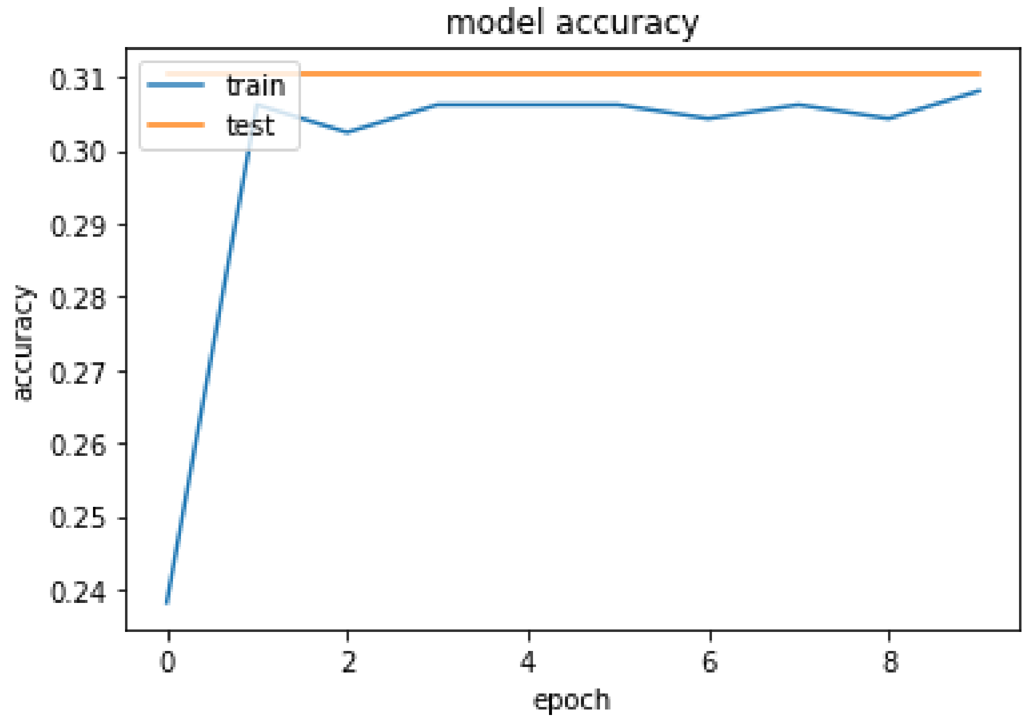
```
[ ]: model_7 = testCustomModel(num_classes,'relu', True, True, False) #error
```

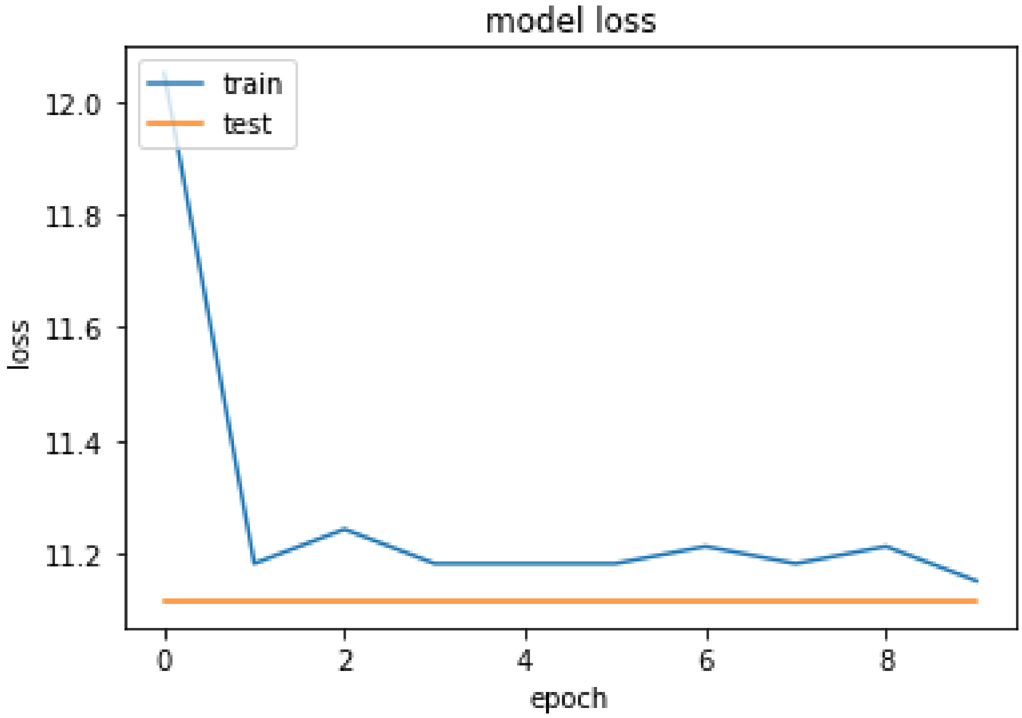
```
[ ]: #model_7a = testCustomModel(num_classes, 'relu',True, True, False, True, True,␣
      ↪0.5, True, True)
```

### 4.2.8 Sin MaxPooling

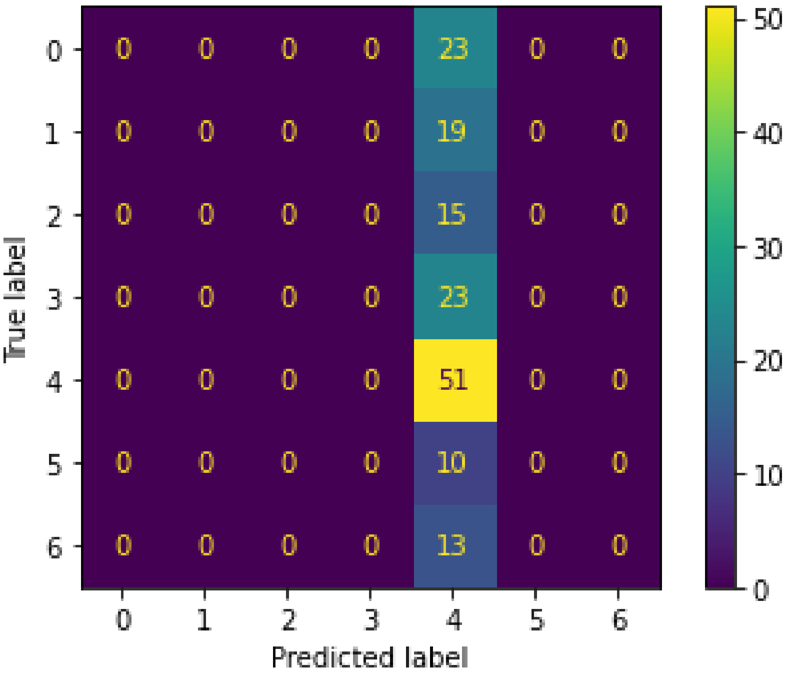
```
[69]: model_8 = testCustomModel(num_classes,'relu', False)
```

```
Activation: relu, maxPooling2D: False, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_10"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_30 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_24 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_31 (Conv2D)          (None, 140, 416, 32)      4640

 conv2d_32 (Conv2D)          (None, 140, 416, 64)      18496
 flatten_14 (Flatten)        (None, 3727360)           0

 dense_18 (Dense)            (None, 128)               477102208

 dropout_7 (Dropout)         (None, 128)               0

 dense_19 (Dense)            (None, 7)                 903

 flatten_15 (Flatten)        (None, 7)                 0

=================================================================
Total params: 477,126,407
Trainable params: 477,126,407
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 632s 12s/step - loss: 12.0494 -
accuracy: 0.2382 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 2/10
53/53 [==============================] - 511s 10s/step - loss: 11.1823 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 3/10
53/53 [==============================] - 423s 8s/step - loss: 11.2431 -
accuracy: 0.3025 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 4/10
53/53 [==============================] - 543s 10s/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 5/10
53/53 [==============================] - 631s 12s/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 6/10
53/53 [==============================] - 685s 13s/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 7/10
53/53 [==============================] - 815s 15s/step - loss: 11.2126 -
accuracy: 0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 8/10
53/53 [==============================] - 1065s 20s/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 9/10
53/53 [==============================] - 336s 6s/step - loss: 11.2126 -
accuracy: 0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 10/10
53/53 [==============================] - 318s 6s/step - loss: 11.1516 -
accuracy: 0.3081 - val_loss: 11.1159 - val_accuracy: 0.3103
Time used: 1:39:30.677803
```


model accuracy
train
test
accuracy
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0
2
4
6
8
epoch


model loss
train
test
loss
12.0
11.8
11.6
11.4
11.2
0
2
4
6
8
epoch

```
16/16 [==============================] - 7s 378ms/step
Test evaluation:
16/16 [==============================] - 7s 414ms/step - loss: 10.7803 -
accuracy: 0.3312
[10.780284881591797, 0.3311688303947449]
% of correct brand in the first 3 positions:
93
0.6038961038961039
% of brand predicted with percentage >= 0.25
0.33116883116883117
% of brand predicted with percentage >= 0.5
0.33116883116883117
% of brand predicted with percentage >= 0.75
0.33116883116883117
Matriz de confusión:
```

