

copia-de-clasification-cats-dogs

March 1, 2023

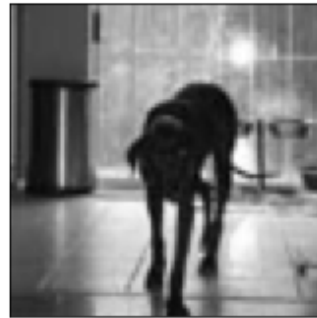
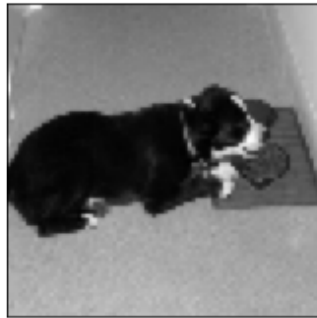
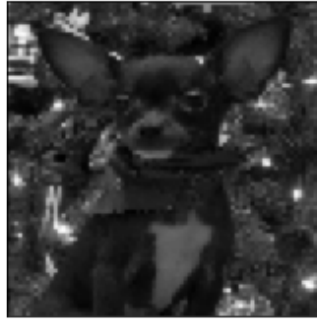
```
[ ]: # Import
import tensorflow as tf
import tensorflow_datasets as tfds
import matplotlib.pyplot as plt
import cv2
from google.colab.patches import cv2_imshow
import numpy as np
from tensorflow.keras.callbacks import TensorBoard
```

```
[ ]: #Importamos los datos
data, metadata = tfds.load('cats_vs_dogs', as_supervised = True, with_info =
↪True)
```

```
[ ]: #Vamos a ver los datos
#Tamaño de las imagenes
plt.figure(figsize = (10,10))

#Píxeles
size_img = 80

for i, (imagen, etiqueta) in enumerate(data['train'].take(3)):
    imagen = cv2.resize(imagen.numpy(), (size_img, size_img))
    imagen = cv2.cvtColor(imagen, cv2.COLOR_BGR2GRAY)
    plt.subplot(3,3,i+1)
    plt.xticks([])
    plt.yticks([])
    plt.imshow(imagen, cmap = 'gray')
```



```
[ ]: #Pasar todas a gris y redimensionar  
data_train = []  
  
for i, (imagen, etiqueta) in enumerate(data['train']):  
    imagen = cv2.resize(imagen.numpy(), (size_img, size_img))  
    imagen = cv2.cvtColor(imagen, cv2.COLOR_BGR2GRAY)  
    imagen = imagen.reshape(size_img, size_img, 1)  
    data_train.append([imagen, etiqueta])
```

```
[ ]: #Número de imágenes en el dataset  
len(data_train)
```

```
[ ]: 23262
```

```
[ ]: #Dividir entre X e Y
X = []
y = []

for imagen, etiqueta in data_train:
    X.append(imagen)
    y.append(etiqueta)
```

```
[ ]: #Normalización de valores
X = np.array(X).astype(float) / 255
y = np.array(y)

print(X.shape) #Imagenes, dimensionxdimension, 1 escala de color
print(y)
```

(23262, 80, 80, 1)

[1 1 1 ... 0 1 0]

Modelo Denso

```
[ ]: #Crear los modelos iniciales
modeloDenso = tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(80, 80, 1)),
    tf.keras.layers.Dense(150, activation='relu'), #Capa densa 150 neuronas
    tf.keras.layers.Dense(150, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid') #Usan sigmoid como salida (en
    ↪ lugar de softmax) para mostrar como podria funcionar con dicha funcion de
    ↪ activacion.
])
```

Modelos convolucionales

```
[ ]: modeloCNN = tf.keras.models.Sequential([ #Red convolucional
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(80, 80, 1)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(100, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

modeloCNN2 = tf.keras.models.Sequential([ #Red convolucional pero con un Dropout
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(80, 80, 1)),
    tf.keras.layers.MaxPooling2D(2, 2),
```

```

tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
tf.keras.layers.MaxPooling2D(2, 2),
tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
tf.keras.layers.MaxPooling2D(2, 2),

tf.keras.layers.Dropout(0.5), #Dropout para evitar sobreajuste
tf.keras.layers.Flatten(),
tf.keras.layers.Dense(250, activation='relu'),
tf.keras.layers.Dense(1, activation='sigmoid')
])

```

```

[ ]: #Compilar modelos. Usar crossentropy binario ya que tenemos solo 2 opciones
      ↪ (perro o gato)
modeloDense.compile(optimizer='adam',
                    loss='binary_crossentropy',
                    metrics=['accuracy'])

modeloCNN.compile(optimizer='adam',
                 loss='binary_crossentropy',
                 metrics=['accuracy'])

modeloCNN2.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])

```

```

[ ]: tensorboardDense = TensorBoard(log_dir='logs/dense')
      #Indicamos division y epocas
modeloDense.fit(X, y, batch_size=32, validation_split=0.
      ↪ 15, epochs=100, callbacks=[tensorboardDense])

```

```

Epoch 1/100
618/618 [=====] - 4s 5ms/step - loss: 0.6993 -
accuracy: 0.5433 - val_loss: 0.6697 - val_accuracy: 0.5825
Epoch 2/100
618/618 [=====] - 3s 4ms/step - loss: 0.6762 -
accuracy: 0.5742 - val_loss: 0.6785 - val_accuracy: 0.5814
Epoch 3/100
618/618 [=====] - 3s 5ms/step - loss: 0.6659 -
accuracy: 0.5922 - val_loss: 0.6618 - val_accuracy: 0.6011
Epoch 4/100
618/618 [=====] - 2s 4ms/step - loss: 0.6633 -
accuracy: 0.5975 - val_loss: 0.6625 - val_accuracy: 0.6069
Epoch 5/100
618/618 [=====] - 3s 4ms/step - loss: 0.6573 -
accuracy: 0.6091 - val_loss: 0.6624 - val_accuracy: 0.6014
Epoch 6/100
618/618 [=====] - 3s 4ms/step - loss: 0.6543 -

```

accuracy: 0.6133 - val_loss: 0.6748 - val_accuracy: 0.5917
 Epoch 7/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6548 -
 accuracy: 0.6145 - val_loss: 0.6637 - val_accuracy: 0.6069
 Epoch 8/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6542 -
 accuracy: 0.6128 - val_loss: 0.6679 - val_accuracy: 0.5951
 Epoch 9/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6501 -
 accuracy: 0.6200 - val_loss: 0.6641 - val_accuracy: 0.6077
 Epoch 10/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6494 -
 accuracy: 0.6205 - val_loss: 0.6601 - val_accuracy: 0.6032
 Epoch 11/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6490 -
 accuracy: 0.6190 - val_loss: 0.6631 - val_accuracy: 0.6032
 Epoch 12/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6458 -
 accuracy: 0.6284 - val_loss: 0.6669 - val_accuracy: 0.6029
 Epoch 13/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6452 -
 accuracy: 0.6272 - val_loss: 0.6631 - val_accuracy: 0.6029
 Epoch 14/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6447 -
 accuracy: 0.6242 - val_loss: 0.6645 - val_accuracy: 0.6029
 Epoch 15/100
 618/618 [=====] - 2s 4ms/step - loss: 0.6432 -
 accuracy: 0.6278 - val_loss: 0.6624 - val_accuracy: 0.6080
 Epoch 16/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6446 -
 accuracy: 0.6265 - val_loss: 0.6691 - val_accuracy: 0.5897
 Epoch 17/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6421 -
 accuracy: 0.6309 - val_loss: 0.6636 - val_accuracy: 0.6095
 Epoch 18/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6406 -
 accuracy: 0.6278 - val_loss: 0.6640 - val_accuracy: 0.6023
 Epoch 19/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6429 -
 accuracy: 0.6278 - val_loss: 0.6684 - val_accuracy: 0.5885
 Epoch 20/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6384 -
 accuracy: 0.6325 - val_loss: 0.6658 - val_accuracy: 0.6100
 Epoch 21/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6372 -
 accuracy: 0.6356 - val_loss: 0.6631 - val_accuracy: 0.6043
 Epoch 22/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6382 -

accuracy: 0.6332 - val_loss: 0.6634 - val_accuracy: 0.6132
Epoch 23/100
618/618 [=====] - 3s 4ms/step - loss: 0.6350 -
accuracy: 0.6382 - val_loss: 0.6660 - val_accuracy: 0.6014
Epoch 24/100
618/618 [=====] - 2s 4ms/step - loss: 0.6331 -
accuracy: 0.6413 - val_loss: 0.6640 - val_accuracy: 0.6126
Epoch 25/100
618/618 [=====] - 3s 5ms/step - loss: 0.6330 -
accuracy: 0.6399 - val_loss: 0.6598 - val_accuracy: 0.6080
Epoch 26/100
618/618 [=====] - 3s 5ms/step - loss: 0.6302 -
accuracy: 0.6440 - val_loss: 0.6694 - val_accuracy: 0.6086
Epoch 27/100
618/618 [=====] - 3s 4ms/step - loss: 0.6330 -
accuracy: 0.6403 - val_loss: 0.6607 - val_accuracy: 0.6072
Epoch 28/100
618/618 [=====] - 3s 4ms/step - loss: 0.6299 -
accuracy: 0.6456 - val_loss: 0.6632 - val_accuracy: 0.6095
Epoch 29/100
618/618 [=====] - 3s 4ms/step - loss: 0.6278 -
accuracy: 0.6463 - val_loss: 0.6640 - val_accuracy: 0.6046
Epoch 30/100
618/618 [=====] - 3s 5ms/step - loss: 0.6268 -
accuracy: 0.6514 - val_loss: 0.6610 - val_accuracy: 0.5983
Epoch 31/100
618/618 [=====] - 3s 4ms/step - loss: 0.6260 -
accuracy: 0.6519 - val_loss: 0.6708 - val_accuracy: 0.6074
Epoch 32/100
618/618 [=====] - 3s 4ms/step - loss: 0.6248 -
accuracy: 0.6484 - val_loss: 0.6713 - val_accuracy: 0.6049
Epoch 33/100
618/618 [=====] - 2s 4ms/step - loss: 0.6237 -
accuracy: 0.6512 - val_loss: 0.6641 - val_accuracy: 0.6066
Epoch 34/100
618/618 [=====] - 3s 5ms/step - loss: 0.6226 -
accuracy: 0.6546 - val_loss: 0.6602 - val_accuracy: 0.6103
Epoch 35/100
618/618 [=====] - 3s 5ms/step - loss: 0.6208 -
accuracy: 0.6546 - val_loss: 0.6688 - val_accuracy: 0.6060
Epoch 36/100
618/618 [=====] - 2s 4ms/step - loss: 0.6225 -
accuracy: 0.6544 - val_loss: 0.6813 - val_accuracy: 0.5897
Epoch 37/100
618/618 [=====] - 3s 4ms/step - loss: 0.6174 -
accuracy: 0.6585 - val_loss: 0.6665 - val_accuracy: 0.6109
Epoch 38/100
618/618 [=====] - 3s 4ms/step - loss: 0.6179 -

accuracy: 0.6566 - val_loss: 0.6723 - val_accuracy: 0.6029
 Epoch 39/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6144 -
 accuracy: 0.6641 - val_loss: 0.6659 - val_accuracy: 0.6020
 Epoch 40/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6129 -
 accuracy: 0.6650 - val_loss: 0.7037 - val_accuracy: 0.5817
 Epoch 41/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6120 -
 accuracy: 0.6643 - val_loss: 0.6821 - val_accuracy: 0.6020
 Epoch 42/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6107 -
 accuracy: 0.6656 - val_loss: 0.6725 - val_accuracy: 0.6052
 Epoch 43/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6095 -
 accuracy: 0.6683 - val_loss: 0.7017 - val_accuracy: 0.6066
 Epoch 44/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6065 -
 accuracy: 0.6713 - val_loss: 0.6734 - val_accuracy: 0.5926
 Epoch 45/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6027 -
 accuracy: 0.6756 - val_loss: 0.6922 - val_accuracy: 0.5819
 Epoch 46/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6039 -
 accuracy: 0.6722 - val_loss: 0.6827 - val_accuracy: 0.6011
 Epoch 47/100
 618/618 [=====] - 2s 4ms/step - loss: 0.6035 -
 accuracy: 0.6736 - val_loss: 0.6897 - val_accuracy: 0.5883
 Epoch 48/100
 618/618 [=====] - 3s 5ms/step - loss: 0.6037 -
 accuracy: 0.6742 - val_loss: 0.6970 - val_accuracy: 0.5765
 Epoch 49/100
 618/618 [=====] - 2s 4ms/step - loss: 0.5981 -
 accuracy: 0.6816 - val_loss: 0.6937 - val_accuracy: 0.6000
 Epoch 50/100
 618/618 [=====] - 2s 4ms/step - loss: 0.5985 -
 accuracy: 0.6786 - val_loss: 0.6988 - val_accuracy: 0.5968
 Epoch 51/100
 618/618 [=====] - 3s 4ms/step - loss: 0.6000 -
 accuracy: 0.6777 - val_loss: 0.6951 - val_accuracy: 0.5797
 Epoch 52/100
 618/618 [=====] - 3s 5ms/step - loss: 0.5955 -
 accuracy: 0.6831 - val_loss: 0.6874 - val_accuracy: 0.5934
 Epoch 53/100
 618/618 [=====] - 3s 5ms/step - loss: 0.5947 -
 accuracy: 0.6810 - val_loss: 0.6774 - val_accuracy: 0.5960
 Epoch 54/100
 618/618 [=====] - 3s 4ms/step - loss: 0.5888 -

accuracy: 0.6887 - val_loss: 0.7000 - val_accuracy: 0.5831
Epoch 55/100
618/618 [=====] - 3s 4ms/step - loss: 0.5906 -
accuracy: 0.6881 - val_loss: 0.7127 - val_accuracy: 0.5885
Epoch 56/100
618/618 [=====] - 3s 4ms/step - loss: 0.5886 -
accuracy: 0.6902 - val_loss: 0.7316 - val_accuracy: 0.5736
Epoch 57/100
618/618 [=====] - 3s 5ms/step - loss: 0.5860 -
accuracy: 0.6901 - val_loss: 0.6960 - val_accuracy: 0.5891
Epoch 58/100
618/618 [=====] - 3s 4ms/step - loss: 0.5890 -
accuracy: 0.6894 - val_loss: 0.6896 - val_accuracy: 0.5968
Epoch 59/100
618/618 [=====] - 3s 4ms/step - loss: 0.5833 -
accuracy: 0.6949 - val_loss: 0.7150 - val_accuracy: 0.5966
Epoch 60/100
618/618 [=====] - 3s 4ms/step - loss: 0.5802 -
accuracy: 0.6945 - val_loss: 0.7183 - val_accuracy: 0.5891
Epoch 61/100
618/618 [=====] - 3s 5ms/step - loss: 0.5817 -
accuracy: 0.6952 - val_loss: 0.7405 - val_accuracy: 0.5837
Epoch 62/100
618/618 [=====] - 3s 5ms/step - loss: 0.5781 -
accuracy: 0.6973 - val_loss: 0.7103 - val_accuracy: 0.5937
Epoch 63/100
618/618 [=====] - 3s 4ms/step - loss: 0.5741 -
accuracy: 0.7054 - val_loss: 0.7141 - val_accuracy: 0.5971
Epoch 64/100
618/618 [=====] - 3s 4ms/step - loss: 0.5751 -
accuracy: 0.7007 - val_loss: 0.7051 - val_accuracy: 0.5991
Epoch 65/100
618/618 [=====] - 3s 4ms/step - loss: 0.5711 -
accuracy: 0.7059 - val_loss: 0.7071 - val_accuracy: 0.5911
Epoch 66/100
618/618 [=====] - 3s 5ms/step - loss: 0.5722 -
accuracy: 0.7056 - val_loss: 0.7124 - val_accuracy: 0.5931
Epoch 67/100
618/618 [=====] - 3s 4ms/step - loss: 0.5734 -
accuracy: 0.7015 - val_loss: 0.7093 - val_accuracy: 0.5754
Epoch 68/100
618/618 [=====] - 3s 4ms/step - loss: 0.5669 -
accuracy: 0.7113 - val_loss: 0.7096 - val_accuracy: 0.5900
Epoch 69/100
618/618 [=====] - 2s 4ms/step - loss: 0.5681 -
accuracy: 0.7066 - val_loss: 0.7167 - val_accuracy: 0.5888
Epoch 70/100
618/618 [=====] - 3s 5ms/step - loss: 0.5661 -