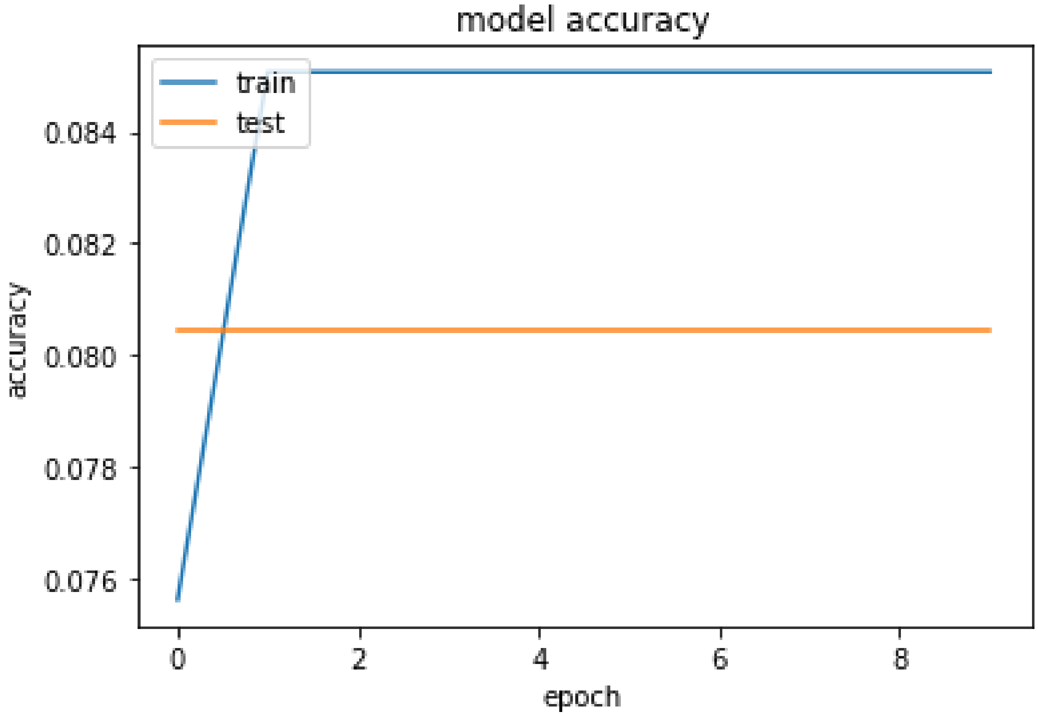


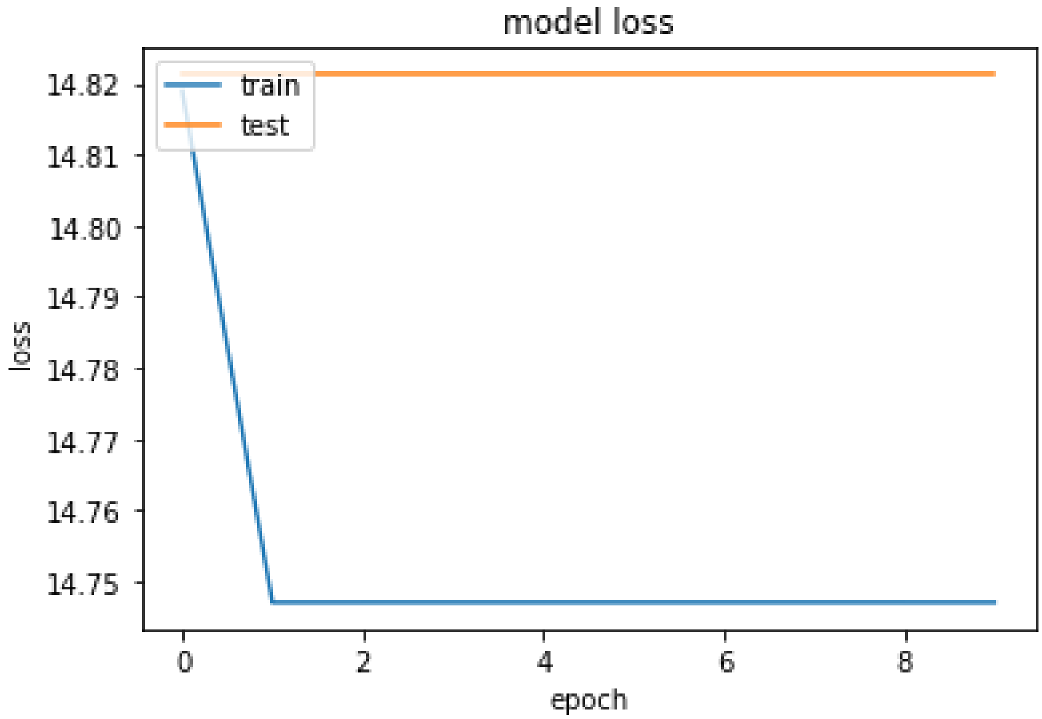
```
[81]: model_9a = testCustomModel(num_classes, 'relu', False, True, True, True, 0.5,␣
      ↪True, True, True) #Falta pero tarda molt
```

```
Aumentation: True
Activation: relu, maxPooling2D: False, extraLayers: True, withFlatten: True,
withDense: True, withDropout: 0.5, Dropout value: True, withSoftmax: True
Model: "sequential_30"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

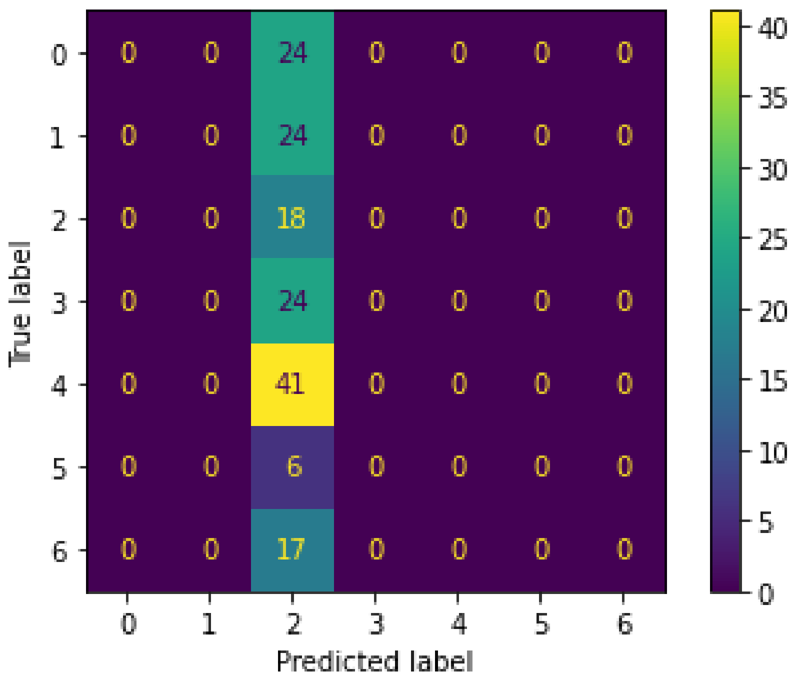
```
=================================================================
 conv2d_88 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_88 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_89 (Conv2D)          (None, 140, 416, 32)      4640

 conv2d_90 (Conv2D)          (None, 140, 416, 64)      18496

 flatten_60 (Flatten)        (None, 3727360)           0

 dense_58 (Dense)            (None, 128)               477102208

 dense_59 (Dense)            (None, 7)                 903

 flatten_61 (Flatten)        (None, 7)                 0

=================================================================
Total params: 477,126,407
Trainable params: 477,126,407
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 431s 8s/step - loss: 14.8189 -
accuracy: 0.0756 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 2/10
53/53 [==============================] - 410s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 3/10
53/53 [==============================] - 398s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 4/10
53/53 [==============================] - 389s 7s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 5/10
53/53 [==============================] - 410s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 6/10
53/53 [==============================] - 411s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 7/10
53/53 [==============================] - 410s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 8/10
53/53 [==============================] - 404s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 9/10
```