accuracy: 0.7095 - val_loss: 0.7097 - val_accuracy: 0.5871
Epoch 71/100
618/618 [=====] - 3s 5ms/step - loss: 0.5641 -
accuracy: 0.7137 - val_loss: 0.7315 - val_accuracy: 0.5768
Epoch 72/100
618/618 [=====] - 3s 4ms/step - loss: 0.5622 -
accuracy: 0.7109 - val_loss: 0.7182 - val_accuracy: 0.5923
Epoch 73/100
618/618 [=====] - 3s 4ms/step - loss: 0.5575 -
accuracy: 0.7191 - val_loss: 0.7392 - val_accuracy: 0.5874
Epoch 74/100
618/618 [=====] - 2s 4ms/step - loss: 0.5602 -
accuracy: 0.7136 - val_loss: 0.7392 - val_accuracy: 0.5817
Epoch 75/100
618/618 [=====] - 3s 5ms/step - loss: 0.5564 -
accuracy: 0.7197 - val_loss: 0.7334 - val_accuracy: 0.5691
Epoch 76/100
618/618 [=====] - 2s 4ms/step - loss: 0.5538 -
accuracy: 0.7185 - val_loss: 0.7314 - val_accuracy: 0.5900
Epoch 77/100
618/618 [=====] - 3s 4ms/step - loss: 0.5553 -
accuracy: 0.7190 - val_loss: 0.7584 - val_accuracy: 0.5891
Epoch 78/100
618/618 [=====] - 3s 4ms/step - loss: 0.5501 -
accuracy: 0.7217 - val_loss: 0.7519 - val_accuracy: 0.5682
Epoch 79/100
618/618 [=====] - 3s 5ms/step - loss: 0.5446 -
accuracy: 0.7293 - val_loss: 0.7488 - val_accuracy: 0.5819
Epoch 80/100
618/618 [=====] - 3s 5ms/step - loss: 0.5533 -
accuracy: 0.7214 - val_loss: 0.8019 - val_accuracy: 0.5736
Epoch 81/100
618/618 [=====] - 3s 4ms/step - loss: 0.5461 -
accuracy: 0.7261 - val_loss: 0.7175 - val_accuracy: 0.5782
Epoch 82/100
618/618 [=====] - 3s 4ms/step - loss: 0.5517 -
accuracy: 0.7243 - val_loss: 0.7461 - val_accuracy: 0.5696
Epoch 83/100
618/618 [=====] - 3s 4ms/step - loss: 0.5478 -
accuracy: 0.7247 - val_loss: 0.7367 - val_accuracy: 0.5739
Epoch 84/100
618/618 [=====] - 3s 5ms/step - loss: 0.5380 -
accuracy: 0.7347 - val_loss: 0.7541 - val_accuracy: 0.5851
Epoch 85/100
618/618 [=====] - 3s 4ms/step - loss: 0.5356 -
accuracy: 0.7348 - val_loss: 0.7469 - val_accuracy: 0.5854
Epoch 86/100
618/618 [=====] - 3s 4ms/step - loss: 0.5388 -

```

accuracy: 0.7302 - val_loss: 0.7672 - val_accuracy: 0.5779
Epoch 87/100
618/618 [=====] - 3s 4ms/step - loss: 0.5321 -
accuracy: 0.7390 - val_loss: 0.8091 - val_accuracy: 0.5828
Epoch 88/100
618/618 [=====] - 3s 5ms/step - loss: 0.5370 -
accuracy: 0.7349 - val_loss: 0.7666 - val_accuracy: 0.5756
Epoch 89/100
618/618 [=====] - 3s 4ms/step - loss: 0.5384 -
accuracy: 0.7339 - val_loss: 0.7753 - val_accuracy: 0.5797
Epoch 90/100
618/618 [=====] - 2s 4ms/step - loss: 0.5305 -
accuracy: 0.7403 - val_loss: 0.7595 - val_accuracy: 0.5759
Epoch 91/100
618/618 [=====] - 2s 4ms/step - loss: 0.5283 -
accuracy: 0.7421 - val_loss: 0.7824 - val_accuracy: 0.5628
Epoch 92/100
618/618 [=====] - 3s 4ms/step - loss: 0.5267 -
accuracy: 0.7411 - val_loss: 0.7680 - val_accuracy: 0.5819
Epoch 93/100
618/618 [=====] - 3s 5ms/step - loss: 0.5266 -
accuracy: 0.7417 - val_loss: 0.7772 - val_accuracy: 0.5819
Epoch 94/100
618/618 [=====] - 3s 4ms/step - loss: 0.5254 -
accuracy: 0.7432 - val_loss: 0.7881 - val_accuracy: 0.5745
Epoch 95/100
618/618 [=====] - 3s 4ms/step - loss: 0.5205 -
accuracy: 0.7482 - val_loss: 0.8010 - val_accuracy: 0.5791
Epoch 96/100
618/618 [=====] - 3s 4ms/step - loss: 0.5162 -
accuracy: 0.7515 - val_loss: 0.8063 - val_accuracy: 0.5805
Epoch 97/100
618/618 [=====] - 3s 5ms/step - loss: 0.5238 -
accuracy: 0.7437 - val_loss: 0.7820 - val_accuracy: 0.5848
Epoch 98/100
618/618 [=====] - 3s 5ms/step - loss: 0.5229 -
accuracy: 0.7457 - val_loss: 0.7747 - val_accuracy: 0.5754
Epoch 99/100
618/618 [=====] - 3s 4ms/step - loss: 0.5250 -
accuracy: 0.7449 - val_loss: 0.8275 - val_accuracy: 0.5791
Epoch 100/100
618/618 [=====] - 3s 4ms/step - loss: 0.5145 -
accuracy: 0.7512 - val_loss: 0.7949 - val_accuracy: 0.5845

```

```
[ ]: <keras.callbacks.History at 0x7f101c5acbe0>
```

```
[ ]: tensorboardCNN = TensorBoard(log_dir='logs/CNN')
#Indicamos division y epocas
modeloCNN.fit(X, y, batch_size=32, validation_split=0.
↳ 15, epochs=100, callbacks=[tensorboardCNN])
```

Epoch 1/100

618/618 [=====] - 14s 10ms/step - loss: 0.6325 - accuracy: 0.6265 - val_loss: 0.5520 - val_accuracy: 0.7146

Epoch 2/100

618/618 [=====] - 5s 9ms/step - loss: 0.4996 - accuracy: 0.7572 - val_loss: 0.4789 - val_accuracy: 0.7762

Epoch 3/100

618/618 [=====] - 6s 9ms/step - loss: 0.4412 - accuracy: 0.7918 - val_loss: 0.4385 - val_accuracy: 0.7991

Epoch 4/100

618/618 [=====] - 5s 9ms/step - loss: 0.3877 - accuracy: 0.8225 - val_loss: 0.4204 - val_accuracy: 0.8037

Epoch 5/100

618/618 [=====] - 6s 9ms/step - loss: 0.3443 - accuracy: 0.8456 - val_loss: 0.4012 - val_accuracy: 0.8201

Epoch 6/100

618/618 [=====] - 5s 8ms/step - loss: 0.2971 - accuracy: 0.8689 - val_loss: 0.3971 - val_accuracy: 0.8232

Epoch 7/100

618/618 [=====] - 6s 9ms/step - loss: 0.2511 - accuracy: 0.8915 - val_loss: 0.4040 - val_accuracy: 0.8307

Epoch 8/100

618/618 [=====] - 5s 9ms/step - loss: 0.1965 - accuracy: 0.9195 - val_loss: 0.4242 - val_accuracy: 0.8335

Epoch 9/100

618/618 [=====] - 5s 9ms/step - loss: 0.1483 - accuracy: 0.9431 - val_loss: 0.4784 - val_accuracy: 0.8215

Epoch 10/100

618/618 [=====] - 5s 9ms/step - loss: 0.1106 - accuracy: 0.9583 - val_loss: 0.5714 - val_accuracy: 0.8221

Epoch 11/100

618/618 [=====] - 6s 9ms/step - loss: 0.0763 - accuracy: 0.9718 - val_loss: 0.5945 - val_accuracy: 0.8266

Epoch 12/100

618/618 [=====] - 6s 9ms/step - loss: 0.0590 - accuracy: 0.9794 - val_loss: 0.6884 - val_accuracy: 0.8223

Epoch 13/100

618/618 [=====] - 5s 9ms/step - loss: 0.0494 - accuracy: 0.9836 - val_loss: 0.7167 - val_accuracy: 0.8315

Epoch 14/100

618/618 [=====] - 6s 9ms/step - loss: 0.0424 - accuracy: 0.9858 - val_loss: 0.7844 - val_accuracy: 0.8175

Epoch 15/100
618/618 [=====] - 5s 8ms/step - loss: 0.0418 -
accuracy: 0.9857 - val_loss: 0.8469 - val_accuracy: 0.8287
Epoch 16/100
618/618 [=====] - 6s 9ms/step - loss: 0.0375 -
accuracy: 0.9875 - val_loss: 0.8449 - val_accuracy: 0.8221
Epoch 17/100
618/618 [=====] - 5s 8ms/step - loss: 0.0209 -
accuracy: 0.9936 - val_loss: 0.8471 - val_accuracy: 0.8201
Epoch 18/100
618/618 [=====] - 6s 9ms/step - loss: 0.0310 -
accuracy: 0.9898 - val_loss: 0.9288 - val_accuracy: 0.8244
Epoch 19/100
618/618 [=====] - 5s 9ms/step - loss: 0.0255 -
accuracy: 0.9916 - val_loss: 1.0449 - val_accuracy: 0.8261
Epoch 20/100
618/618 [=====] - 5s 8ms/step - loss: 0.0255 -
accuracy: 0.9908 - val_loss: 1.0002 - val_accuracy: 0.8218
Epoch 21/100
618/618 [=====] - 6s 10ms/step - loss: 0.0227 -
accuracy: 0.9927 - val_loss: 1.0120 - val_accuracy: 0.8160
Epoch 22/100
618/618 [=====] - 6s 9ms/step - loss: 0.0264 -
accuracy: 0.9911 - val_loss: 1.0473 - val_accuracy: 0.8264
Epoch 23/100
618/618 [=====] - 6s 10ms/step - loss: 0.0282 -
accuracy: 0.9899 - val_loss: 1.1720 - val_accuracy: 0.8266
Epoch 24/100
618/618 [=====] - 6s 9ms/step - loss: 0.0177 -
accuracy: 0.9945 - val_loss: 1.1779 - val_accuracy: 0.8255
Epoch 25/100
618/618 [=====] - 6s 9ms/step - loss: 0.0208 -
accuracy: 0.9932 - val_loss: 1.0619 - val_accuracy: 0.8278
Epoch 26/100
618/618 [=====] - 5s 8ms/step - loss: 0.0217 -
accuracy: 0.9942 - val_loss: 1.2424 - val_accuracy: 0.8115
Epoch 27/100
618/618 [=====] - 6s 9ms/step - loss: 0.0069 -
accuracy: 0.9981 - val_loss: 1.3262 - val_accuracy: 0.8209
Epoch 28/100
618/618 [=====] - 6s 9ms/step - loss: 0.0272 -
accuracy: 0.9910 - val_loss: 1.2079 - val_accuracy: 0.8163
Epoch 29/100
618/618 [=====] - 6s 9ms/step - loss: 0.0220 -
accuracy: 0.9928 - val_loss: 1.1330 - val_accuracy: 0.8226
Epoch 30/100
618/618 [=====] - 5s 9ms/step - loss: 0.0108 -
accuracy: 0.9967 - val_loss: 1.2933 - val_accuracy: 0.8269

Epoch 31/100
618/618 [=====] - 5s 8ms/step - loss: 0.0190 -
accuracy: 0.9938 - val_loss: 1.4541 - val_accuracy: 0.7986
Epoch 32/100
618/618 [=====] - 6s 9ms/step - loss: 0.0242 -
accuracy: 0.9920 - val_loss: 1.3810 - val_accuracy: 0.8143
Epoch 33/100
618/618 [=====] - 5s 9ms/step - loss: 0.0112 -
accuracy: 0.9966 - val_loss: 1.3323 - val_accuracy: 0.8218
Epoch 34/100
618/618 [=====] - 6s 9ms/step - loss: 0.0125 -
accuracy: 0.9960 - val_loss: 1.6085 - val_accuracy: 0.7860
Epoch 35/100
618/618 [=====] - 5s 8ms/step - loss: 0.0348 -
accuracy: 0.9886 - val_loss: 1.2714 - val_accuracy: 0.8229
Epoch 36/100
618/618 [=====] - 6s 10ms/step - loss: 0.0159 -
accuracy: 0.9950 - val_loss: 1.3862 - val_accuracy: 0.8244
Epoch 37/100
618/618 [=====] - 5s 8ms/step - loss: 0.0187 -
accuracy: 0.9947 - val_loss: 1.3113 - val_accuracy: 0.8146
Epoch 38/100
618/618 [=====] - 6s 9ms/step - loss: 0.0092 -
accuracy: 0.9974 - val_loss: 1.2514 - val_accuracy: 0.8183
Epoch 39/100
618/618 [=====] - 5s 9ms/step - loss: 0.0163 -
accuracy: 0.9951 - val_loss: 1.3189 - val_accuracy: 0.8221
Epoch 40/100
618/618 [=====] - 5s 9ms/step - loss: 0.0064 -
accuracy: 0.9982 - val_loss: 1.5794 - val_accuracy: 0.8060
Epoch 41/100
618/618 [=====] - 6s 9ms/step - loss: 0.0251 -
accuracy: 0.9925 - val_loss: 1.4037 - val_accuracy: 0.8152
Epoch 42/100
618/618 [=====] - 5s 8ms/step - loss: 0.0088 -
accuracy: 0.9973 - val_loss: 1.5341 - val_accuracy: 0.8298
Epoch 43/100
618/618 [=====] - 6s 9ms/step - loss: 0.0274 -
accuracy: 0.9917 - val_loss: 1.3264 - val_accuracy: 0.8192
Epoch 44/100
618/618 [=====] - 5s 8ms/step - loss: 0.0147 -
accuracy: 0.9954 - val_loss: 1.3506 - val_accuracy: 0.8149
Epoch 45/100
618/618 [=====] - 6s 9ms/step - loss: 0.0126 -
accuracy: 0.9961 - val_loss: 1.5146 - val_accuracy: 0.8275
Epoch 46/100
618/618 [=====] - 5s 9ms/step - loss: 0.0066 -
accuracy: 0.9983 - val_loss: 1.4588 - val_accuracy: 0.8143