```
53/53 [==============================] - 385s 7s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Epoch 10/10
53/53 [==============================] - 421s 8s/step - loss: 14.7470 -
accuracy: 0.0851 - val_loss: 14.8212 - val_accuracy: 0.0805
Time used: 1:07:58.339346
```





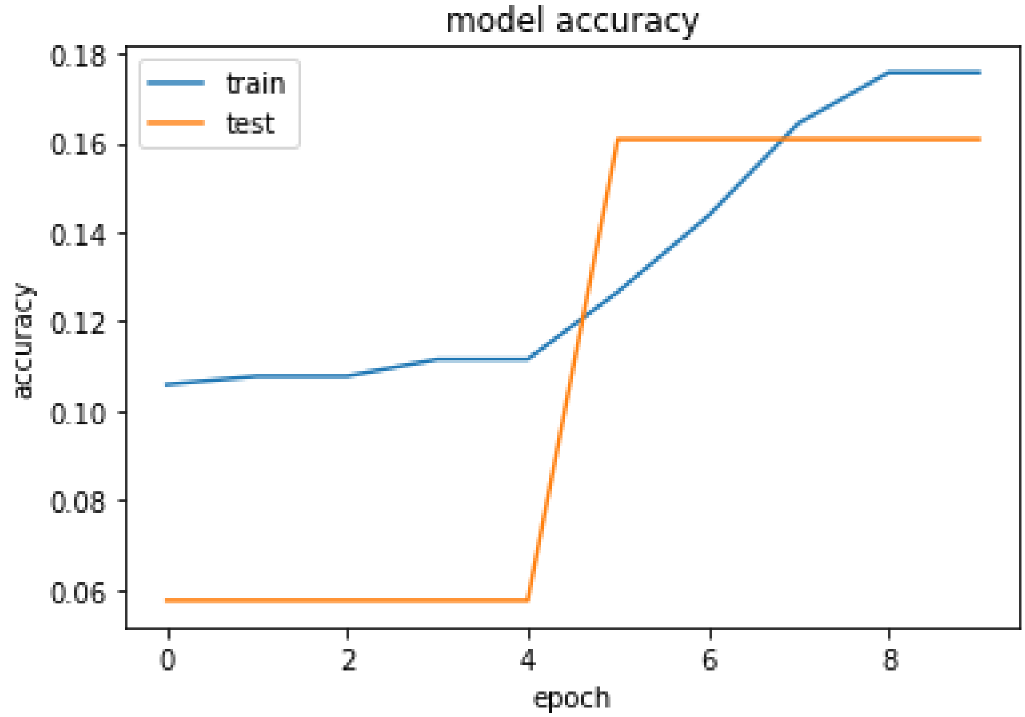
```
16/16 [==============================] - 7s 366ms/step
Test evaluation:
16/16 [==============================] - 6s 368ms/step - loss: 14.2342 -
accuracy: 0.1169
[14.234162330627441, 0.11688311398029327]
% of correct brand in the first 3 positions:
66
0.42857142857142855
% of brand predicted with percentage >= 0.25
0.11688311688311688
% of brand predicted with percentage >= 0.5
0.11688311688311688
% of brand predicted with percentage >= 0.75
0.11688311688311688
Matriz de confusión:
```

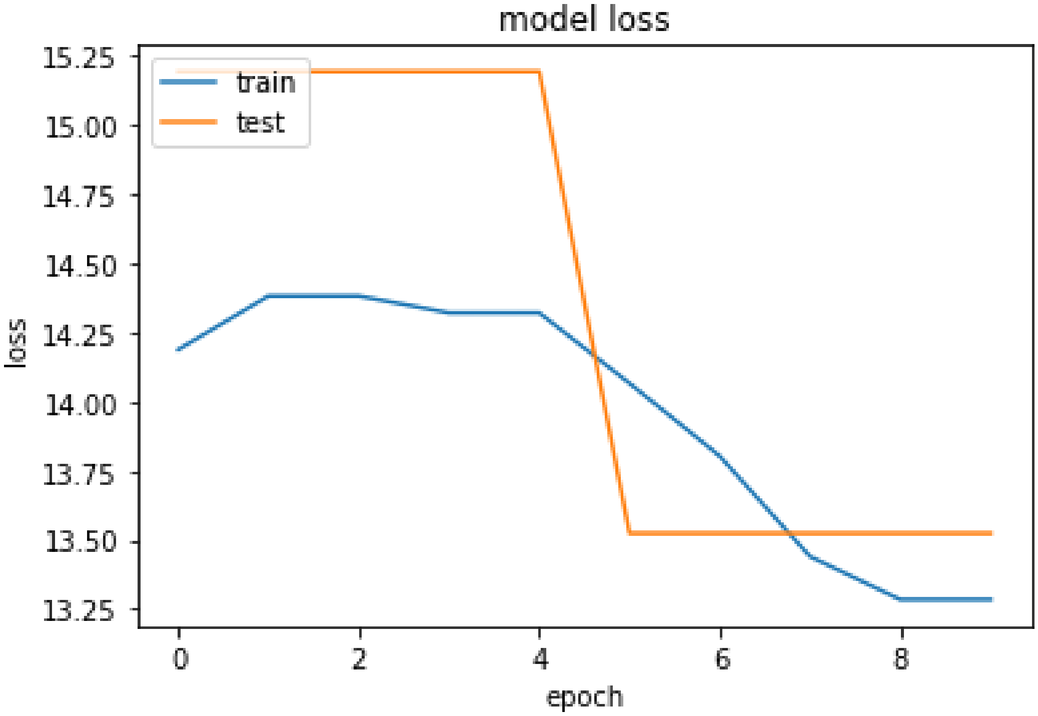


### 4.2.9 Modelo propuesto con diferentes valores de activación:

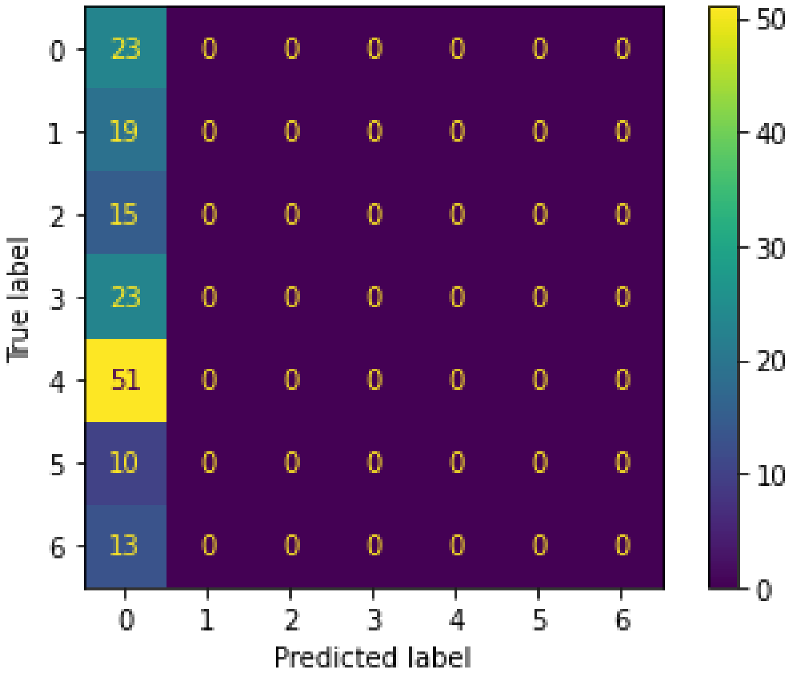
```
[70]: model_sigmoid = testCustomModel(num_classes, 'sigmoid')
```

```
Activation: sigmoid, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_11"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_33 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_25 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_34 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_26 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_35 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_27 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_16 (Flatten)        (None, 232960)            0

 dense_20 (Dense)            (None, 128)               29819008

 dropout_8 (Dropout)         (None, 128)               0

 dense_21 (Dense)            (None, 7)                 903

 flatten_17 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 57s 1s/step - loss: 14.1873 - accuracy:
0.1059 - val_loss: 15.1918 - val_accuracy: 0.0575
Epoch 2/10
53/53 [==============================] - 56s 1s/step - loss: 14.3814 - accuracy:
0.1078 - val_loss: 15.1918 - val_accuracy: 0.0575
Epoch 3/10
53/53 [==============================] - 55s 1s/step - loss: 14.3814 - accuracy:
0.1078 - val_loss: 15.1918 - val_accuracy: 0.0575
Epoch 4/10
53/53 [==============================] - 55s 1s/step - loss: 14.3204 - accuracy:
0.1115 - val_loss: 15.1918 - val_accuracy: 0.0575
Epoch 5/10
53/53 [==============================] - 54s 1s/step - loss: 14.3206 - accuracy:
0.1115 - val_loss: 15.1918 - val_accuracy: 0.0575
Epoch 6/10
53/53 [==============================] - 54s 1s/step - loss: 14.0657 - accuracy:
0.1267 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 7/10
53/53 [==============================] - 53s 1s/step - loss: 13.8025 - accuracy:
0.1437 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 8/10
53/53 [==============================] - 54s 1s/step - loss: 13.4400 - accuracy:
0.1645 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 9/10
53/53 [==============================] - 54s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Epoch 10/10
53/53 [==============================] - 53s 1s/step - loss: 13.2845 - accuracy:
0.1758 - val_loss: 13.5244 - val_accuracy: 0.1609
Time used: 0:09:06.040666
```


model accuracy
0.18
0.16
0.14
0.12
0.10
0.08
0.06
accuracy
0
2
4
6
8
epoch
train
test


model loss
15.25
15.00
14.75
14.50
14.25
14.00
13.75
13.50
13.25
loss
0
2
4
6
8
epoch
train
test

```
16/16 [==============================] - 4s 222ms/step
Test evaluation:
16/16 [==============================] - 4s 236ms/step - loss: 13.7108 -
accuracy: 0.1494
[13.710848808288574, 0.14935064315795898]
% of correct brand in the first 3 positions:
57
0.37012987012987014
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```

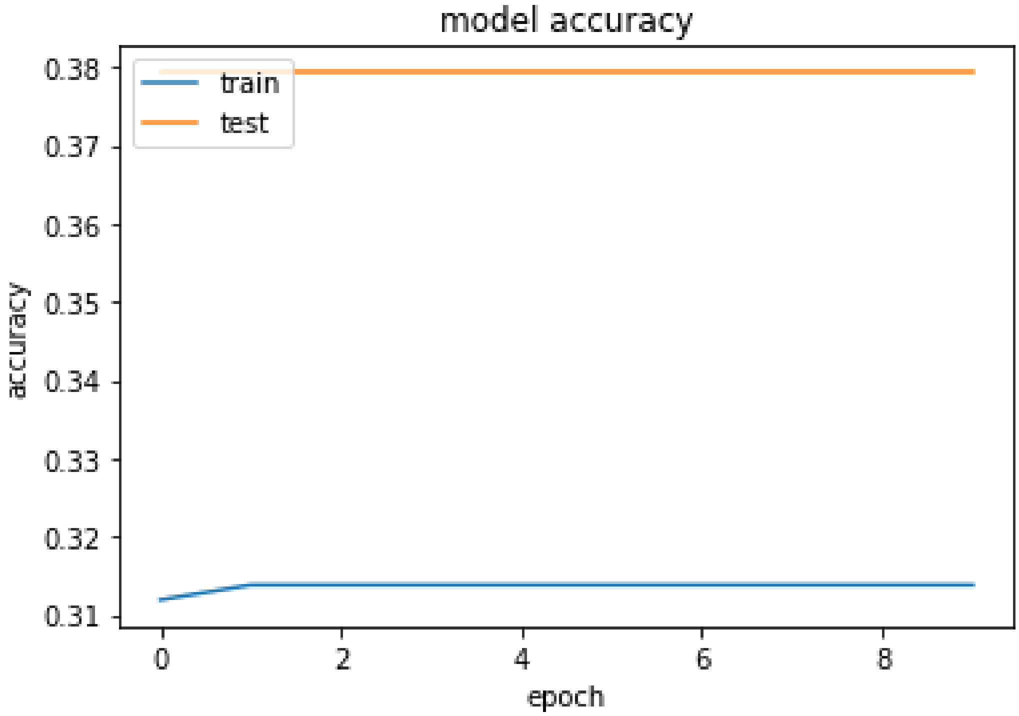


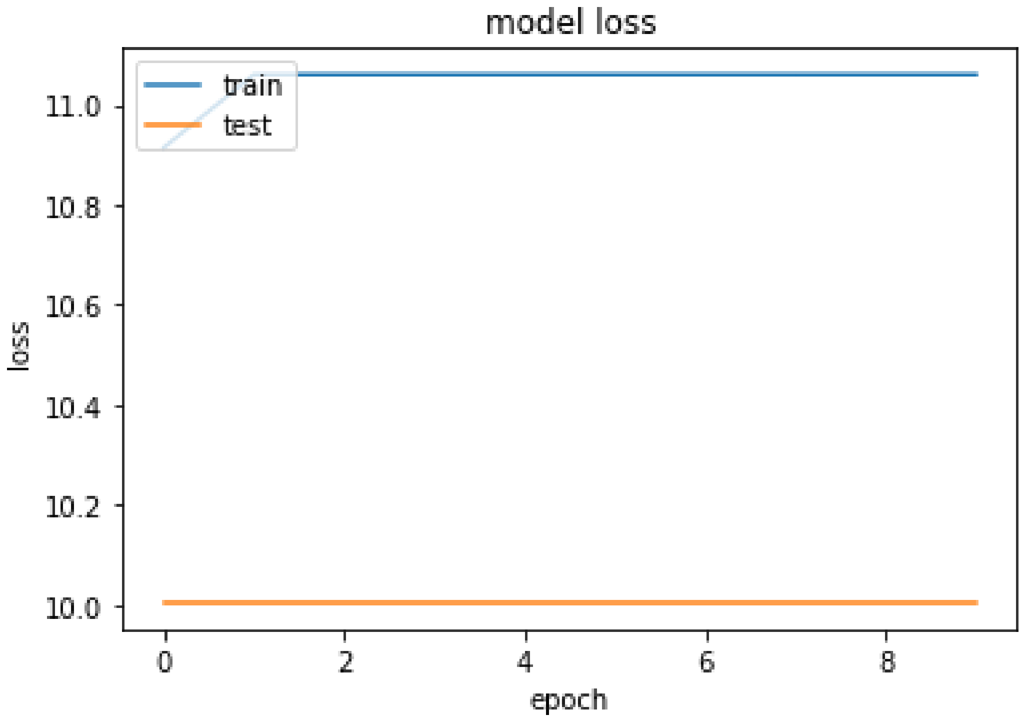
[78]:
```
model_sigmoida = testCustomModel(num_classes, 'sigmoid', True, True, True,␣
 ↪True, 0.5, True, True)
```

```
Aumentation: False
Activation: sigmoid, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: 0.5, Dropout value: True, withSoftmax: True
Model: "sequential_27"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

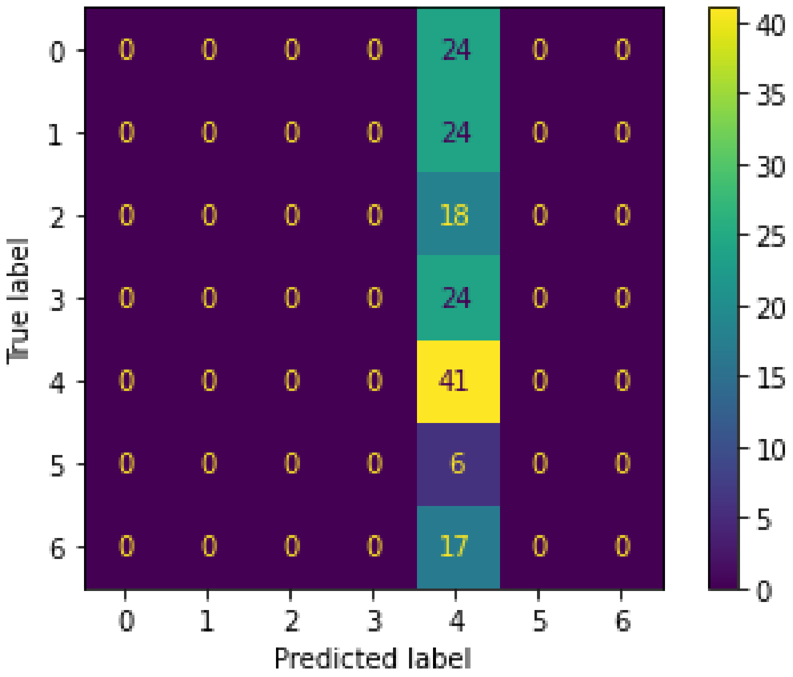
```
=================================================================
 conv2d_79 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_79 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_80 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_80 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_81 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_81 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_54 (Flatten)        (None, 232960)            0

 dense_52 (Dense)            (None, 128)               29819008

 dense_53 (Dense)            (None, 7)                 903

 flatten_55 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 56s 1s/step - loss: 10.9144 - accuracy:
0.3119 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 2/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 6/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 7/10
```

```
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 8/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 9/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 10/10
53/53 [==============================] - 55s 1s/step - loss: 11.0602 - accuracy:
0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Time used: 0:09:10.390472
```



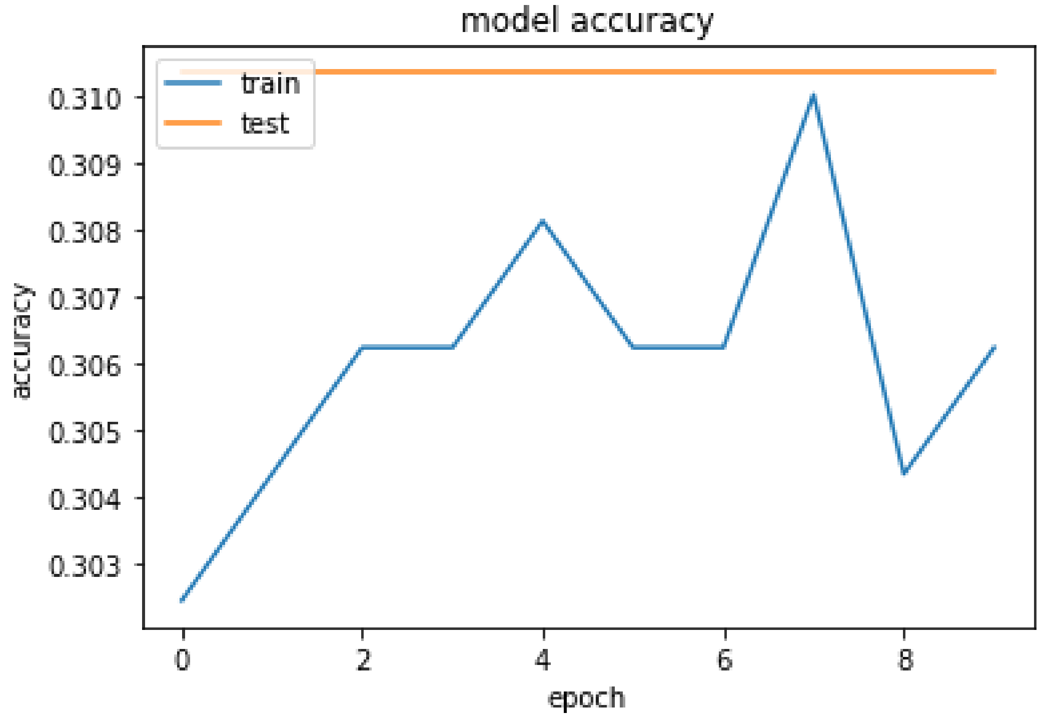


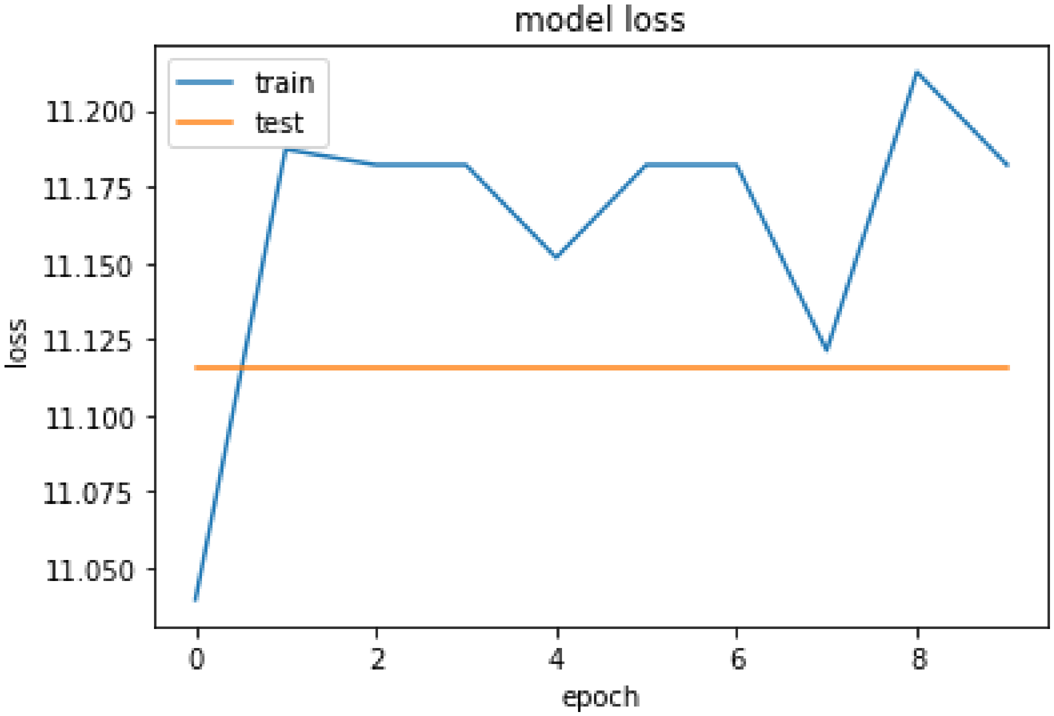
```
16/16 [==============================] - 4s 216ms/step
Test evaluation:
16/16 [==============================] - 4s 218ms/step - loss: 11.8269 -
accuracy: 0.2662
[11.826915740966797, 0.26623377203941345]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.2662337662337662
Matriz de confusión:
```



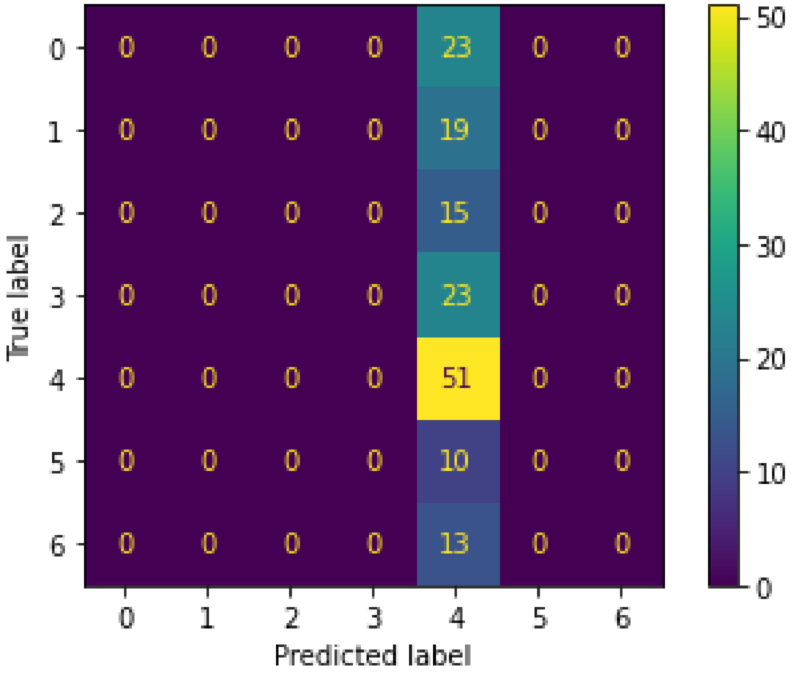
```
[71]: model_tanh=testCustomModel(num_classes, 'tanh')
```