Epoch 47/100
618/618 [=====] - 6s 10ms/step - loss: 0.0209 -
accuracy: 0.9943 - val_loss: 1.4100 - val_accuracy: 0.8203
Epoch 48/100
618/618 [=====] - 5s 9ms/step - loss: 0.0145 -
accuracy: 0.9951 - val_loss: 1.5127 - val_accuracy: 0.8212
Epoch 49/100
618/618 [=====] - 6s 9ms/step - loss: 0.0144 -
accuracy: 0.9958 - val_loss: 1.5444 - val_accuracy: 0.8138
Epoch 50/100
618/618 [=====] - 6s 9ms/step - loss: 0.0112 -
accuracy: 0.9962 - val_loss: 1.5657 - val_accuracy: 0.8241
Epoch 51/100
618/618 [=====] - 6s 9ms/step - loss: 0.0090 -
accuracy: 0.9972 - val_loss: 1.6428 - val_accuracy: 0.8074
Epoch 52/100
618/618 [=====] - 6s 9ms/step - loss: 0.0119 -
accuracy: 0.9966 - val_loss: 1.6599 - val_accuracy: 0.8020
Epoch 53/100
618/618 [=====] - 6s 9ms/step - loss: 0.0091 -
accuracy: 0.9976 - val_loss: 1.5951 - val_accuracy: 0.8203
Epoch 54/100
618/618 [=====] - 6s 9ms/step - loss: 0.0014 -
accuracy: 0.9998 - val_loss: 1.6578 - val_accuracy: 0.8246
Epoch 55/100
618/618 [=====] - 6s 10ms/step - loss: 5.6855e-04 -
accuracy: 0.9999 - val_loss: 1.6794 - val_accuracy: 0.8258
Epoch 56/100
618/618 [=====] - 6s 9ms/step - loss: 8.2255e-04 -
accuracy: 0.9999 - val_loss: 1.6792 - val_accuracy: 0.8258
Epoch 57/100
618/618 [=====] - 6s 9ms/step - loss: 3.3192e-04 -
accuracy: 0.9999 - val_loss: 1.7296 - val_accuracy: 0.8249
Epoch 58/100
618/618 [=====] - 6s 10ms/step - loss: 0.0249 -
accuracy: 0.9929 - val_loss: 1.5300 - val_accuracy: 0.8074
Epoch 59/100
618/618 [=====] - 5s 9ms/step - loss: 0.0341 -
accuracy: 0.9898 - val_loss: 1.3731 - val_accuracy: 0.8106
Epoch 60/100
618/618 [=====] - 6s 9ms/step - loss: 0.0116 -
accuracy: 0.9958 - val_loss: 1.5688 - val_accuracy: 0.8255
Epoch 61/100
618/618 [=====] - 5s 9ms/step - loss: 0.0038 -
accuracy: 0.9991 - val_loss: 1.5224 - val_accuracy: 0.8289
Epoch 62/100
618/618 [=====] - 6s 9ms/step - loss: 0.0125 -
accuracy: 0.9961 - val_loss: 1.6435 - val_accuracy: 0.8181

Epoch 63/100
618/618 [=====] - 6s 9ms/step - loss: 0.0149 -
accuracy: 0.9950 - val_loss: 1.5633 - val_accuracy: 0.8212
Epoch 64/100
618/618 [=====] - 5s 8ms/step - loss: 0.0109 -
accuracy: 0.9973 - val_loss: 1.6026 - val_accuracy: 0.8155
Epoch 65/100
618/618 [=====] - 6s 10ms/step - loss: 0.0114 -
accuracy: 0.9966 - val_loss: 1.5977 - val_accuracy: 0.8272
Epoch 66/100
618/618 [=====] - 5s 8ms/step - loss: 0.0129 -
accuracy: 0.9952 - val_loss: 1.7844 - val_accuracy: 0.8138
Epoch 67/100
618/618 [=====] - 6s 9ms/step - loss: 0.0151 -
accuracy: 0.9954 - val_loss: 1.5740 - val_accuracy: 0.8123
Epoch 68/100
618/618 [=====] - 5s 9ms/step - loss: 0.0041 -
accuracy: 0.9984 - val_loss: 1.9015 - val_accuracy: 0.8181
Epoch 69/100
618/618 [=====] - 6s 9ms/step - loss: 0.0130 -
accuracy: 0.9959 - val_loss: 1.7787 - val_accuracy: 0.8183
Epoch 70/100
618/618 [=====] - 6s 9ms/step - loss: 0.0122 -
accuracy: 0.9961 - val_loss: 1.8660 - val_accuracy: 0.8160
Epoch 71/100
618/618 [=====] - 6s 9ms/step - loss: 0.0097 -
accuracy: 0.9967 - val_loss: 1.6706 - val_accuracy: 0.8269
Epoch 72/100
618/618 [=====] - 6s 9ms/step - loss: 0.0026 -
accuracy: 0.9992 - val_loss: 1.8165 - val_accuracy: 0.8278
Epoch 73/100
618/618 [=====] - 6s 9ms/step - loss: 0.0121 -
accuracy: 0.9964 - val_loss: 1.6991 - val_accuracy: 0.8169
Epoch 74/100
618/618 [=====] - 5s 9ms/step - loss: 0.0176 -
accuracy: 0.9952 - val_loss: 1.6404 - val_accuracy: 0.8181
Epoch 75/100
618/618 [=====] - 6s 9ms/step - loss: 0.0091 -
accuracy: 0.9969 - val_loss: 1.9121 - val_accuracy: 0.8258
Epoch 76/100
618/618 [=====] - 6s 9ms/step - loss: 0.0039 -
accuracy: 0.9989 - val_loss: 1.7710 - val_accuracy: 0.8043
Epoch 77/100
618/618 [=====] - 5s 9ms/step - loss: 0.0129 -
accuracy: 0.9959 - val_loss: 1.7303 - val_accuracy: 0.8212
Epoch 78/100
618/618 [=====] - 6s 9ms/step - loss: 0.0119 -
accuracy: 0.9963 - val_loss: 1.7714 - val_accuracy: 0.8212

Epoch 79/100
618/618 [=====] - 5s 9ms/step - loss: 0.0103 -
accuracy: 0.9966 - val_loss: 1.8435 - val_accuracy: 0.8163
Epoch 80/100
618/618 [=====] - 6s 10ms/step - loss: 0.0108 -
accuracy: 0.9966 - val_loss: 1.8221 - val_accuracy: 0.8092
Epoch 81/100
618/618 [=====] - 5s 9ms/step - loss: 0.0075 -
accuracy: 0.9970 - val_loss: 1.9265 - val_accuracy: 0.8232
Epoch 82/100
618/618 [=====] - 6s 10ms/step - loss: 0.0196 -
accuracy: 0.9946 - val_loss: 1.8336 - val_accuracy: 0.8109
Epoch 83/100
618/618 [=====] - 5s 9ms/step - loss: 0.0081 -
accuracy: 0.9981 - val_loss: 1.8364 - val_accuracy: 0.8143
Epoch 84/100
618/618 [=====] - 6s 9ms/step - loss: 0.0042 -
accuracy: 0.9988 - val_loss: 1.8742 - val_accuracy: 0.8003
Epoch 85/100
618/618 [=====] - 6s 9ms/step - loss: 0.0125 -
accuracy: 0.9962 - val_loss: 2.4114 - val_accuracy: 0.8066
Epoch 86/100
618/618 [=====] - 6s 9ms/step - loss: 0.0110 -
accuracy: 0.9963 - val_loss: 1.8419 - val_accuracy: 0.8146
Epoch 87/100
618/618 [=====] - 6s 10ms/step - loss: 0.0086 -
accuracy: 0.9977 - val_loss: 2.0111 - val_accuracy: 0.8209
Epoch 88/100
618/618 [=====] - 6s 9ms/step - loss: 0.0034 -
accuracy: 0.9988 - val_loss: 1.8394 - val_accuracy: 0.8209
Epoch 89/100
618/618 [=====] - 6s 10ms/step - loss: 0.0127 -
accuracy: 0.9964 - val_loss: 1.8845 - val_accuracy: 0.8192
Epoch 90/100
618/618 [=====] - 5s 9ms/step - loss: 0.0097 -
accuracy: 0.9970 - val_loss: 1.9238 - val_accuracy: 0.8218
Epoch 91/100
618/618 [=====] - 6s 10ms/step - loss: 0.0090 -
accuracy: 0.9975 - val_loss: 1.8918 - val_accuracy: 0.8292
Epoch 92/100
618/618 [=====] - 6s 9ms/step - loss: 0.0063 -
accuracy: 0.9982 - val_loss: 1.8997 - val_accuracy: 0.8160
Epoch 93/100
618/618 [=====] - 6s 10ms/step - loss: 0.0097 -
accuracy: 0.9971 - val_loss: 1.9263 - val_accuracy: 0.8097
Epoch 94/100
618/618 [=====] - 6s 9ms/step - loss: 0.0117 -
accuracy: 0.9971 - val_loss: 1.9128 - val_accuracy: 0.8143


```
Epoch 95/100
618/618 [=====] - 6s 9ms/step - loss: 0.0127 -
accuracy: 0.9966 - val_loss: 1.9028 - val_accuracy: 0.8284
Epoch 96/100
618/618 [=====] - 5s 9ms/step - loss: 0.0034 -
accuracy: 0.9987 - val_loss: 2.0628 - val_accuracy: 0.8203
Epoch 97/100
618/618 [=====] - 6s 9ms/step - loss: 0.0147 -
accuracy: 0.9961 - val_loss: 2.1655 - val_accuracy: 0.8100
Epoch 98/100
618/618 [=====] - 6s 9ms/step - loss: 0.0124 -
accuracy: 0.9958 - val_loss: 2.0013 - val_accuracy: 0.8149
Epoch 99/100
618/618 [=====] - 6s 9ms/step - loss: 0.0038 -
accuracy: 0.9989 - val_loss: 2.0775 - val_accuracy: 0.8261
Epoch 100/100
618/618 [=====] - 6s 9ms/step - loss: 0.0013 -
accuracy: 0.9994 - val_loss: 2.1616 - val_accuracy: 0.8284
```

```
[ ]: <keras.callbacks.History at 0x7f1000621d90>
```

```
[ ]: tensorboardCNN2 = TensorBoard(log_dir='logs/CNN2')
#Indicamos division y epocas
modeloCNN2.fit(X, y, batch_size=32,validation_split=0.
↪15,epochs=100,callbacks=[tensorboardCNN2])
```

```
Epoch 1/100
618/618 [=====] - 9s 11ms/step - loss: 0.6344 -
accuracy: 0.6335 - val_loss: 0.5757 - val_accuracy: 0.6885
Epoch 2/100
618/618 [=====] - 7s 11ms/step - loss: 0.5083 -
accuracy: 0.7492 - val_loss: 0.4458 - val_accuracy: 0.7900
Epoch 3/100
618/618 [=====] - 7s 11ms/step - loss: 0.4447 -
accuracy: 0.7926 - val_loss: 0.4111 - val_accuracy: 0.8069
Epoch 4/100
618/618 [=====] - 6s 10ms/step - loss: 0.4064 -
accuracy: 0.8144 - val_loss: 0.3957 - val_accuracy: 0.8158
Epoch 5/100
618/618 [=====] - 7s 11ms/step - loss: 0.3737 -
accuracy: 0.8309 - val_loss: 0.3635 - val_accuracy: 0.8361
Epoch 6/100
618/618 [=====] - 7s 11ms/step - loss: 0.3381 -
accuracy: 0.8508 - val_loss: 0.3618 - val_accuracy: 0.8358
Epoch 7/100
618/618 [=====] - 7s 11ms/step - loss: 0.3025 -
accuracy: 0.8690 - val_loss: 0.3245 - val_accuracy: 0.8567
Epoch 8/100
```

618/618 [=====] - 6s 10ms/step - loss: 0.2732 -
accuracy: 0.8815 - val_loss: 0.3296 - val_accuracy: 0.8593
Epoch 9/100
618/618 [=====] - 7s 11ms/step - loss: 0.2505 -
accuracy: 0.8960 - val_loss: 0.3297 - val_accuracy: 0.8619
Epoch 10/100
618/618 [=====] - 7s 11ms/step - loss: 0.2210 -
accuracy: 0.9083 - val_loss: 0.3433 - val_accuracy: 0.8570
Epoch 11/100
618/618 [=====] - 6s 10ms/step - loss: 0.2003 -
accuracy: 0.9196 - val_loss: 0.3203 - val_accuracy: 0.8662
Epoch 12/100
618/618 [=====] - 7s 11ms/step - loss: 0.1769 -
accuracy: 0.9276 - val_loss: 0.3297 - val_accuracy: 0.8656
Epoch 13/100
618/618 [=====] - 6s 10ms/step - loss: 0.1524 -
accuracy: 0.9407 - val_loss: 0.3370 - val_accuracy: 0.8673
Epoch 14/100
618/618 [=====] - 7s 11ms/step - loss: 0.1389 -
accuracy: 0.9455 - val_loss: 0.3361 - val_accuracy: 0.8702
Epoch 15/100
618/618 [=====] - 7s 11ms/step - loss: 0.1221 -
accuracy: 0.9529 - val_loss: 0.3609 - val_accuracy: 0.8691
Epoch 16/100
618/618 [=====] - 7s 11ms/step - loss: 0.1086 -
accuracy: 0.9570 - val_loss: 0.3854 - val_accuracy: 0.8685
Epoch 17/100
618/618 [=====] - 7s 11ms/step - loss: 0.0954 -
accuracy: 0.9648 - val_loss: 0.4343 - val_accuracy: 0.8564
Epoch 18/100
618/618 [=====] - 7s 11ms/step - loss: 0.0948 -
accuracy: 0.9643 - val_loss: 0.4045 - val_accuracy: 0.8665
Epoch 19/100
618/618 [=====] - 7s 11ms/step - loss: 0.0804 -
accuracy: 0.9724 - val_loss: 0.4275 - val_accuracy: 0.8676
Epoch 20/100
618/618 [=====] - 7s 12ms/step - loss: 0.0887 -
accuracy: 0.9684 - val_loss: 0.4501 - val_accuracy: 0.8533
Epoch 21/100
618/618 [=====] - 7s 11ms/step - loss: 0.0750 -
accuracy: 0.9728 - val_loss: 0.4338 - val_accuracy: 0.8622
Epoch 22/100
618/618 [=====] - 7s 11ms/step - loss: 0.0657 -
accuracy: 0.9752 - val_loss: 0.4392 - val_accuracy: 0.8676
Epoch 23/100
618/618 [=====] - 7s 11ms/step - loss: 0.0633 -
accuracy: 0.9780 - val_loss: 0.4291 - val_accuracy: 0.8696
Epoch 24/100