```
Activation: tanh, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: True, Dropout value: 0.5, withSoftmax: True
Model: "sequential_12"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_36 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_28 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_37 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_29 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_38 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_30 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_18 (Flatten)        (None, 232960)            0
 dense_22 (Dense)            (None, 128)               29819008

 dropout_9 (Dropout)         (None, 128)               0

 dense_23 (Dense)            (None, 7)                 903

 flatten_19 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 54s 1s/step - loss: 11.0394 - accuracy:
0.3025 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 2/10
53/53 [==============================] - 53s 998ms/step - loss: 11.1873 -
accuracy: 0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 3/10
53/53 [==============================] - 53s 991ms/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 4/10
53/53 [==============================] - 53s 1s/step - loss: 11.1821 - accuracy:
0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 5/10
53/53 [==============================] - 53s 992ms/step - loss: 11.1517 -
accuracy: 0.3081 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 6/10
53/53 [==============================] - 54s 1s/step - loss: 11.1821 - accuracy:
0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 7/10
53/53 [==============================] - 53s 992ms/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 8/10
53/53 [==============================] - 53s 998ms/step - loss: 11.1212 -
accuracy: 0.3100 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 9/10
53/53 [==============================] - 52s 988ms/step - loss: 11.2126 -
accuracy: 0.3043 - val_loss: 11.1159 - val_accuracy: 0.3103
Epoch 10/10
53/53 [==============================] - 53s 988ms/step - loss: 11.1821 -
accuracy: 0.3062 - val_loss: 11.1159 - val_accuracy: 0.3103
Time used: 0:08:50.479358
```


model accuracy
train
test
0.310
0.309
0.308
0.307
0.306
0.305
0.304
0.303
accuracy
0
2
4
6
8
epoch


model loss
train
test
11.200
11.175
11.150
11.125
11.100
11.075
11.050
loss
0
2
4
6
8
epoch

```
16/16 [==============================] - 4s 228ms/step
Test evaluation:
16/16 [==============================] - 4s 225ms/step - loss: 10.7803 -
accuracy: 0.3312
[10.780284881591797, 0.3311688303947449]
% of correct brand in the first 3 positions:
93
0.6038961038961039
% of brand predicted with percentage >= 0.25
0.33116883116883117
% of brand predicted with percentage >= 0.5
0.33116883116883117
% of brand predicted with percentage >= 0.75
0.33116883116883117
Matriz de confusión:
```

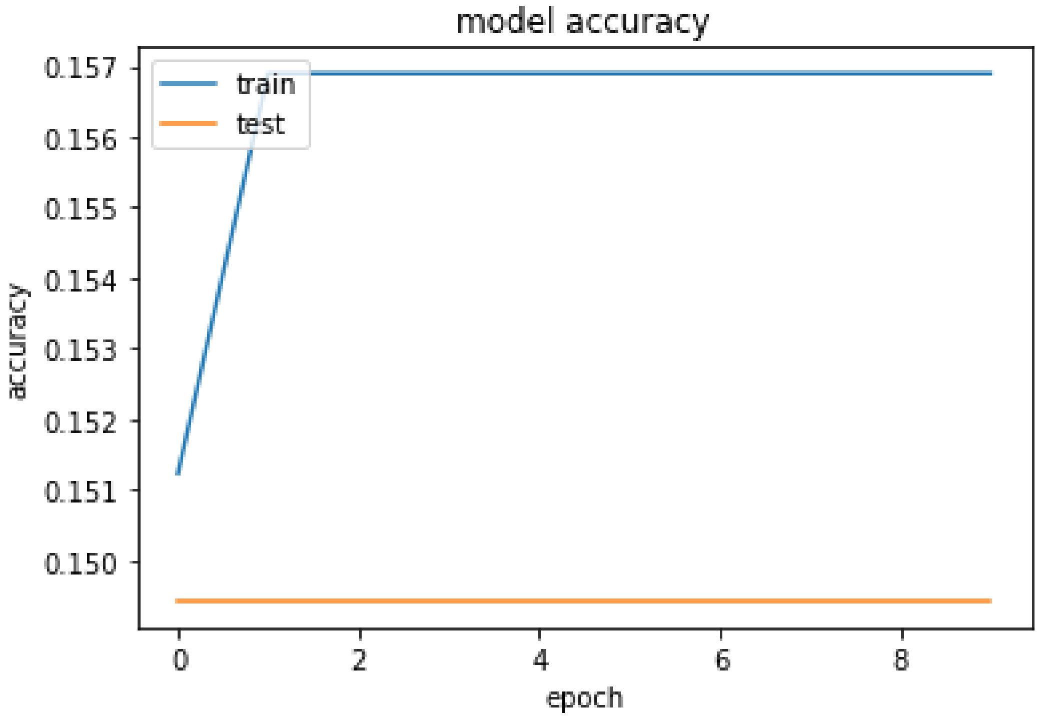


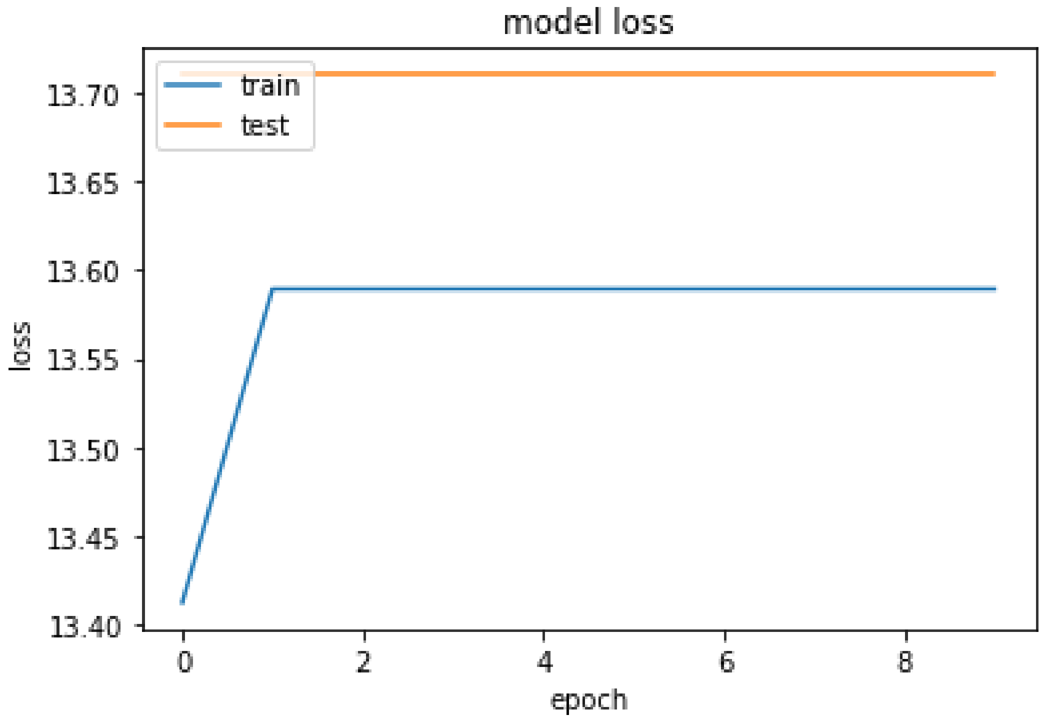
```
[79]: model_tanha = testCustomModel(num_classes, 'tanh', True, True, True, True, 0.5,␣
       ↪True, True)
```

```
Aumentation: False
Activation: tanh, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: 0.5, Dropout value: True, withSoftmax: True
Model: "sequential_28"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

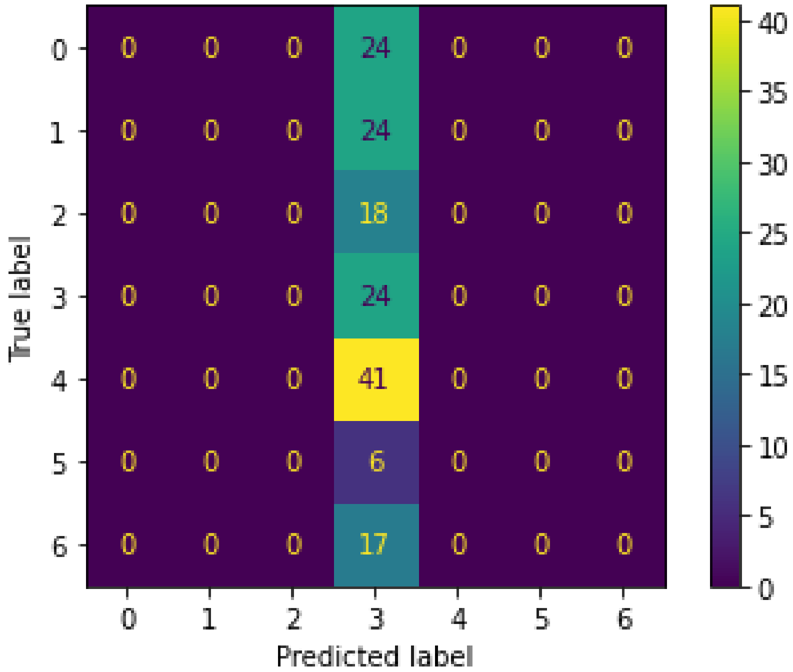
```
=================================================================
 conv2d_82 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_82 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_83 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_83 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_84 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_84 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_56 (Flatten)        (None, 232960)            0

 dense_54 (Dense)            (None, 128)               29819008

 dense_55 (Dense)            (None, 7)                 903

 flatten_57 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 55s 1s/step - loss: 13.4128 - accuracy:
0.1512 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 2/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 3/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 4/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 5/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 6/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 7/10
```

```
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 8/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 9/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Epoch 10/10
53/53 [==============================] - 54s 1s/step - loss: 13.5892 - accuracy:
0.1569 - val_loss: 13.7096 - val_accuracy: 0.1494
Time used: 0:08:59.443288
```





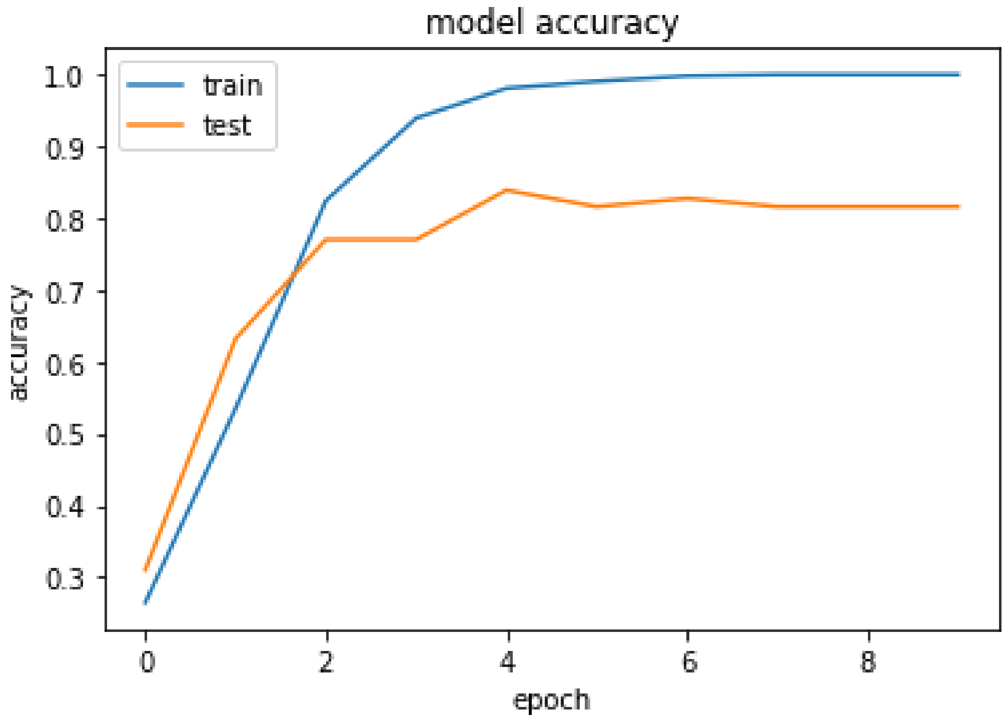
```
16/16 [==============================] - 4s 213ms/step
Test evaluation:
16/16 [==============================] - 4s 218ms/step - loss: 13.6062 -
accuracy: 0.1558
[13.606184959411621, 0.15584415197372437]
% of correct brand in the first 3 positions:
72
0.4675324675324675
% of brand predicted with percentage >= 0.25
0.15584415584415584
% of brand predicted with percentage >= 0.5
0.15584415584415584
% of brand predicted with percentage >= 0.75
0.15584415584415584
Matriz de confusión:
```

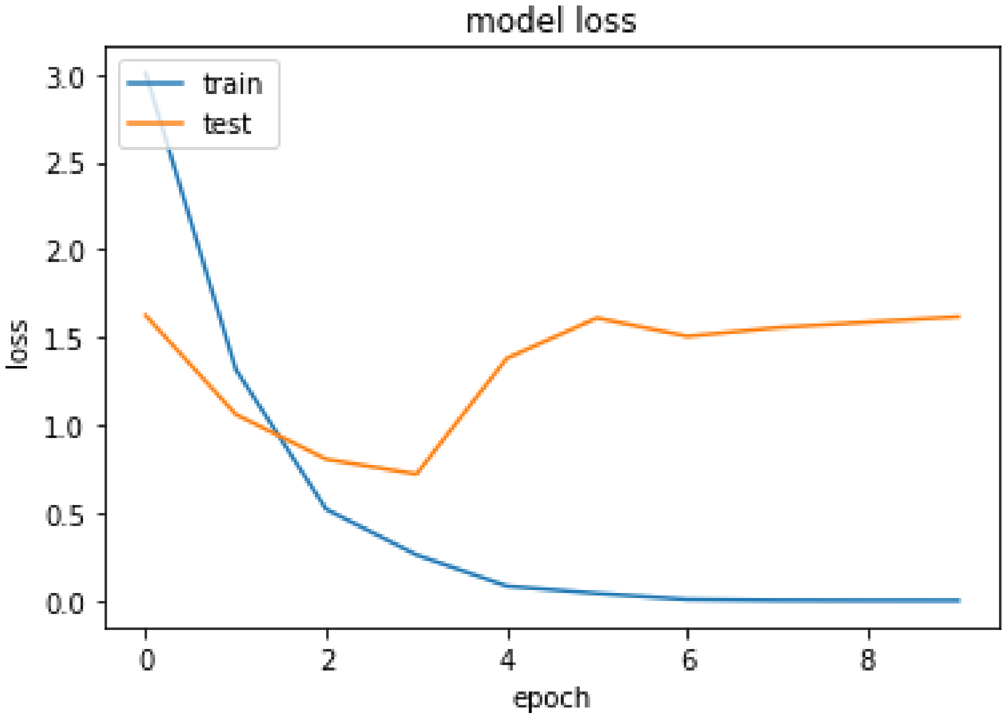


[93]:

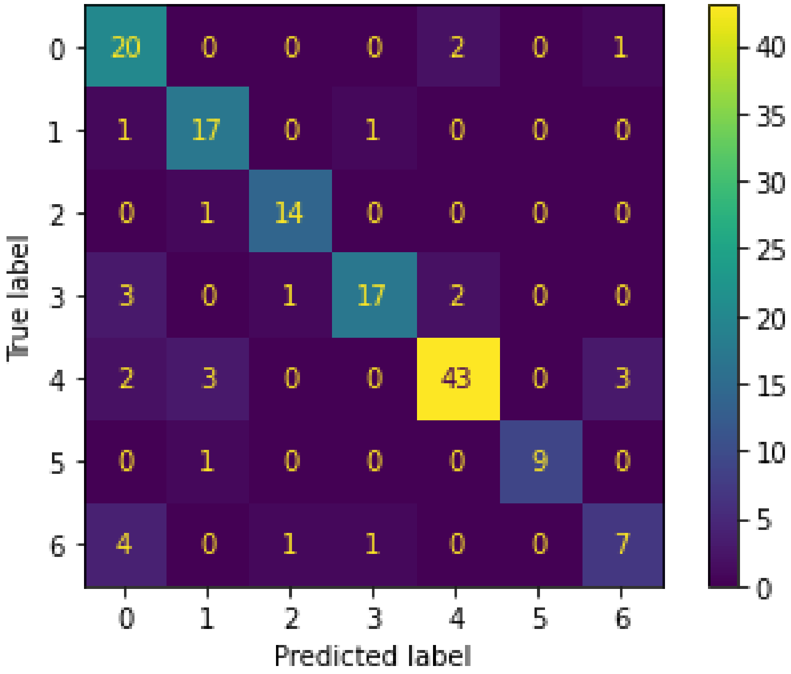
```
#sin eliminar nada:
model_complete = testCustomModel(num_classes, 'relu', True, True, True, True, 0.
↪5, True)
```

```
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: 0.5, Dropout value: True, withSoftmax: True
Model: "sequential_33"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_95 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_83 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_96 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_84 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_97 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_85 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)
 flatten_58 (Flatten)        (None, 232960)            0

 dense_60 (Dense)            (None, 128)               29819008

 dense_61 (Dense)            (None, 7)                 903

 flatten_59 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 52s 965ms/step - loss: 3.0075 -
accuracy: 0.2647 - val_loss: 1.6264 - val_accuracy: 0.3103
Epoch 2/10
53/53 [==============================] - 52s 970ms/step - loss: 1.3174 -
accuracy: 0.5350 - val_loss: 1.0612 - val_accuracy: 0.6322
Epoch 3/10
53/53 [==============================] - 52s 976ms/step - loss: 0.5219 -
accuracy: 0.8242 - val_loss: 0.8069 - val_accuracy: 0.7701
Epoch 4/10
53/53 [==============================] - 52s 974ms/step - loss: 0.2611 -
accuracy: 0.9395 - val_loss: 0.7218 - val_accuracy: 0.7701
Epoch 5/10
53/53 [==============================] - 52s 972ms/step - loss: 0.0832 -
accuracy: 0.9811 - val_loss: 1.3811 - val_accuracy: 0.8391
Epoch 6/10
53/53 [==============================] - 52s 989ms/step - loss: 0.0411 -
accuracy: 0.9905 - val_loss: 1.6120 - val_accuracy: 0.8161
Epoch 7/10
53/53 [==============================] - 59s 1s/step - loss: 0.0068 - accuracy:
0.9981 - val_loss: 1.5071 - val_accuracy: 0.8276
Epoch 8/10
53/53 [==============================] - 60s 1s/step - loss: 0.0016 - accuracy:
1.0000 - val_loss: 1.5565 - val_accuracy: 0.8161
Epoch 9/10
53/53 [==============================] - 58s 1s/step - loss: 2.7727e-04 -
accuracy: 1.0000 - val_loss: 1.5882 - val_accuracy: 0.8161
Epoch 10/10
53/53 [==============================] - 58s 1s/step - loss: 1.5080e-04 -
accuracy: 1.0000 - val_loss: 1.6187 - val_accuracy: 0.8161
Time used: 0:09:07.531068
```


model accuracy
accuracy
epoch
train
test
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
2
4
6
8


model loss
loss
epoch
train
test
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8

```
16/16 [==============================] - 5s 270ms/step
Test evaluation:
16/16 [==============================] - 4s 255ms/step - loss: 1.0065 -
accuracy: 0.8247
[1.0065144300460815, 0.8246753215789795]
% of correct brand in the first 3 positions:
152
0.987012987012987
% of brand predicted with percentage >= 0.25
0.14935064935064934
% of brand predicted with percentage >= 0.5
0.14935064935064934
% of brand predicted with percentage >= 0.75
0.14935064935064934
Matriz de confusión:
```