618/618 [=====] - 6s 10ms/step - loss: 0.0677 -
accuracy: 0.9766 - val_loss: 0.5656 - val_accuracy: 0.8461
Epoch 25/100
618/618 [=====] - 7s 11ms/step - loss: 0.0636 -
accuracy: 0.9778 - val_loss: 0.4617 - val_accuracy: 0.8582
Epoch 26/100
618/618 [=====] - 7s 11ms/step - loss: 0.0507 -
accuracy: 0.9823 - val_loss: 0.4488 - val_accuracy: 0.8662
Epoch 27/100
618/618 [=====] - 7s 11ms/step - loss: 0.0558 -
accuracy: 0.9793 - val_loss: 0.4785 - val_accuracy: 0.8625
Epoch 28/100
618/618 [=====] - 6s 10ms/step - loss: 0.0512 -
accuracy: 0.9824 - val_loss: 0.4696 - val_accuracy: 0.8639
Epoch 29/100
618/618 [=====] - 7s 11ms/step - loss: 0.0535 -
accuracy: 0.9813 - val_loss: 0.4434 - val_accuracy: 0.8636
Epoch 30/100
618/618 [=====] - 7s 11ms/step - loss: 0.0527 -
accuracy: 0.9811 - val_loss: 0.5282 - val_accuracy: 0.8481
Epoch 31/100
618/618 [=====] - 7s 11ms/step - loss: 0.0462 -
accuracy: 0.9835 - val_loss: 0.4926 - val_accuracy: 0.8659
Epoch 32/100
618/618 [=====] - 7s 11ms/step - loss: 0.0384 -
accuracy: 0.9869 - val_loss: 0.4893 - val_accuracy: 0.8648
Epoch 33/100
618/618 [=====] - 6s 10ms/step - loss: 0.0469 -
accuracy: 0.9844 - val_loss: 0.4704 - val_accuracy: 0.8699
Epoch 34/100
618/618 [=====] - 7s 11ms/step - loss: 0.0414 -
accuracy: 0.9859 - val_loss: 0.5150 - val_accuracy: 0.8688
Epoch 35/100
618/618 [=====] - 7s 11ms/step - loss: 0.0386 -
accuracy: 0.9863 - val_loss: 0.5681 - val_accuracy: 0.8619
Epoch 36/100
618/618 [=====] - 7s 11ms/step - loss: 0.0470 -
accuracy: 0.9845 - val_loss: 0.4994 - val_accuracy: 0.8642
Epoch 37/100
618/618 [=====] - 6s 10ms/step - loss: 0.0372 -
accuracy: 0.9875 - val_loss: 0.5419 - val_accuracy: 0.8559
Epoch 38/100
618/618 [=====] - 7s 11ms/step - loss: 0.0316 -
accuracy: 0.9891 - val_loss: 0.6741 - val_accuracy: 0.8458
Epoch 39/100
618/618 [=====] - 7s 11ms/step - loss: 0.0395 -
accuracy: 0.9863 - val_loss: 0.5652 - val_accuracy: 0.8605
Epoch 40/100

618/618 [=====] - 7s 11ms/step - loss: 0.0386 -
accuracy: 0.9870 - val_loss: 0.5864 - val_accuracy: 0.8536
Epoch 41/100
618/618 [=====] - 7s 11ms/step - loss: 0.0342 -
accuracy: 0.9889 - val_loss: 0.5908 - val_accuracy: 0.8599
Epoch 42/100
618/618 [=====] - 7s 11ms/step - loss: 0.0324 -
accuracy: 0.9893 - val_loss: 0.5307 - val_accuracy: 0.8645
Epoch 43/100
618/618 [=====] - 7s 11ms/step - loss: 0.0337 -
accuracy: 0.9888 - val_loss: 0.5856 - val_accuracy: 0.8542
Epoch 44/100
618/618 [=====] - 7s 11ms/step - loss: 0.0359 -
accuracy: 0.9875 - val_loss: 0.6369 - val_accuracy: 0.8567
Epoch 45/100
618/618 [=====] - 7s 11ms/step - loss: 0.0315 -
accuracy: 0.9894 - val_loss: 0.5580 - val_accuracy: 0.8593
Epoch 46/100
618/618 [=====] - 6s 10ms/step - loss: 0.0340 -
accuracy: 0.9883 - val_loss: 0.5930 - val_accuracy: 0.8590
Epoch 47/100
618/618 [=====] - 7s 11ms/step - loss: 0.0376 -
accuracy: 0.9871 - val_loss: 0.5650 - val_accuracy: 0.8590
Epoch 48/100
618/618 [=====] - 7s 11ms/step - loss: 0.0314 -
accuracy: 0.9893 - val_loss: 0.6199 - val_accuracy: 0.8519
Epoch 49/100
618/618 [=====] - 7s 11ms/step - loss: 0.0305 -
accuracy: 0.9893 - val_loss: 0.6127 - val_accuracy: 0.8653
Epoch 50/100
618/618 [=====] - 7s 11ms/step - loss: 0.0273 -
accuracy: 0.9911 - val_loss: 0.6682 - val_accuracy: 0.8616
Epoch 51/100
618/618 [=====] - 7s 11ms/step - loss: 0.0326 -
accuracy: 0.9895 - val_loss: 0.5772 - val_accuracy: 0.8653
Epoch 52/100
618/618 [=====] - 6s 10ms/step - loss: 0.0313 -
accuracy: 0.9900 - val_loss: 0.6680 - val_accuracy: 0.8542
Epoch 53/100
618/618 [=====] - 7s 11ms/step - loss: 0.0326 -
accuracy: 0.9890 - val_loss: 0.6438 - val_accuracy: 0.8481
Epoch 54/100
618/618 [=====] - 7s 11ms/step - loss: 0.0297 -
accuracy: 0.9897 - val_loss: 0.6638 - val_accuracy: 0.8587
Epoch 55/100
618/618 [=====] - 7s 11ms/step - loss: 0.0268 -
accuracy: 0.9913 - val_loss: 0.7024 - val_accuracy: 0.8530
Epoch 56/100

618/618 [=====] - 7s 11ms/step - loss: 0.0262 -
accuracy: 0.9908 - val_loss: 0.6816 - val_accuracy: 0.8607
Epoch 57/100
618/618 [=====] - 6s 10ms/step - loss: 0.0251 -
accuracy: 0.9916 - val_loss: 0.6275 - val_accuracy: 0.8559
Epoch 58/100
618/618 [=====] - 7s 11ms/step - loss: 0.0281 -
accuracy: 0.9906 - val_loss: 0.6585 - val_accuracy: 0.8479
Epoch 59/100
618/618 [=====] - 6s 10ms/step - loss: 0.0272 -
accuracy: 0.9912 - val_loss: 0.6063 - val_accuracy: 0.8510
Epoch 60/100
618/618 [=====] - 7s 11ms/step - loss: 0.0258 -
accuracy: 0.9913 - val_loss: 0.6395 - val_accuracy: 0.8476
Epoch 61/100
618/618 [=====] - 7s 11ms/step - loss: 0.0268 -
accuracy: 0.9913 - val_loss: 0.7813 - val_accuracy: 0.8404
Epoch 62/100
618/618 [=====] - 7s 11ms/step - loss: 0.0215 -
accuracy: 0.9927 - val_loss: 0.7183 - val_accuracy: 0.8576
Epoch 63/100
618/618 [=====] - 7s 11ms/step - loss: 0.0308 -
accuracy: 0.9897 - val_loss: 0.5670 - val_accuracy: 0.8590
Epoch 64/100
618/618 [=====] - 7s 11ms/step - loss: 0.0245 -
accuracy: 0.9915 - val_loss: 0.7569 - val_accuracy: 0.8539
Epoch 65/100
618/618 [=====] - 6s 10ms/step - loss: 0.0339 -
accuracy: 0.9894 - val_loss: 0.6015 - val_accuracy: 0.8562
Epoch 66/100
618/618 [=====] - 7s 11ms/step - loss: 0.0284 -
accuracy: 0.9907 - val_loss: 0.5929 - val_accuracy: 0.8596
Epoch 67/100
618/618 [=====] - 7s 11ms/step - loss: 0.0265 -
accuracy: 0.9917 - val_loss: 0.6139 - val_accuracy: 0.8570
Epoch 68/100
618/618 [=====] - 7s 11ms/step - loss: 0.0213 -
accuracy: 0.9928 - val_loss: 0.7046 - val_accuracy: 0.8490
Epoch 69/100
618/618 [=====] - 7s 11ms/step - loss: 0.0276 -
accuracy: 0.9916 - val_loss: 0.6303 - val_accuracy: 0.8539
Epoch 70/100
618/618 [=====] - 7s 11ms/step - loss: 0.0271 -
accuracy: 0.9917 - val_loss: 0.6529 - val_accuracy: 0.8450
Epoch 71/100
618/618 [=====] - 7s 11ms/step - loss: 0.0244 -
accuracy: 0.9917 - val_loss: 0.6823 - val_accuracy: 0.8496
Epoch 72/100

618/618 [=====] - 7s 11ms/step - loss: 0.0219 -
accuracy: 0.9934 - val_loss: 0.7295 - val_accuracy: 0.8527
Epoch 73/100
618/618 [=====] - 7s 11ms/step - loss: 0.0254 -
accuracy: 0.9917 - val_loss: 0.7265 - val_accuracy: 0.8513
Epoch 74/100
618/618 [=====] - 7s 11ms/step - loss: 0.0286 -
accuracy: 0.9905 - val_loss: 0.5830 - val_accuracy: 0.8510
Epoch 75/100
618/618 [=====] - 7s 11ms/step - loss: 0.0272 -
accuracy: 0.9915 - val_loss: 0.6697 - val_accuracy: 0.8507
Epoch 76/100
618/618 [=====] - 7s 11ms/step - loss: 0.0220 -
accuracy: 0.9938 - val_loss: 0.6572 - val_accuracy: 0.8544
Epoch 77/100
618/618 [=====] - 7s 11ms/step - loss: 0.0187 -
accuracy: 0.9940 - val_loss: 0.6938 - val_accuracy: 0.8516
Epoch 78/100
618/618 [=====] - 7s 11ms/step - loss: 0.0214 -
accuracy: 0.9925 - val_loss: 0.6726 - val_accuracy: 0.8570
Epoch 79/100
618/618 [=====] - 7s 11ms/step - loss: 0.0210 -
accuracy: 0.9937 - val_loss: 0.7114 - val_accuracy: 0.8544
Epoch 80/100
618/618 [=====] - 7s 11ms/step - loss: 0.0267 -
accuracy: 0.9920 - val_loss: 0.6907 - val_accuracy: 0.8516
Epoch 81/100
618/618 [=====] - 7s 11ms/step - loss: 0.0258 -
accuracy: 0.9917 - val_loss: 0.7234 - val_accuracy: 0.8484
Epoch 82/100
618/618 [=====] - 7s 11ms/step - loss: 0.0287 -
accuracy: 0.9914 - val_loss: 0.7469 - val_accuracy: 0.8493
Epoch 83/100
618/618 [=====] - 7s 11ms/step - loss: 0.0192 -
accuracy: 0.9940 - val_loss: 0.6828 - val_accuracy: 0.8467
Epoch 84/100
618/618 [=====] - 7s 11ms/step - loss: 0.0169 -
accuracy: 0.9948 - val_loss: 0.7044 - val_accuracy: 0.8530
Epoch 85/100
618/618 [=====] - 6s 10ms/step - loss: 0.0204 -
accuracy: 0.9939 - val_loss: 0.7469 - val_accuracy: 0.8613
Epoch 86/100
618/618 [=====] - 7s 11ms/step - loss: 0.0196 -
accuracy: 0.9942 - val_loss: 0.7516 - val_accuracy: 0.8481
Epoch 87/100
618/618 [=====] - 6s 10ms/step - loss: 0.0208 -
accuracy: 0.9933 - val_loss: 0.7004 - val_accuracy: 0.8456
Epoch 88/100

```

618/618 [=====] - 7s 11ms/step - loss: 0.0219 -
accuracy: 0.9934 - val_loss: 0.6895 - val_accuracy: 0.8490
Epoch 89/100
618/618 [=====] - 6s 10ms/step - loss: 0.0219 -
accuracy: 0.9939 - val_loss: 0.7879 - val_accuracy: 0.8450
Epoch 90/100
618/618 [=====] - 7s 11ms/step - loss: 0.0217 -
accuracy: 0.9928 - val_loss: 0.7090 - val_accuracy: 0.8473
Epoch 91/100
618/618 [=====] - 6s 10ms/step - loss: 0.0246 -
accuracy: 0.9919 - val_loss: 0.7511 - val_accuracy: 0.8519
Epoch 92/100
618/618 [=====] - 7s 11ms/step - loss: 0.0196 -
accuracy: 0.9939 - val_loss: 0.7501 - val_accuracy: 0.8521
Epoch 93/100
618/618 [=====] - 7s 11ms/step - loss: 0.0177 -
accuracy: 0.9938 - val_loss: 0.7407 - val_accuracy: 0.8550
Epoch 94/100
618/618 [=====] - 7s 11ms/step - loss: 0.0193 -
accuracy: 0.9937 - val_loss: 0.8707 - val_accuracy: 0.8510
Epoch 95/100
618/618 [=====] - 7s 11ms/step - loss: 0.0176 -
accuracy: 0.9955 - val_loss: 0.7540 - val_accuracy: 0.8567
Epoch 96/100
618/618 [=====] - 7s 11ms/step - loss: 0.0209 -
accuracy: 0.9937 - val_loss: 0.7687 - val_accuracy: 0.8536
Epoch 97/100
618/618 [=====] - 7s 11ms/step - loss: 0.0166 -
accuracy: 0.9946 - val_loss: 0.8025 - val_accuracy: 0.8530
Epoch 98/100
618/618 [=====] - 7s 11ms/step - loss: 0.0245 -
accuracy: 0.9926 - val_loss: 0.7091 - val_accuracy: 0.8476
Epoch 99/100
618/618 [=====] - 7s 11ms/step - loss: 0.0203 -
accuracy: 0.9933 - val_loss: 0.7103 - val_accuracy: 0.8493
Epoch 100/100
618/618 [=====] - 6s 10ms/step - loss: 0.0195 -
accuracy: 0.9938 - val_loss: 0.7232 - val_accuracy: 0.8576

```

```
[ ]: <keras.callbacks.History at 0x7f100c16e2b0>
```

```
[ ]: #Cargar la extension de tensorboard de colab
%load_ext tensorboard
#Ejecutar tensorboard e indicarle que lea la carpeta "logs"
%tensorboard --logdir logs
```

```
<IPython.core.display.Javascript object>
```

Generación de imágenes nuevas para poder entrenar el modelo

```
[ ]: #Realizar el aumento de datos con varias transformaciones. Al final, graficar
    ↪ 10 como ejemplo
from tensorflow.keras.preprocessing.image import ImageDataGenerator

datagen = ImageDataGenerator(
    rotation_range=30,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=15,
    zoom_range=[0.7, 1.4],
    horizontal_flip=True,
    vertical_flip=True
)

datagen.fit(X)

plt.figure(figsize=(20,8))

for imagen, etiqueta in datagen.flow(X, y, batch_size=10, shuffle=False):
    for i in range(10):
        plt.subplot(2, 5, i+1)
        plt.xticks([])
        plt.yticks([])
        plt.imshow(imagen[i].reshape(80, 80), cmap="gray")
    break
```



```
[ ]: modeloDenso_MD = tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(80, 80, 1)),
    tf.keras.layers.Dense(150, activation='relu'),
    tf.keras.layers.Dense(150, activation='relu'),
```



```

    tf.keras.layers.Dense(1, activation='sigmoid')
])

modeloCNN_MD = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(80, 80, 1)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(100, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

modeloCNN2_MD = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(80, 80, 1)),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),

    tf.keras.layers.Dropout(0.5),
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(250, activation='relu'),
    tf.keras.layers.Dense(1, activation='sigmoid')
])

```

```

[ ]: modeloDenso_MD.compile(optimizer='adam',
                             loss='binary_crossentropy',
                             metrics=['accuracy'])

modeloCNN_MD.compile(optimizer='adam',
                      loss='binary_crossentropy',
                      metrics=['accuracy'])

modeloCNN2_MD.compile(optimizer='adam',
                       loss='binary_crossentropy',
                       metrics=['accuracy'])

```

```

[ ]: # Entrenamiento un 85% y el resto a validacion
X_entrenamiento = X[:19700]
X_validacion = X[19700:]

y_entrenamiento = y[:19700]

```

```
y_validacion = y[19700:]
```

```
[ ]: #Generamos nuevas imagenes con escalado, zoom...  
data_gen_entrenamiento = datagen.flow(X_entrenamiento, y_entrenamiento,  
    ↪batch_size=32)
```

```
[ ]: tensorboardDenso_MD = TensorBoard(log_dir='logs/denso_MD')  
  
modeloDenso_MD.fit(  
    data_gen_entrenamiento,  
    epochs=100, batch_size=32,  
    validation_data=(X_validacion, y_validacion),  
    steps_per_epoch=int(np.ceil(len(X_entrenamiento) / float(32))),  
    validation_steps=int(np.ceil(len(X_validacion) / float(32))),  
    callbacks=[tensorboardDenso_MD]  
)
```

Epoch 1/100

616/616 [=====] - 18s 27ms/step - loss: 0.7213 -
accuracy: 0.5198 - val_loss: 0.6926 - val_accuracy: 0.5163

Epoch 2/100

616/616 [=====] - 16s 26ms/step - loss: 0.6918 -
accuracy: 0.5230 - val_loss: 0.7025 - val_accuracy: 0.5208

Epoch 3/100

616/616 [=====] - 18s 30ms/step - loss: 0.6921 -
accuracy: 0.5223 - val_loss: 0.6912 - val_accuracy: 0.5292

Epoch 4/100

616/616 [=====] - 16s 26ms/step - loss: 0.6923 -
accuracy: 0.5216 - val_loss: 0.6928 - val_accuracy: 0.5042

Epoch 5/100

616/616 [=====] - 16s 26ms/step - loss: 0.6902 -
accuracy: 0.5269 - val_loss: 0.6937 - val_accuracy: 0.4997

Epoch 6/100

616/616 [=====] - 17s 28ms/step - loss: 0.6912 -
accuracy: 0.5324 - val_loss: 0.6919 - val_accuracy: 0.5208

Epoch 7/100

616/616 [=====] - 16s 27ms/step - loss: 0.6897 -
accuracy: 0.5316 - val_loss: 0.6874 - val_accuracy: 0.5415

Epoch 8/100

616/616 [=====] - 16s 26ms/step - loss: 0.6907 -
accuracy: 0.5282 - val_loss: 0.6926 - val_accuracy: 0.5101

Epoch 9/100

616/616 [=====] - 16s 26ms/step - loss: 0.6910 -
accuracy: 0.5194 - val_loss: 0.6892 - val_accuracy: 0.5379

Epoch 10/100

616/616 [=====] - 17s 27ms/step - loss: 0.6897 -
accuracy: 0.5309 - val_loss: 0.6886 - val_accuracy: 0.5418

Epoch 11/100
616/616 [=====] - 16s 26ms/step - loss: 0.6892 - accuracy: 0.5339 - val_loss: 0.6892 - val_accuracy: 0.5326
Epoch 12/100
616/616 [=====] - 16s 26ms/step - loss: 0.6891 - accuracy: 0.5370 - val_loss: 0.6895 - val_accuracy: 0.5272
Epoch 13/100
616/616 [=====] - 17s 27ms/step - loss: 0.6889 - accuracy: 0.5323 - val_loss: 0.6888 - val_accuracy: 0.5328
Epoch 14/100
616/616 [=====] - 16s 26ms/step - loss: 0.6889 - accuracy: 0.5341 - val_loss: 0.6959 - val_accuracy: 0.5135
Epoch 15/100
616/616 [=====] - 16s 26ms/step - loss: 0.6916 - accuracy: 0.5142 - val_loss: 0.6929 - val_accuracy: 0.5020
Epoch 16/100
616/616 [=====] - 17s 28ms/step - loss: 0.6891 - accuracy: 0.5304 - val_loss: 0.6903 - val_accuracy: 0.5219
Epoch 17/100
616/616 [=====] - 16s 26ms/step - loss: 0.6891 - accuracy: 0.5322 - val_loss: 0.6916 - val_accuracy: 0.5284
Epoch 18/100
616/616 [=====] - 17s 27ms/step - loss: 0.6889 - accuracy: 0.5298 - val_loss: 0.6920 - val_accuracy: 0.5121
Epoch 19/100
616/616 [=====] - 17s 27ms/step - loss: 0.6885 - accuracy: 0.5365 - val_loss: 0.6962 - val_accuracy: 0.4966
Epoch 20/100
616/616 [=====] - 16s 26ms/step - loss: 0.6877 - accuracy: 0.5456 - val_loss: 0.6906 - val_accuracy: 0.5289
Epoch 21/100
616/616 [=====] - 16s 26ms/step - loss: 0.6884 - accuracy: 0.5380 - val_loss: 0.6877 - val_accuracy: 0.5390
Epoch 22/100
616/616 [=====] - 16s 26ms/step - loss: 0.6867 - accuracy: 0.5482 - val_loss: 0.6890 - val_accuracy: 0.5331
Epoch 23/100
616/616 [=====] - 17s 27ms/step - loss: 0.6866 - accuracy: 0.5453 - val_loss: 0.6844 - val_accuracy: 0.5590
Epoch 24/100
616/616 [=====] - 16s 26ms/step - loss: 0.6886 - accuracy: 0.5339 - val_loss: 0.6838 - val_accuracy: 0.5547
Epoch 25/100
616/616 [=====] - 16s 26ms/step - loss: 0.6868 - accuracy: 0.5432 - val_loss: 0.6841 - val_accuracy: 0.5564
Epoch 26/100
616/616 [=====] - 17s 28ms/step - loss: 0.6865 - accuracy: 0.5498 - val_loss: 0.6841 - val_accuracy: 0.5525

Epoch 27/100
616/616 [=====] - 16s 25ms/step - loss: 0.6856 - accuracy: 0.5519 - val_loss: 0.6884 - val_accuracy: 0.5415
Epoch 28/100
616/616 [=====] - 16s 26ms/step - loss: 0.6849 - accuracy: 0.5512 - val_loss: 0.6854 - val_accuracy: 0.5570
Epoch 29/100
616/616 [=====] - 17s 27ms/step - loss: 0.6862 - accuracy: 0.5478 - val_loss: 0.6826 - val_accuracy: 0.5595
Epoch 30/100
616/616 [=====] - 16s 26ms/step - loss: 0.6857 - accuracy: 0.5479 - val_loss: 0.6804 - val_accuracy: 0.5604
Epoch 31/100
616/616 [=====] - 16s 26ms/step - loss: 0.6849 - accuracy: 0.5535 - val_loss: 0.6881 - val_accuracy: 0.5357
Epoch 32/100
616/616 [=====] - 17s 28ms/step - loss: 0.6858 - accuracy: 0.5495 - val_loss: 0.6823 - val_accuracy: 0.5595
Epoch 33/100
616/616 [=====] - 16s 26ms/step - loss: 0.6862 - accuracy: 0.5505 - val_loss: 0.6882 - val_accuracy: 0.5354
Epoch 34/100
616/616 [=====] - 16s 26ms/step - loss: 0.6872 - accuracy: 0.5469 - val_loss: 0.6848 - val_accuracy: 0.5654
Epoch 35/100
616/616 [=====] - 17s 28ms/step - loss: 0.6857 - accuracy: 0.5478 - val_loss: 0.6835 - val_accuracy: 0.5682
Epoch 36/100
616/616 [=====] - 16s 26ms/step - loss: 0.6852 - accuracy: 0.5479 - val_loss: 0.6912 - val_accuracy: 0.5328
Epoch 37/100
616/616 [=====] - 16s 26ms/step - loss: 0.6867 - accuracy: 0.5462 - val_loss: 0.6824 - val_accuracy: 0.5604
Epoch 38/100
616/616 [=====] - 16s 26ms/step - loss: 0.6856 - accuracy: 0.5501 - val_loss: 0.6838 - val_accuracy: 0.5643
Epoch 39/100
616/616 [=====] - 16s 26ms/step - loss: 0.6846 - accuracy: 0.5536 - val_loss: 0.6846 - val_accuracy: 0.5539
Epoch 40/100
616/616 [=====] - 16s 26ms/step - loss: 0.6851 - accuracy: 0.5482 - val_loss: 0.6856 - val_accuracy: 0.5525
Epoch 41/100
616/616 [=====] - 16s 25ms/step - loss: 0.6849 - accuracy: 0.5488 - val_loss: 0.6831 - val_accuracy: 0.5604
Epoch 42/100
616/616 [=====] - 16s 26ms/step - loss: 0.6849 - accuracy: 0.5532 - val_loss: 0.6822 - val_accuracy: 0.5609

Epoch 43/100
616/616 [=====] - 17s 28ms/step - loss: 0.6847 - accuracy: 0.5484 - val_loss: 0.6874 - val_accuracy: 0.5477
Epoch 44/100
616/616 [=====] - 16s 26ms/step - loss: 0.6851 - accuracy: 0.5480 - val_loss: 0.6861 - val_accuracy: 0.5480
Epoch 45/100
616/616 [=====] - 16s 26ms/step - loss: 0.6867 - accuracy: 0.5484 - val_loss: 0.6858 - val_accuracy: 0.5592
Epoch 46/100
616/616 [=====] - 17s 27ms/step - loss: 0.6839 - accuracy: 0.5525 - val_loss: 0.6851 - val_accuracy: 0.5547
Epoch 47/100
616/616 [=====] - 16s 25ms/step - loss: 0.6849 - accuracy: 0.5516 - val_loss: 0.6835 - val_accuracy: 0.5629
Epoch 48/100
616/616 [=====] - 16s 26ms/step - loss: 0.6853 - accuracy: 0.5534 - val_loss: 0.6808 - val_accuracy: 0.5730
Epoch 49/100
616/616 [=====] - 17s 28ms/step - loss: 0.6830 - accuracy: 0.5582 - val_loss: 0.6800 - val_accuracy: 0.5758
Epoch 50/100
616/616 [=====] - 16s 26ms/step - loss: 0.6816 - accuracy: 0.5605 - val_loss: 0.6791 - val_accuracy: 0.5744
Epoch 51/100
616/616 [=====] - 16s 26ms/step - loss: 0.6804 - accuracy: 0.5641 - val_loss: 0.6798 - val_accuracy: 0.5696
Epoch 52/100
616/616 [=====] - 17s 27ms/step - loss: 0.6815 - accuracy: 0.5598 - val_loss: 0.6769 - val_accuracy: 0.5778
Epoch 53/100
616/616 [=====] - 16s 25ms/step - loss: 0.6811 - accuracy: 0.5658 - val_loss: 0.6772 - val_accuracy: 0.5750
Epoch 54/100
616/616 [=====] - 16s 25ms/step - loss: 0.6813 - accuracy: 0.5617 - val_loss: 0.6779 - val_accuracy: 0.5693
Epoch 55/100
616/616 [=====] - 16s 26ms/step - loss: 0.6811 - accuracy: 0.5625 - val_loss: 0.6809 - val_accuracy: 0.5823
Epoch 56/100
616/616 [=====] - 16s 27ms/step - loss: 0.6810 - accuracy: 0.5603 - val_loss: 0.6814 - val_accuracy: 0.5747
Epoch 57/100
616/616 [=====] - 16s 26ms/step - loss: 0.6808 - accuracy: 0.5620 - val_loss: 0.6777 - val_accuracy: 0.5685
Epoch 58/100
616/616 [=====] - 16s 25ms/step - loss: 0.6815 - accuracy: 0.5576 - val_loss: 0.6750 - val_accuracy: 0.5797

Epoch 59/100
616/616 [=====] - 17s 28ms/step - loss: 0.6803 -
accuracy: 0.5655 - val_loss: 0.6783 - val_accuracy: 0.5786
Epoch 60/100
616/616 [=====] - 17s 27ms/step - loss: 0.6800 -
accuracy: 0.5656 - val_loss: 0.6818 - val_accuracy: 0.5811
Epoch 61/100
616/616 [=====] - 16s 26ms/step - loss: 0.6814 -
accuracy: 0.5620 - val_loss: 0.6796 - val_accuracy: 0.5657
Epoch 62/100
616/616 [=====] - 16s 25ms/step - loss: 0.6819 -
accuracy: 0.5579 - val_loss: 0.6796 - val_accuracy: 0.5786
Epoch 63/100
616/616 [=====] - 16s 27ms/step - loss: 0.6807 -
accuracy: 0.5604 - val_loss: 0.6780 - val_accuracy: 0.5747
Epoch 64/100
616/616 [=====] - 16s 26ms/step - loss: 0.6808 -
accuracy: 0.5589 - val_loss: 0.6773 - val_accuracy: 0.5778
Epoch 65/100
616/616 [=====] - 16s 26ms/step - loss: 0.6775 -
accuracy: 0.5680 - val_loss: 0.6777 - val_accuracy: 0.5747
Epoch 66/100
616/616 [=====] - 16s 25ms/step - loss: 0.6806 -
accuracy: 0.5630 - val_loss: 0.6775 - val_accuracy: 0.5738
Epoch 67/100
616/616 [=====] - 16s 25ms/step - loss: 0.6802 -
accuracy: 0.5661 - val_loss: 0.6769 - val_accuracy: 0.5713
Epoch 68/100
616/616 [=====] - 17s 27ms/step - loss: 0.6811 -
accuracy: 0.5615 - val_loss: 0.6760 - val_accuracy: 0.5733
Epoch 69/100
616/616 [=====] - 16s 26ms/step - loss: 0.6802 -
accuracy: 0.5644 - val_loss: 0.6775 - val_accuracy: 0.5741
Epoch 70/100
616/616 [=====] - 16s 26ms/step - loss: 0.6792 -
accuracy: 0.5639 - val_loss: 0.6790 - val_accuracy: 0.5744
Epoch 71/100
616/616 [=====] - 16s 26ms/step - loss: 0.6797 -
accuracy: 0.5675 - val_loss: 0.6784 - val_accuracy: 0.5778
Epoch 72/100
616/616 [=====] - 17s 27ms/step - loss: 0.6813 -
accuracy: 0.5602 - val_loss: 0.6759 - val_accuracy: 0.5750
Epoch 73/100
616/616 [=====] - 16s 25ms/step - loss: 0.6808 -
accuracy: 0.5629 - val_loss: 0.6751 - val_accuracy: 0.5769
Epoch 74/100
616/616 [=====] - 16s 26ms/step - loss: 0.6793 -
accuracy: 0.5679 - val_loss: 0.6784 - val_accuracy: 0.5699