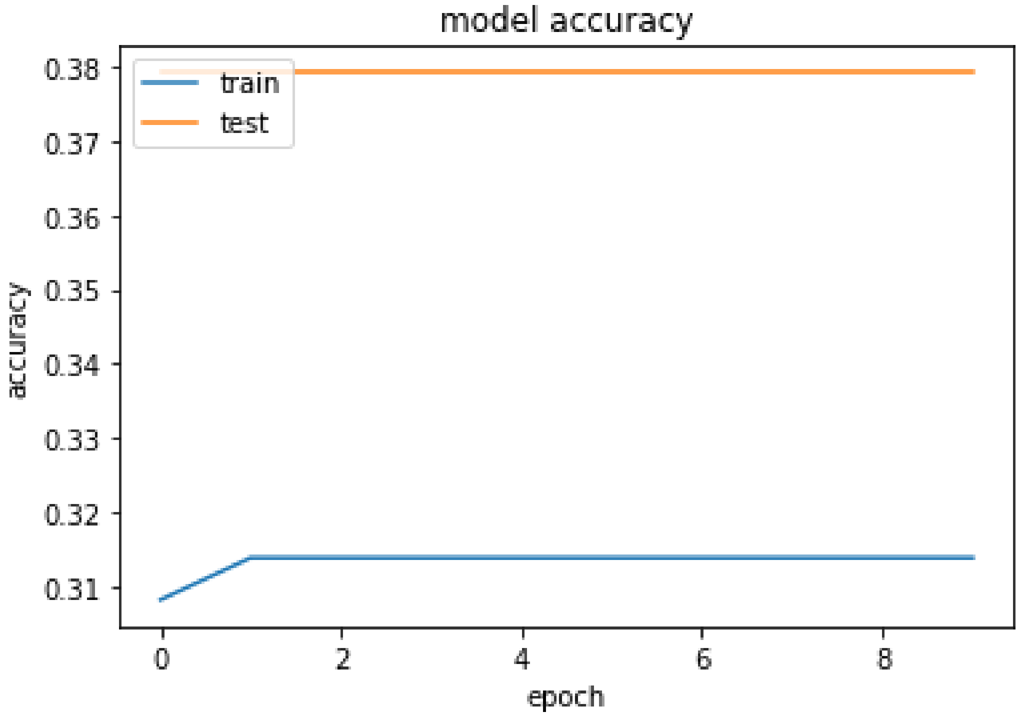
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 20 | 0 | 0 | 0 | 2 | 0 | 1 |
| 1 | 1 | 17 | 0 | 1 | 0 | 0 | 0 |
| 2 | 0 | 1 | 14 | 0 | 0 | 0 | 0 |
| 3 | 3 | 0 | 1 | 17 | 2 | 0 | 0 |
| 4 | 2 | 3 | 0 | 0 | 43 | 0 | 3 |
| 5 | 0 | 1 | 0 | 0 | 0 | 9 | 0 |
| 6 | 4 | 0 | 1 | 1 | 0 | 0 | 7 |

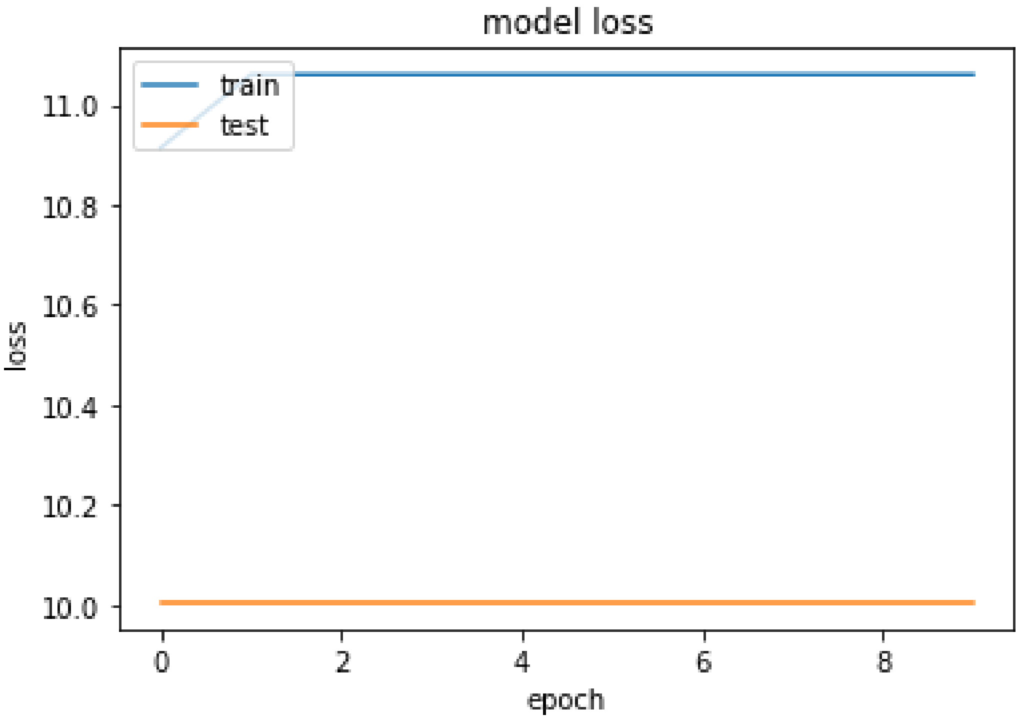
[80]:
```
model_complete_a=testCustomModel(num_classes, 'relu', True, True, True, True, 0.
↪5, True, True)
```

```
Aumentation: False
Activation: relu, maxPooling2D: True, extraLayers: True, withFlatten: True,
withDense: True, withDropout: 0.5, Dropout value: True, withSoftmax: True
Model: "sequential_29"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

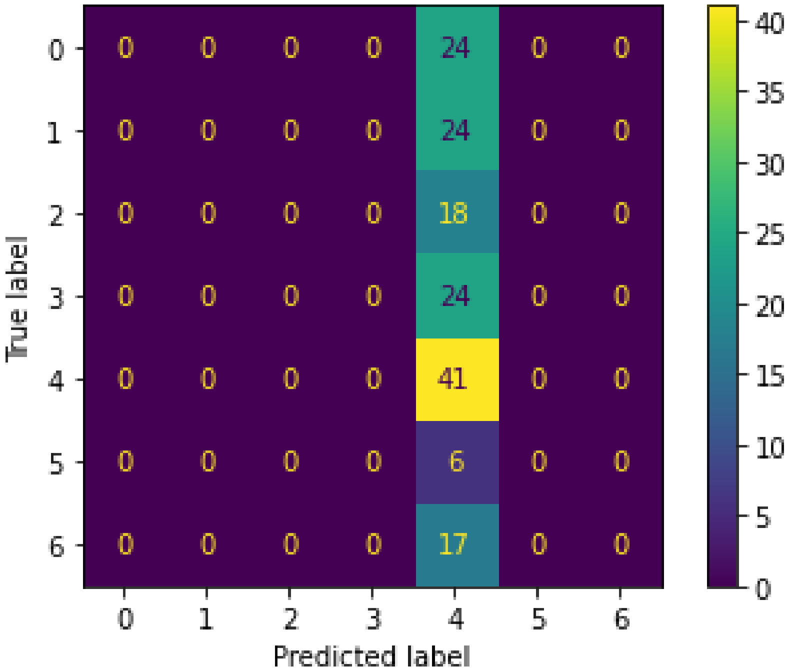
```
=================================================================
 conv2d_85 (Conv2D)          (None, 280, 832, 16)      160

 max_pooling2d_85 (MaxPoolin  (None, 140, 416, 16)     0
 g2D)

 conv2d_86 (Conv2D)          (None, 140, 416, 32)      4640

 max_pooling2d_86 (MaxPoolin  (None, 70, 208, 32)      0
 g2D)

 conv2d_87 (Conv2D)          (None, 70, 208, 64)       18496

 max_pooling2d_87 (MaxPoolin  (None, 35, 104, 64)      0
 g2D)

 flatten_58 (Flatten)        (None, 232960)            0

 dense_56 (Dense)            (None, 128)               29819008

 dense_57 (Dense)            (None, 7)                 903

 flatten_59 (Flatten)        (None, 7)                 0

=================================================================
Total params: 29,843,207
Trainable params: 29,843,207
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
53/53 [==============================] - 54s 994ms/step - loss: 10.9140 -
accuracy: 0.3081 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 2/10
53/53 [==============================] - 52s 976ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 3/10
53/53 [==============================] - 52s 986ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 4/10
53/53 [==============================] - 52s 987ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 5/10
53/53 [==============================] - 53s 989ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 6/10
53/53 [==============================] - 53s 989ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 7/10
```

```
53/53 [==============================] - 52s 987ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 8/10
53/53 [==============================] - 53s 990ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 9/10
53/53 [==============================] - 52s 988ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Epoch 10/10
53/53 [==============================] - 53s 994ms/step - loss: 11.0602 -
accuracy: 0.3138 - val_loss: 10.0043 - val_accuracy: 0.3793
Time used: 0:08:46.497775
```





```
16/16 [==============================] - 4s 212ms/step
Test evaluation:
16/16 [==============================] - 3s 210ms/step - loss: 11.8269 -
accuracy: 0.2662
[11.826915740966797, 0.26623377203941345]
% of correct brand in the first 3 positions:
89
0.577922077922078
% of brand predicted with percentage >= 0.25
0.2662337662337662
% of brand predicted with percentage >= 0.5
0.2662337662337662
% of brand predicted with percentage >= 0.75
0.2662337662337662
Matriz de confusión:
```



### 4.2.10 RestNet50

ResNet50 + capas

[139]:

```
import tensorflow as tf
from tensorflow.keras.applications.resnet50 import ResNet50


modelPre3 = models.Sequential()
modelPre3.add(ResNet50(include_top=False, input_shape=(832, 280, 3),
                   weights="imagenet", classes = num_classes,␣
 ↪classifier_activation="softmax"))
modelPre3.add(Flatten())
modelPre3.add(Dense(512, activation='relu'))
modelPre3.add(BatchNormalization())
modelPre3.add(Dropout(0.5))
modelPre3.add(Dense(num_classes, activation='softmax'))
modelPre3.add(Flatten())



modelPre3.summary()
```

```
Model: "sequential_10"
_________________________________________________________________
```