Epoch 75/100
616/616 [=====] - 17s 27ms/step - loss: 0.6800 -
accuracy: 0.5584 - val_loss: 0.6779 - val_accuracy: 0.5668
Epoch 76/100
616/616 [=====] - 16s 26ms/step - loss: 0.6813 -
accuracy: 0.5591 - val_loss: 0.6787 - val_accuracy: 0.5738
Epoch 77/100
616/616 [=====] - 15s 25ms/step - loss: 0.6812 -
accuracy: 0.5629 - val_loss: 0.6785 - val_accuracy: 0.5755
Epoch 78/100
616/616 [=====] - 16s 25ms/step - loss: 0.6801 -
accuracy: 0.5613 - val_loss: 0.6797 - val_accuracy: 0.5744
Epoch 79/100
616/616 [=====] - 17s 27ms/step - loss: 0.6802 -
accuracy: 0.5638 - val_loss: 0.6789 - val_accuracy: 0.5707
Epoch 80/100
616/616 [=====] - 16s 26ms/step - loss: 0.6821 -
accuracy: 0.5588 - val_loss: 0.6785 - val_accuracy: 0.5705
Epoch 81/100
616/616 [=====] - 16s 25ms/step - loss: 0.6802 -
accuracy: 0.5629 - val_loss: 0.6758 - val_accuracy: 0.5764
Epoch 82/100
616/616 [=====] - 17s 27ms/step - loss: 0.6806 -
accuracy: 0.5593 - val_loss: 0.6762 - val_accuracy: 0.5750
Epoch 83/100
616/616 [=====] - 16s 26ms/step - loss: 0.6799 -
accuracy: 0.5662 - val_loss: 0.6768 - val_accuracy: 0.5755
Epoch 84/100
616/616 [=====] - 16s 26ms/step - loss: 0.6821 -
accuracy: 0.5568 - val_loss: 0.6816 - val_accuracy: 0.5618
Epoch 85/100
616/616 [=====] - 17s 27ms/step - loss: 0.6788 -
accuracy: 0.5683 - val_loss: 0.6759 - val_accuracy: 0.5780
Epoch 86/100
616/616 [=====] - 15s 25ms/step - loss: 0.6809 -
accuracy: 0.5597 - val_loss: 0.6757 - val_accuracy: 0.5769
Epoch 87/100
616/616 [=====] - 16s 26ms/step - loss: 0.6796 -
accuracy: 0.5640 - val_loss: 0.6755 - val_accuracy: 0.5699
Epoch 88/100
616/616 [=====] - 15s 25ms/step - loss: 0.6806 -
accuracy: 0.5580 - val_loss: 0.6754 - val_accuracy: 0.5671
Epoch 89/100
616/616 [=====] - 17s 27ms/step - loss: 0.6796 -
accuracy: 0.5666 - val_loss: 0.6781 - val_accuracy: 0.5741
Epoch 90/100
616/616 [=====] - 16s 25ms/step - loss: 0.6794 -
accuracy: 0.5643 - val_loss: 0.6785 - val_accuracy: 0.5693

```

Epoch 91/100
616/616 [=====] - 16s 26ms/step - loss: 0.6788 -
accuracy: 0.5661 - val_loss: 0.6775 - val_accuracy: 0.5727
Epoch 92/100
616/616 [=====] - 15s 25ms/step - loss: 0.6798 -
accuracy: 0.5647 - val_loss: 0.6771 - val_accuracy: 0.5682
Epoch 93/100
616/616 [=====] - 16s 26ms/step - loss: 0.6794 -
accuracy: 0.5637 - val_loss: 0.6743 - val_accuracy: 0.5747
Epoch 94/100
616/616 [=====] - 17s 27ms/step - loss: 0.6805 -
accuracy: 0.5608 - val_loss: 0.6763 - val_accuracy: 0.5738
Epoch 95/100
616/616 [=====] - 16s 25ms/step - loss: 0.6795 -
accuracy: 0.5641 - val_loss: 0.6755 - val_accuracy: 0.5688
Epoch 96/100
616/616 [=====] - 16s 25ms/step - loss: 0.6809 -
accuracy: 0.5596 - val_loss: 0.6747 - val_accuracy: 0.5727
Epoch 97/100
616/616 [=====] - 16s 25ms/step - loss: 0.6796 -
accuracy: 0.5655 - val_loss: 0.6756 - val_accuracy: 0.5719
Epoch 98/100
616/616 [=====] - 17s 27ms/step - loss: 0.6792 -
accuracy: 0.5652 - val_loss: 0.6798 - val_accuracy: 0.5722
Epoch 99/100
616/616 [=====] - 16s 26ms/step - loss: 0.6798 -
accuracy: 0.5622 - val_loss: 0.6791 - val_accuracy: 0.5710
Epoch 100/100
616/616 [=====] - 15s 25ms/step - loss: 0.6796 -
accuracy: 0.5601 - val_loss: 0.6776 - val_accuracy: 0.5705

```

```
[ ]: <keras.callbacks.History at 0x7f10083f8c70>
```

```
[ ]: tensorboardCNN_MD = TensorBoard(log_dir='logs-new/cnn_MD')
```

```

modeloCNN_MD.fit(
    data_gen_entrenamiento,
    epochs=150, batch_size=32,
    validation_data=(X_validacion, y_validacion),
    steps_per_epoch=int(np.ceil(len(X_entrenamiento) / float(32))),
    validation_steps=int(np.ceil(len(X_validacion) / float(32))),
    callbacks=[tensorboardCNN_MD]
)

```

```

Epoch 1/150
616/616 [=====] - 20s 30ms/step - loss: 0.6852 -
accuracy: 0.5527 - val_loss: 0.6788 - val_accuracy: 0.5691
Epoch 2/150

```


616/616 [=====] - 17s 28ms/step - loss: 0.6715 - accuracy: 0.5805 - val_loss: 0.6657 - val_accuracy: 0.5783
Epoch 3/150
616/616 [=====] - 18s 29ms/step - loss: 0.6533 - accuracy: 0.6173 - val_loss: 0.6654 - val_accuracy: 0.5907
Epoch 4/150
616/616 [=====] - 17s 28ms/step - loss: 0.6403 - accuracy: 0.6345 - val_loss: 0.6097 - val_accuracy: 0.6763
Epoch 5/150
616/616 [=====] - 17s 28ms/step - loss: 0.6282 - accuracy: 0.6506 - val_loss: 0.5773 - val_accuracy: 0.6946
Epoch 6/150
616/616 [=====] - 18s 28ms/step - loss: 0.6153 - accuracy: 0.6618 - val_loss: 0.5707 - val_accuracy: 0.7044
Epoch 7/150
616/616 [=====] - 18s 29ms/step - loss: 0.6052 - accuracy: 0.6724 - val_loss: 0.5553 - val_accuracy: 0.7271
Epoch 8/150
616/616 [=====] - 18s 28ms/step - loss: 0.5938 - accuracy: 0.6843 - val_loss: 0.5831 - val_accuracy: 0.6873
Epoch 9/150
616/616 [=====] - 18s 29ms/step - loss: 0.5880 - accuracy: 0.6913 - val_loss: 0.5466 - val_accuracy: 0.7226
Epoch 10/150
616/616 [=====] - 17s 28ms/step - loss: 0.5784 - accuracy: 0.6962 - val_loss: 0.5768 - val_accuracy: 0.6946
Epoch 11/150
616/616 [=====] - 18s 29ms/step - loss: 0.5693 - accuracy: 0.7008 - val_loss: 0.5066 - val_accuracy: 0.7588
Epoch 12/150
616/616 [=====] - 18s 29ms/step - loss: 0.5646 - accuracy: 0.7086 - val_loss: 0.5599 - val_accuracy: 0.7094
Epoch 13/150
616/616 [=====] - 19s 30ms/step - loss: 0.5584 - accuracy: 0.7134 - val_loss: 0.5001 - val_accuracy: 0.7577
Epoch 14/150
616/616 [=====] - 19s 30ms/step - loss: 0.5464 - accuracy: 0.7243 - val_loss: 0.5161 - val_accuracy: 0.7426
Epoch 15/150
616/616 [=====] - 20s 33ms/step - loss: 0.5439 - accuracy: 0.7240 - val_loss: 0.4898 - val_accuracy: 0.7760
Epoch 16/150
616/616 [=====] - 19s 31ms/step - loss: 0.5387 - accuracy: 0.7279 - val_loss: 0.5046 - val_accuracy: 0.7558
Epoch 17/150
616/616 [=====] - 19s 31ms/step - loss: 0.5311 - accuracy: 0.7363 - val_loss: 0.5076 - val_accuracy: 0.7434
Epoch 18/150

616/616 [=====] - 20s 32ms/step - loss: 0.5275 - accuracy: 0.7380 - val_loss: 0.5034 - val_accuracy: 0.7513
Epoch 19/150
616/616 [=====] - 19s 31ms/step - loss: 0.5163 - accuracy: 0.7444 - val_loss: 0.4818 - val_accuracy: 0.7701
Epoch 20/150
616/616 [=====] - 18s 30ms/step - loss: 0.5137 - accuracy: 0.7475 - val_loss: 0.4518 - val_accuracy: 0.7945
Epoch 21/150
616/616 [=====] - 20s 32ms/step - loss: 0.5051 - accuracy: 0.7545 - val_loss: 0.4821 - val_accuracy: 0.7698
Epoch 22/150
616/616 [=====] - 19s 30ms/step - loss: 0.5089 - accuracy: 0.7524 - val_loss: 0.5161 - val_accuracy: 0.7515
Epoch 23/150
616/616 [=====] - 20s 32ms/step - loss: 0.5058 - accuracy: 0.7488 - val_loss: 0.4648 - val_accuracy: 0.7782
Epoch 24/150
616/616 [=====] - 19s 31ms/step - loss: 0.4917 - accuracy: 0.7609 - val_loss: 0.4344 - val_accuracy: 0.8060
Epoch 25/150
616/616 [=====] - 20s 32ms/step - loss: 0.4887 - accuracy: 0.7644 - val_loss: 0.4603 - val_accuracy: 0.7765
Epoch 26/150
616/616 [=====] - 18s 29ms/step - loss: 0.4896 - accuracy: 0.7637 - val_loss: 0.4540 - val_accuracy: 0.7850
Epoch 27/150
616/616 [=====] - 20s 32ms/step - loss: 0.4799 - accuracy: 0.7664 - val_loss: 0.4141 - val_accuracy: 0.8153
Epoch 28/150
616/616 [=====] - 18s 30ms/step - loss: 0.4727 - accuracy: 0.7745 - val_loss: 0.4452 - val_accuracy: 0.7883
Epoch 29/150
616/616 [=====] - 19s 31ms/step - loss: 0.4725 - accuracy: 0.7750 - val_loss: 0.4156 - val_accuracy: 0.8038
Epoch 30/150
616/616 [=====] - 19s 30ms/step - loss: 0.4674 - accuracy: 0.7791 - val_loss: 0.4049 - val_accuracy: 0.8161
Epoch 31/150
616/616 [=====] - 19s 31ms/step - loss: 0.4624 - accuracy: 0.7807 - val_loss: 0.4317 - val_accuracy: 0.7976
Epoch 32/150
616/616 [=====] - 18s 30ms/step - loss: 0.4613 - accuracy: 0.7808 - val_loss: 0.4973 - val_accuracy: 0.7723
Epoch 33/150
616/616 [=====] - 20s 32ms/step - loss: 0.4533 - accuracy: 0.7893 - val_loss: 0.4160 - val_accuracy: 0.8133
Epoch 34/150

616/616 [=====] - 18s 30ms/step - loss: 0.4545 - accuracy: 0.7853 - val_loss: 0.3784 - val_accuracy: 0.8310
Epoch 35/150
616/616 [=====] - 19s 31ms/step - loss: 0.4476 - accuracy: 0.7915 - val_loss: 0.3875 - val_accuracy: 0.8276
Epoch 36/150
616/616 [=====] - 18s 30ms/step - loss: 0.4477 - accuracy: 0.7882 - val_loss: 0.3972 - val_accuracy: 0.8285
Epoch 37/150
616/616 [=====] - 19s 31ms/step - loss: 0.4483 - accuracy: 0.7900 - val_loss: 0.4058 - val_accuracy: 0.8136
Epoch 38/150
616/616 [=====] - 18s 30ms/step - loss: 0.4439 - accuracy: 0.7937 - val_loss: 0.3616 - val_accuracy: 0.8383
Epoch 39/150
616/616 [=====] - 19s 31ms/step - loss: 0.4352 - accuracy: 0.7942 - val_loss: 0.4089 - val_accuracy: 0.8153
Epoch 40/150
616/616 [=====] - 19s 31ms/step - loss: 0.4297 - accuracy: 0.7995 - val_loss: 0.3822 - val_accuracy: 0.8282
Epoch 41/150
616/616 [=====] - 19s 32ms/step - loss: 0.4390 - accuracy: 0.7974 - val_loss: 0.3972 - val_accuracy: 0.8203
Epoch 42/150
616/616 [=====] - 19s 30ms/step - loss: 0.4283 - accuracy: 0.7999 - val_loss: 0.3992 - val_accuracy: 0.8150
Epoch 43/150
616/616 [=====] - 20s 32ms/step - loss: 0.4291 - accuracy: 0.8003 - val_loss: 0.3762 - val_accuracy: 0.8259
Epoch 44/150
616/616 [=====] - 19s 30ms/step - loss: 0.4276 - accuracy: 0.8031 - val_loss: 0.3510 - val_accuracy: 0.8324
Epoch 45/150
616/616 [=====] - 19s 31ms/step - loss: 0.4206 - accuracy: 0.8039 - val_loss: 0.3636 - val_accuracy: 0.8397
Epoch 46/150
616/616 [=====] - 19s 30ms/step - loss: 0.4178 - accuracy: 0.8050 - val_loss: 0.3452 - val_accuracy: 0.8470
Epoch 47/150
616/616 [=====] - 20s 32ms/step - loss: 0.4173 - accuracy: 0.8078 - val_loss: 0.4110 - val_accuracy: 0.8136
Epoch 48/150
616/616 [=====] - 20s 33ms/step - loss: 0.4182 - accuracy: 0.8049 - val_loss: 0.3596 - val_accuracy: 0.8428
Epoch 49/150
616/616 [=====] - 20s 32ms/step - loss: 0.4080 - accuracy: 0.8120 - val_loss: 0.3572 - val_accuracy: 0.8397
Epoch 50/150