```
 Layer (type)                Output Shape              Param #
=================================================================
 resnet50 (Functional)       (None, 26, 9, 2048)       23587712

 flatten_11 (Flatten)        (None, 479232)            0

 dense_21 (Dense)            (None, 512)               245367296

 batch_normalization_10 (Bat  (None, 512)              2048
 chNormalization)

 dropout_12 (Dropout)        (None, 512)               0

 dense_22 (Dense)            (None, 7)                 3591

 flatten_12 (Flatten)        (None, 7)                 0

=================================================================
Total params: 268,960,647
Trainable params: 268,906,503
Non-trainable params: 54,144
_________________________________________________________________
```

[140]:

```
modelPre3.compile(optimizer='adam',
              loss=tf.keras.losses.
 ↪SparseCategoricalCrossentropy(from_logits=False),
              metrics=['accuracy'])
```

[141]:

```
trainGeneratorPre3=DataGenerator2dFootwear(shoes_train['X'].
 ↪tolist(),df_shoe_brand,False, "images/", False, False, False)
testGeneratorPre3=DataGenerator2dFootwear(shoes_test['X'].
 ↪tolist(),df_shoe_brand,False, "images/", False, False, False)
valGeneratorPre3=DataGenerator2dFootwear(shoes_val['X'].
 ↪tolist(),df_shoe_brand,False, "images/",False, False, False)
```

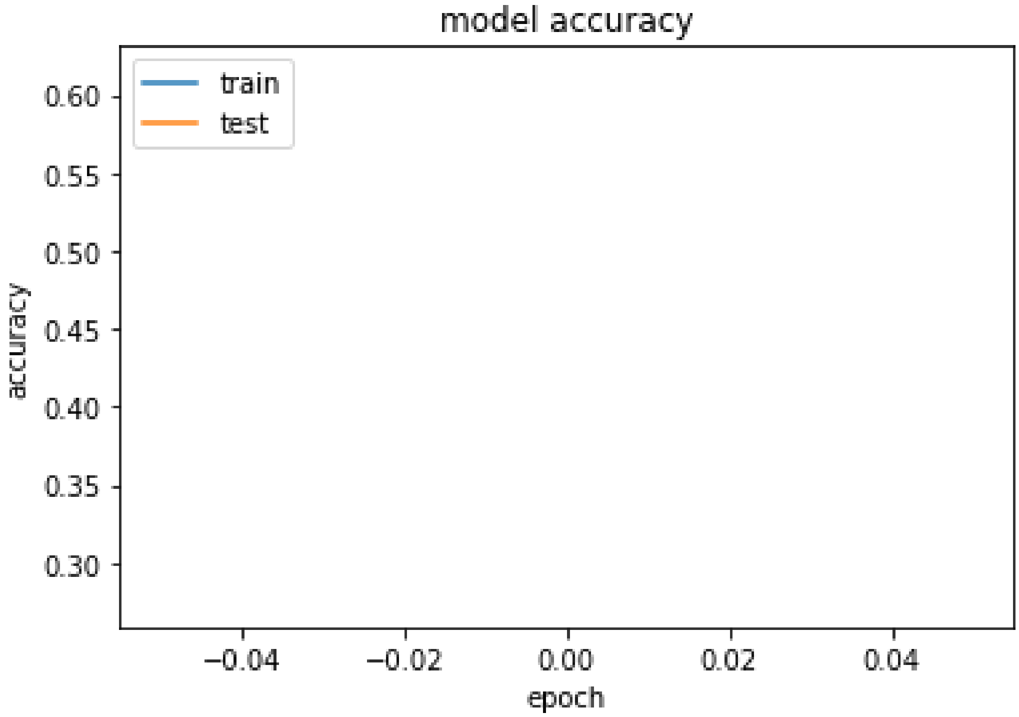
[143]:

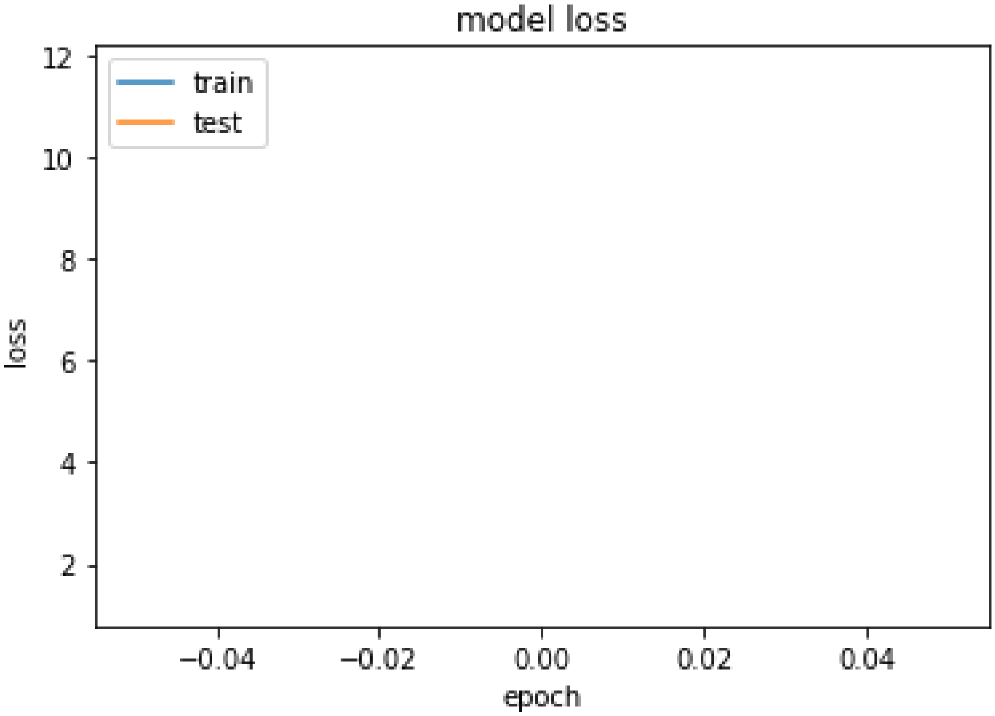
```
preHistory3 = modelPre3.
 ↪fit(trainGeneratorPre3,validation_data=valGeneratorPre3, epochs=10)
```

```
53/53 [==============================] - 1821s 34s/step - loss: 1.2982 -
accuracy: 0.6144 - val_loss: 11.6717 - val_accuracy: 0.2759
```

[144]:

```
plot_history(preHistory3)
```


model accuracy
train
test
accuracy
0.60
0.55
0.50
0.45
0.40
0.35
0.30
−0.04
−0.02
0.00
0.02
0.04
epoch


model loss
train
test
loss
12
10
8
6
4
2
−0.04
−0.02
0.00
0.02
0.04
epoch

```
[145]: print(modelPre3.evaluate(testGeneratorPre3))
```

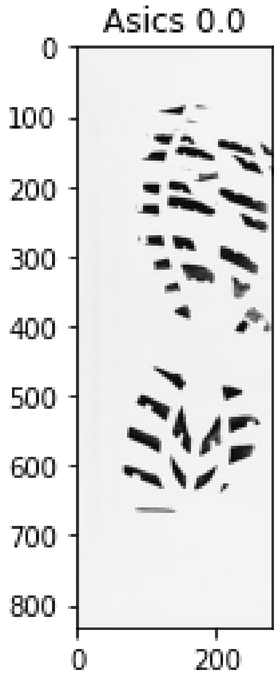
```
16/16 [==============================] - 66s 4s/step - loss: 11.0943 - accuracy:
0.3117
[11.094273567199707, 0.3116883039474487З]
```

```
[146]: test = np.empty([280,832], dtype=int)

       test = np.array([io.imread("images/"+p) for p in shoes_test.X.values])
       pre_predicted_y3 = modelPre3.predict(test)
```

```
5/5 [==============================] - 68s 12s/step
```

```
[147]: showResult(pre_predicted_y3[0],shoes_test.iloc[0], True)
```

```
[0. 0. 0. 0. 1. 0. 0.]
[4 0 1 2 3 5 6]
```



```
[152]: checkAccuracyFirstPositions(pre_predicted_y3, shoes_test,3)
```

```
91
0.5909090909090909
```

```
[ ]: modelPre4 = models.Sequential()
     modelPre4.add(ResNet50(include_top=False, input_shape=(832, 280, 3),
                        weights="imagenet", classes = num_classes,␣
     ↪classifier_activation="softmax"))
     modelPre4.add(Flatten())

     modelPre4.summary()

     modelPre4.compile(optimizer='adam',
                   loss=tf.keras.losses.
     ↪SparseCategoricalCrossentropy(from_logits=False),
                   metrics=['accuracy'])

     trainGeneratorPre4=DataGenerator2dFootwear(shoes_train['X'].
     ↪tolist(),df_shoe_brand,False, "images/", False, False, False)
     testGeneratorPre4=DataGenerator2dFootwear(shoes_test['X'].
     ↪tolist(),df_shoe_brand,False, "images/", False, False, False)
     valGeneratorPre4=DataGenerator2dFootwear(shoes_val['X'].
     ↪tolist(),df_shoe_brand,False, "images/",False, False, False)
```

[ ]:

```
preHistory4 = modelPre4.
 ↪fit(trainGeneratorPre4,validation_data=valGeneratorPre4, epochs=10)
```

[ ]:

```
print(modelPre4.evaluate(testGeneratorPre4))
```

[ ]:

```
test = np.empty([280,832], dtype=int)

test = np.array([io.imread("images/"+p) for p in shoes_test.X.values])
pre_predicted_y4 = modelPre4.predict(test)
```

[ ]:

```
checkAccuracyFirstPositions(pre_predicted_y4, shoes_test,1)
```

[ ]:

```
checkAccuracyFirstPositions(pre_predicted_y4, shoes_test,3)
```

### 4.3 Análisis de resultados

https://pypi.org/project/tabulate/