616/616 [=====] - 19s 30ms/step - loss: 0.4130 - accuracy: 0.8105 - val_loss: 0.4150 - val_accuracy: 0.8156
Epoch 51/150
616/616 [=====] - 19s 32ms/step - loss: 0.4072 - accuracy: 0.8125 - val_loss: 0.3540 - val_accuracy: 0.8405
Epoch 52/150
616/616 [=====] - 19s 30ms/step - loss: 0.4173 - accuracy: 0.8072 - val_loss: 0.3596 - val_accuracy: 0.8391
Epoch 53/150
616/616 [=====] - 19s 31ms/step - loss: 0.4080 - accuracy: 0.8094 - val_loss: 0.3446 - val_accuracy: 0.8453
Epoch 54/150
616/616 [=====] - 18s 30ms/step - loss: 0.4101 - accuracy: 0.8120 - val_loss: 0.3744 - val_accuracy: 0.8324
Epoch 55/150
616/616 [=====] - 20s 32ms/step - loss: 0.4008 - accuracy: 0.8186 - val_loss: 0.3512 - val_accuracy: 0.8456
Epoch 56/150
616/616 [=====] - 18s 30ms/step - loss: 0.4027 - accuracy: 0.8147 - val_loss: 0.4127 - val_accuracy: 0.8147
Epoch 57/150
616/616 [=====] - 19s 31ms/step - loss: 0.3961 - accuracy: 0.8193 - val_loss: 0.3723 - val_accuracy: 0.8372
Epoch 58/150
616/616 [=====] - 18s 30ms/step - loss: 0.3978 - accuracy: 0.8180 - val_loss: 0.3929 - val_accuracy: 0.8243
Epoch 59/150
616/616 [=====] - 19s 32ms/step - loss: 0.4005 - accuracy: 0.8166 - val_loss: 0.4309 - val_accuracy: 0.8024
Epoch 60/150
616/616 [=====] - 18s 30ms/step - loss: 0.3923 - accuracy: 0.8240 - val_loss: 0.4308 - val_accuracy: 0.8040
Epoch 61/150
616/616 [=====] - 20s 32ms/step - loss: 0.3937 - accuracy: 0.8183 - val_loss: 0.3627 - val_accuracy: 0.8355
Epoch 62/150
616/616 [=====] - 19s 32ms/step - loss: 0.3935 - accuracy: 0.8204 - val_loss: 0.4447 - val_accuracy: 0.8085
Epoch 63/150
616/616 [=====] - 19s 32ms/step - loss: 0.3942 - accuracy: 0.8185 - val_loss: 0.3799 - val_accuracy: 0.8352
Epoch 64/150
616/616 [=====] - 19s 30ms/step - loss: 0.3843 - accuracy: 0.8248 - val_loss: 0.3966 - val_accuracy: 0.8186
Epoch 65/150
616/616 [=====] - 20s 32ms/step - loss: 0.3872 - accuracy: 0.8241 - val_loss: 0.3748 - val_accuracy: 0.8372
Epoch 66/150

616/616 [=====] - 18s 30ms/step - loss: 0.3851 -
accuracy: 0.8266 - val_loss: 0.3310 - val_accuracy: 0.8512
Epoch 67/150
616/616 [=====] - 19s 31ms/step - loss: 0.3810 -
accuracy: 0.8265 - val_loss: 0.3266 - val_accuracy: 0.8501
Epoch 68/150
616/616 [=====] - 19s 30ms/step - loss: 0.3873 -
accuracy: 0.8258 - val_loss: 0.3273 - val_accuracy: 0.8596
Epoch 69/150
616/616 [=====] - 19s 32ms/step - loss: 0.3792 -
accuracy: 0.8282 - val_loss: 0.3701 - val_accuracy: 0.8279
Epoch 70/150
616/616 [=====] - 18s 30ms/step - loss: 0.3856 -
accuracy: 0.8237 - val_loss: 0.3132 - val_accuracy: 0.8661
Epoch 71/150
616/616 [=====] - 20s 32ms/step - loss: 0.3804 -
accuracy: 0.8279 - val_loss: 0.3629 - val_accuracy: 0.8394
Epoch 72/150
616/616 [=====] - 18s 30ms/step - loss: 0.3862 -
accuracy: 0.8256 - val_loss: 0.3683 - val_accuracy: 0.8377
Epoch 73/150
616/616 [=====] - 19s 31ms/step - loss: 0.3766 -
accuracy: 0.8308 - val_loss: 0.3432 - val_accuracy: 0.8501
Epoch 74/150
616/616 [=====] - 21s 34ms/step - loss: 0.3745 -
accuracy: 0.8311 - val_loss: 0.3521 - val_accuracy: 0.8535
Epoch 75/150
616/616 [=====] - 25s 41ms/step - loss: 0.3755 -
accuracy: 0.8318 - val_loss: 0.3556 - val_accuracy: 0.8433
Epoch 76/150
616/616 [=====] - 18s 30ms/step - loss: 0.3760 -
accuracy: 0.8304 - val_loss: 0.4064 - val_accuracy: 0.8217
Epoch 77/150
616/616 [=====] - 20s 32ms/step - loss: 0.3730 -
accuracy: 0.8314 - val_loss: 0.3552 - val_accuracy: 0.8459
Epoch 78/150
616/616 [=====] - 19s 30ms/step - loss: 0.3758 -
accuracy: 0.8295 - val_loss: 0.2970 - val_accuracy: 0.8742
Epoch 79/150
616/616 [=====] - 21s 34ms/step - loss: 0.3807 -
accuracy: 0.8240 - val_loss: 0.3317 - val_accuracy: 0.8568
Epoch 80/150
616/616 [=====] - 19s 31ms/step - loss: 0.3690 -
accuracy: 0.8328 - val_loss: 0.3400 - val_accuracy: 0.8557
Epoch 81/150
616/616 [=====] - 19s 31ms/step - loss: 0.3699 -
accuracy: 0.8360 - val_loss: 0.3366 - val_accuracy: 0.8549
Epoch 82/150

616/616 [=====] - 19s 30ms/step - loss: 0.3628 -
accuracy: 0.8388 - val_loss: 0.3321 - val_accuracy: 0.8554
Epoch 83/150
616/616 [=====] - 19s 31ms/step - loss: 0.3635 -
accuracy: 0.8369 - val_loss: 0.3354 - val_accuracy: 0.8532
Epoch 84/150
616/616 [=====] - 19s 31ms/step - loss: 0.3670 -
accuracy: 0.8350 - val_loss: 0.3026 - val_accuracy: 0.8711
Epoch 85/150
616/616 [=====] - 18s 30ms/step - loss: 0.3618 -
accuracy: 0.8344 - val_loss: 0.3032 - val_accuracy: 0.8669
Epoch 86/150
616/616 [=====] - 19s 31ms/step - loss: 0.3657 -
accuracy: 0.8361 - val_loss: 0.3698 - val_accuracy: 0.8366
Epoch 87/150
616/616 [=====] - 18s 30ms/step - loss: 0.3626 -
accuracy: 0.8375 - val_loss: 0.3360 - val_accuracy: 0.8509
Epoch 88/150
616/616 [=====] - 19s 31ms/step - loss: 0.3613 -
accuracy: 0.8380 - val_loss: 0.3315 - val_accuracy: 0.8613
Epoch 89/150
616/616 [=====] - 19s 30ms/step - loss: 0.3627 -
accuracy: 0.8361 - val_loss: 0.3236 - val_accuracy: 0.8579
Epoch 90/150
616/616 [=====] - 19s 31ms/step - loss: 0.3619 -
accuracy: 0.8379 - val_loss: 0.3439 - val_accuracy: 0.8529
Epoch 91/150
616/616 [=====] - 18s 29ms/step - loss: 0.3647 -
accuracy: 0.8376 - val_loss: 0.4030 - val_accuracy: 0.8212
Epoch 92/150
616/616 [=====] - 20s 32ms/step - loss: 0.3589 -
accuracy: 0.8391 - val_loss: 0.4256 - val_accuracy: 0.8133
Epoch 93/150
616/616 [=====] - 18s 30ms/step - loss: 0.3563 -
accuracy: 0.8433 - val_loss: 0.3218 - val_accuracy: 0.8588
Epoch 94/150
616/616 [=====] - 20s 32ms/step - loss: 0.3585 -
accuracy: 0.8375 - val_loss: 0.3626 - val_accuracy: 0.8400
Epoch 95/150
616/616 [=====] - 19s 31ms/step - loss: 0.3564 -
accuracy: 0.8380 - val_loss: 0.2944 - val_accuracy: 0.8666
Epoch 96/150
616/616 [=====] - 20s 32ms/step - loss: 0.3552 -
accuracy: 0.8407 - val_loss: 0.3381 - val_accuracy: 0.8484
Epoch 97/150
616/616 [=====] - 18s 29ms/step - loss: 0.3521 -
accuracy: 0.8432 - val_loss: 0.2964 - val_accuracy: 0.8672
Epoch 98/150

616/616 [=====] - 20s 32ms/step - loss: 0.3540 -
accuracy: 0.8421 - val_loss: 0.3068 - val_accuracy: 0.8697
Epoch 99/150
616/616 [=====] - 18s 29ms/step - loss: 0.3515 -
accuracy: 0.8423 - val_loss: 0.3144 - val_accuracy: 0.8650
Epoch 100/150
616/616 [=====] - 20s 32ms/step - loss: 0.3533 -
accuracy: 0.8391 - val_loss: 0.3891 - val_accuracy: 0.8285
Epoch 101/150
616/616 [=====] - 18s 30ms/step - loss: 0.3542 -
accuracy: 0.8411 - val_loss: 0.3253 - val_accuracy: 0.8591
Epoch 102/150
616/616 [=====] - 20s 32ms/step - loss: 0.3515 -
accuracy: 0.8389 - val_loss: 0.3117 - val_accuracy: 0.8605
Epoch 103/150
616/616 [=====] - 18s 30ms/step - loss: 0.3458 -
accuracy: 0.8471 - val_loss: 0.3266 - val_accuracy: 0.8602
Epoch 104/150
616/616 [=====] - 19s 31ms/step - loss: 0.3478 -
accuracy: 0.8432 - val_loss: 0.2966 - val_accuracy: 0.8703
Epoch 105/150
616/616 [=====] - 18s 30ms/step - loss: 0.3552 -
accuracy: 0.8413 - val_loss: 0.2847 - val_accuracy: 0.8728
Epoch 106/150
616/616 [=====] - 19s 31ms/step - loss: 0.3484 -
accuracy: 0.8442 - val_loss: 0.3138 - val_accuracy: 0.8610
Epoch 107/150
616/616 [=====] - 18s 30ms/step - loss: 0.3486 -
accuracy: 0.8437 - val_loss: 0.3118 - val_accuracy: 0.8666
Epoch 108/150
616/616 [=====] - 20s 32ms/step - loss: 0.3489 -
accuracy: 0.8434 - val_loss: 0.3324 - val_accuracy: 0.8577
Epoch 109/150
616/616 [=====] - 19s 30ms/step - loss: 0.3429 -
accuracy: 0.8446 - val_loss: 0.4111 - val_accuracy: 0.8318
Epoch 110/150
616/616 [=====] - 20s 33ms/step - loss: 0.3460 -
accuracy: 0.8475 - val_loss: 0.3380 - val_accuracy: 0.8529
Epoch 111/150
616/616 [=====] - 19s 31ms/step - loss: 0.3440 -
accuracy: 0.8460 - val_loss: 0.3665 - val_accuracy: 0.8375
Epoch 112/150
616/616 [=====] - 20s 32ms/step - loss: 0.3436 -
accuracy: 0.8465 - val_loss: 0.3684 - val_accuracy: 0.8318
Epoch 113/150
616/616 [=====] - 19s 30ms/step - loss: 0.3423 -
accuracy: 0.8475 - val_loss: 0.3321 - val_accuracy: 0.8532
Epoch 114/150

616/616 [=====] - 20s 32ms/step - loss: 0.3465 -
accuracy: 0.8450 - val_loss: 0.2997 - val_accuracy: 0.8723
Epoch 115/150
616/616 [=====] - 18s 30ms/step - loss: 0.3408 -
accuracy: 0.8469 - val_loss: 0.2838 - val_accuracy: 0.8787
Epoch 116/150
616/616 [=====] - 19s 31ms/step - loss: 0.3470 -
accuracy: 0.8460 - val_loss: 0.3587 - val_accuracy: 0.8405
Epoch 117/150
616/616 [=====] - 19s 30ms/step - loss: 0.3367 -
accuracy: 0.8505 - val_loss: 0.3905 - val_accuracy: 0.8360
Epoch 118/150
616/616 [=====] - 19s 31ms/step - loss: 0.3465 -
accuracy: 0.8458 - val_loss: 0.2901 - val_accuracy: 0.8759
Epoch 119/150
616/616 [=====] - 18s 30ms/step - loss: 0.3434 -
accuracy: 0.8442 - val_loss: 0.3291 - val_accuracy: 0.8593
Epoch 120/150
616/616 [=====] - 20s 32ms/step - loss: 0.3416 -
accuracy: 0.8474 - val_loss: 0.3369 - val_accuracy: 0.8492
Epoch 121/150
616/616 [=====] - 19s 30ms/step - loss: 0.3393 -
accuracy: 0.8497 - val_loss: 0.2783 - val_accuracy: 0.8754
Epoch 122/150
616/616 [=====] - 19s 31ms/step - loss: 0.3388 -
accuracy: 0.8474 - val_loss: 0.2957 - val_accuracy: 0.8720
Epoch 123/150
616/616 [=====] - 19s 31ms/step - loss: 0.3363 -
accuracy: 0.8497 - val_loss: 0.3018 - val_accuracy: 0.8742
Epoch 124/150
616/616 [=====] - 20s 32ms/step - loss: 0.3343 -
accuracy: 0.8530 - val_loss: 0.2767 - val_accuracy: 0.8770
Epoch 125/150
616/616 [=====] - 18s 30ms/step - loss: 0.3424 -
accuracy: 0.8477 - val_loss: 0.2906 - val_accuracy: 0.8720
Epoch 126/150
616/616 [=====] - 20s 32ms/step - loss: 0.3313 -
accuracy: 0.8550 - val_loss: 0.3105 - val_accuracy: 0.8647
Epoch 127/150
616/616 [=====] - 19s 31ms/step - loss: 0.3343 -
accuracy: 0.8511 - val_loss: 0.3089 - val_accuracy: 0.8641
Epoch 128/150
616/616 [=====] - 19s 32ms/step - loss: 0.3347 -
accuracy: 0.8534 - val_loss: 0.2985 - val_accuracy: 0.8706
Epoch 129/150
616/616 [=====] - 18s 29ms/step - loss: 0.3340 -
accuracy: 0.8501 - val_loss: 0.3267 - val_accuracy: 0.8697
Epoch 130/150

616/616 [=====] - 20s 32ms/step - loss: 0.3371 - accuracy: 0.8524 - val_loss: 0.3446 - val_accuracy: 0.8549
Epoch 131/150
616/616 [=====] - 18s 30ms/step - loss: 0.3354 - accuracy: 0.8522 - val_loss: 0.3198 - val_accuracy: 0.8596
Epoch 132/150
616/616 [=====] - 19s 31ms/step - loss: 0.3317 - accuracy: 0.8531 - val_loss: 0.4018 - val_accuracy: 0.8344
Epoch 133/150
616/616 [=====] - 19s 31ms/step - loss: 0.3421 - accuracy: 0.8482 - val_loss: 0.3772 - val_accuracy: 0.8358
Epoch 134/150
616/616 [=====] - 20s 32ms/step - loss: 0.3407 - accuracy: 0.8476 - val_loss: 0.2903 - val_accuracy: 0.8765
Epoch 135/150
616/616 [=====] - 18s 30ms/step - loss: 0.3344 - accuracy: 0.8508 - val_loss: 0.3199 - val_accuracy: 0.8619
Epoch 136/150
616/616 [=====] - 20s 32ms/step - loss: 0.3281 - accuracy: 0.8543 - val_loss: 0.3303 - val_accuracy: 0.8574
Epoch 137/150
616/616 [=====] - 18s 30ms/step - loss: 0.3304 - accuracy: 0.8538 - val_loss: 0.3685 - val_accuracy: 0.8372
Epoch 138/150
616/616 [=====] - 19s 31ms/step - loss: 0.3266 - accuracy: 0.8548 - val_loss: 0.3596 - val_accuracy: 0.8394
Epoch 139/150
616/616 [=====] - 19s 30ms/step - loss: 0.3278 - accuracy: 0.8570 - val_loss: 0.3140 - val_accuracy: 0.8630
Epoch 140/150
616/616 [=====] - 20s 32ms/step - loss: 0.3326 - accuracy: 0.8534 - val_loss: 0.2784 - val_accuracy: 0.8821
Epoch 141/150
616/616 [=====] - 20s 32ms/step - loss: 0.3303 - accuracy: 0.8535 - val_loss: 0.2987 - val_accuracy: 0.8672
Epoch 142/150
616/616 [=====] - 20s 32ms/step - loss: 0.3340 - accuracy: 0.8526 - val_loss: 0.3442 - val_accuracy: 0.8537
Epoch 143/150
616/616 [=====] - 19s 31ms/step - loss: 0.3299 - accuracy: 0.8540 - val_loss: 0.3151 - val_accuracy: 0.8599
Epoch 144/150
616/616 [=====] - 20s 32ms/step - loss: 0.3273 - accuracy: 0.8541 - val_loss: 0.2875 - val_accuracy: 0.8762
Epoch 145/150
616/616 [=====] - 18s 30ms/step - loss: 0.3290 - accuracy: 0.8540 - val_loss: 0.3099 - val_accuracy: 0.8664
Epoch 146/150

```

616/616 [=====] - 20s 32ms/step - loss: 0.3285 -
accuracy: 0.8530 - val_loss: 0.3049 - val_accuracy: 0.8697
Epoch 147/150
616/616 [=====] - 18s 30ms/step - loss: 0.3280 -
accuracy: 0.8564 - val_loss: 0.2977 - val_accuracy: 0.8711
Epoch 148/150
616/616 [=====] - 19s 30ms/step - loss: 0.3326 -
accuracy: 0.8489 - val_loss: 0.3543 - val_accuracy: 0.8518
Epoch 149/150
616/616 [=====] - 20s 32ms/step - loss: 0.3224 -
accuracy: 0.8574 - val_loss: 0.3555 - val_accuracy: 0.8450
Epoch 150/150
616/616 [=====] - 19s 30ms/step - loss: 0.3170 -
accuracy: 0.8627 - val_loss: 0.3310 - val_accuracy: 0.8613

```

```
[ ]: <keras.callbacks.History at 0x7f0f91fcde20>
```

```

[ ]: tensorboardCNN2_MD = TensorBoard(log_dir='logs/cnn2_MD')

modeloCNN2_MD.fit(
    data_gen_entrenamiento,
    epochs=100, batch_size=32,
    validation_data=(X_validacion, y_validacion),
    steps_per_epoch=int(np.ceil(len(X_entrenamiento) / float(32))),
    validation_steps=int(np.ceil(len(X_validacion) / float(32))),
    callbacks=[tensorboardCNN2_MD]
)

```

```

Epoch 1/100
616/616 [=====] - 22s 31ms/step - loss: 0.6863 -
accuracy: 0.5441 - val_loss: 0.6796 - val_accuracy: 0.5598
Epoch 2/100
616/616 [=====] - 19s 31ms/step - loss: 0.6757 -
accuracy: 0.5778 - val_loss: 0.6676 - val_accuracy: 0.5912
Epoch 3/100
616/616 [=====] - 18s 30ms/step - loss: 0.6624 -
accuracy: 0.6017 - val_loss: 0.6839 - val_accuracy: 0.5710
Epoch 4/100
616/616 [=====] - 20s 33ms/step - loss: 0.6550 -
accuracy: 0.6121 - val_loss: 0.6387 - val_accuracy: 0.6454
Epoch 5/100
616/616 [=====] - 19s 30ms/step - loss: 0.6457 -
accuracy: 0.6257 - val_loss: 0.6201 - val_accuracy: 0.6567
Epoch 6/100
616/616 [=====] - 19s 31ms/step - loss: 0.6339 -
accuracy: 0.6428 - val_loss: 0.6096 - val_accuracy: 0.6645
Epoch 7/100
616/616 [=====] - 18s 29ms/step - loss: 0.6251 -

```

accuracy: 0.6511 - val_loss: 0.6098 - val_accuracy: 0.6783
Epoch 8/100
616/616 [=====] - 20s 32ms/step - loss: 0.6193 -
accuracy: 0.6572 - val_loss: 0.5958 - val_accuracy: 0.6839
Epoch 9/100
616/616 [=====] - 18s 30ms/step - loss: 0.6095 -
accuracy: 0.6679 - val_loss: 0.6066 - val_accuracy: 0.6631
Epoch 10/100
616/616 [=====] - 19s 31ms/step - loss: 0.6023 -
accuracy: 0.6744 - val_loss: 0.6304 - val_accuracy: 0.6567
Epoch 11/100
616/616 [=====] - 19s 30ms/step - loss: 0.6039 -
accuracy: 0.6755 - val_loss: 0.6320 - val_accuracy: 0.6407
Epoch 12/100
616/616 [=====] - 19s 31ms/step - loss: 0.5955 -
accuracy: 0.6830 - val_loss: 0.5747 - val_accuracy: 0.7021
Epoch 13/100
616/616 [=====] - 18s 30ms/step - loss: 0.5834 -
accuracy: 0.6921 - val_loss: 0.5977 - val_accuracy: 0.6802
Epoch 14/100
616/616 [=====] - 20s 32ms/step - loss: 0.5808 -
accuracy: 0.6920 - val_loss: 0.5713 - val_accuracy: 0.7024
Epoch 15/100
616/616 [=====] - 19s 30ms/step - loss: 0.5835 -
accuracy: 0.6918 - val_loss: 0.5525 - val_accuracy: 0.7226
Epoch 16/100
616/616 [=====] - 19s 31ms/step - loss: 0.5740 -
accuracy: 0.6996 - val_loss: 0.5094 - val_accuracy: 0.7614
Epoch 17/100
616/616 [=====] - 19s 31ms/step - loss: 0.5717 -
accuracy: 0.7046 - val_loss: 0.5248 - val_accuracy: 0.7403
Epoch 18/100
616/616 [=====] - 20s 32ms/step - loss: 0.5699 -
accuracy: 0.7040 - val_loss: 0.5971 - val_accuracy: 0.6842
Epoch 19/100
616/616 [=====] - 18s 30ms/step - loss: 0.5600 -
accuracy: 0.7137 - val_loss: 0.5022 - val_accuracy: 0.7625
Epoch 20/100
616/616 [=====] - 20s 32ms/step - loss: 0.5612 -
accuracy: 0.7106 - val_loss: 0.5091 - val_accuracy: 0.7583
Epoch 21/100
616/616 [=====] - 20s 32ms/step - loss: 0.5517 -
accuracy: 0.7206 - val_loss: 0.5163 - val_accuracy: 0.7555
Epoch 22/100
616/616 [=====] - 20s 32ms/step - loss: 0.5527 -
accuracy: 0.7195 - val_loss: 0.5023 - val_accuracy: 0.7614
Epoch 23/100
616/616 [=====] - 18s 30ms/step - loss: 0.5540 -

accuracy: 0.7146 - val_loss: 0.5237 - val_accuracy: 0.7538
 Epoch 24/100
 616/616 [=====] - 20s 32ms/step - loss: 0.5476 -
 accuracy: 0.7215 - val_loss: 0.4857 - val_accuracy: 0.7734
 Epoch 25/100
 616/616 [=====] - 19s 30ms/step - loss: 0.5439 -
 accuracy: 0.7215 - val_loss: 0.6316 - val_accuracy: 0.6794
 Epoch 26/100
 616/616 [=====] - 20s 32ms/step - loss: 0.5426 -
 accuracy: 0.7239 - val_loss: 0.5312 - val_accuracy: 0.7406
 Epoch 27/100
 616/616 [=====] - 19s 31ms/step - loss: 0.5390 -
 accuracy: 0.7265 - val_loss: 0.5301 - val_accuracy: 0.7296
 Epoch 28/100
 616/616 [=====] - 19s 32ms/step - loss: 0.5375 -
 accuracy: 0.7264 - val_loss: 0.5025 - val_accuracy: 0.7619
 Epoch 29/100
 616/616 [=====] - 18s 30ms/step - loss: 0.5358 -
 accuracy: 0.7347 - val_loss: 0.5614 - val_accuracy: 0.7184
 Epoch 30/100
 616/616 [=====] - 20s 32ms/step - loss: 0.5295 -
 accuracy: 0.7356 - val_loss: 0.5565 - val_accuracy: 0.7077
 Epoch 31/100
 616/616 [=====] - 18s 29ms/step - loss: 0.5295 -
 accuracy: 0.7361 - val_loss: 0.4778 - val_accuracy: 0.7720
 Epoch 32/100
 616/616 [=====] - 20s 32ms/step - loss: 0.5272 -
 accuracy: 0.7383 - val_loss: 0.4817 - val_accuracy: 0.7723
 Epoch 33/100
 616/616 [=====] - 19s 31ms/step - loss: 0.5218 -
 accuracy: 0.7416 - val_loss: 0.5186 - val_accuracy: 0.7527
 Epoch 34/100
 616/616 [=====] - 19s 32ms/step - loss: 0.5205 -
 accuracy: 0.7374 - val_loss: 0.4722 - val_accuracy: 0.7782
 Epoch 35/100
 616/616 [=====] - 19s 30ms/step - loss: 0.5180 -
 accuracy: 0.7444 - val_loss: 0.4639 - val_accuracy: 0.7923
 Epoch 36/100
 616/616 [=====] - 19s 31ms/step - loss: 0.5177 -
 accuracy: 0.7468 - val_loss: 0.4718 - val_accuracy: 0.7830
 Epoch 37/100
 616/616 [=====] - 19s 30ms/step - loss: 0.5121 -
 accuracy: 0.7488 - val_loss: 0.6058 - val_accuracy: 0.7092
 Epoch 38/100
 616/616 [=====] - 19s 31ms/step - loss: 0.5138 -
 accuracy: 0.7474 - val_loss: 0.4873 - val_accuracy: 0.7720
 Epoch 39/100
 616/616 [=====] - 19s 31ms/step - loss: 0.5104 -

accuracy: 0.7508 - val_loss: 0.5128 - val_accuracy: 0.7515
Epoch 40/100
616/616 [=====] - 19s 31ms/step - loss: 0.5040 -
accuracy: 0.7547 - val_loss: 0.5319 - val_accuracy: 0.7361
Epoch 41/100
616/616 [=====] - 19s 30ms/step - loss: 0.5064 -
accuracy: 0.7516 - val_loss: 0.4462 - val_accuracy: 0.7956
Epoch 42/100
616/616 [=====] - 19s 31ms/step - loss: 0.5008 -
accuracy: 0.7574 - val_loss: 0.4284 - val_accuracy: 0.8060
Epoch 43/100
616/616 [=====] - 20s 32ms/step - loss: 0.4979 -
accuracy: 0.7593 - val_loss: 0.4762 - val_accuracy: 0.7757
Epoch 44/100
616/616 [=====] - 19s 30ms/step - loss: 0.5007 -
accuracy: 0.7579 - val_loss: 0.4892 - val_accuracy: 0.7656
Epoch 45/100
616/616 [=====] - 20s 32ms/step - loss: 0.4937 -
accuracy: 0.7590 - val_loss: 0.4507 - val_accuracy: 0.7925
Epoch 46/100
616/616 [=====] - 19s 31ms/step - loss: 0.4969 -
accuracy: 0.7568 - val_loss: 0.4393 - val_accuracy: 0.7987
Epoch 47/100
616/616 [=====] - 20s 33ms/step - loss: 0.4883 -
accuracy: 0.7652 - val_loss: 0.4529 - val_accuracy: 0.7875
Epoch 48/100
616/616 [=====] - 19s 31ms/step - loss: 0.4905 -
accuracy: 0.7612 - val_loss: 0.4260 - val_accuracy: 0.8052
Epoch 49/100
616/616 [=====] - 19s 31ms/step - loss: 0.4864 -
accuracy: 0.7611 - val_loss: 0.4891 - val_accuracy: 0.7642
Epoch 50/100
616/616 [=====] - 21s 34ms/step - loss: 0.4877 -
accuracy: 0.7623 - val_loss: 0.4175 - val_accuracy: 0.8178
Epoch 51/100
616/616 [=====] - 19s 31ms/step - loss: 0.4854 -
accuracy: 0.7636 - val_loss: 0.5387 - val_accuracy: 0.7423
Epoch 52/100
616/616 [=====] - 20s 33ms/step - loss: 0.4854 -
accuracy: 0.7646 - val_loss: 0.4593 - val_accuracy: 0.7827
Epoch 53/100
616/616 [=====] - 19s 31ms/step - loss: 0.4860 -
accuracy: 0.7644 - val_loss: 0.4139 - val_accuracy: 0.8108
Epoch 54/100
616/616 [=====] - 20s 32ms/step - loss: 0.4802 -
accuracy: 0.7657 - val_loss: 0.4465 - val_accuracy: 0.7883
Epoch 55/100
616/616 [=====] - 20s 32ms/step - loss: 0.4776 -

accuracy: 0.7718 - val_loss: 0.4286 - val_accuracy: 0.8010
 Epoch 56/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4770 -
 accuracy: 0.7727 - val_loss: 0.4314 - val_accuracy: 0.7937
 Epoch 57/100
 616/616 [=====] - 20s 32ms/step - loss: 0.4766 -
 accuracy: 0.7707 - val_loss: 0.4103 - val_accuracy: 0.8167
 Epoch 58/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4769 -
 accuracy: 0.7703 - val_loss: 0.4938 - val_accuracy: 0.7588
 Epoch 59/100
 616/616 [=====] - 21s 34ms/step - loss: 0.4740 -
 accuracy: 0.7733 - val_loss: 0.4244 - val_accuracy: 0.8077
 Epoch 60/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4701 -
 accuracy: 0.7780 - val_loss: 0.4246 - val_accuracy: 0.8080
 Epoch 61/100
 616/616 [=====] - 20s 33ms/step - loss: 0.4715 -
 accuracy: 0.7748 - val_loss: 0.4639 - val_accuracy: 0.7785
 Epoch 62/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4694 -
 accuracy: 0.7762 - val_loss: 0.4027 - val_accuracy: 0.8150
 Epoch 63/100
 616/616 [=====] - 20s 33ms/step - loss: 0.4673 -
 accuracy: 0.7771 - val_loss: 0.4217 - val_accuracy: 0.8097
 Epoch 64/100
 616/616 [=====] - 20s 32ms/step - loss: 0.4643 -
 accuracy: 0.7788 - val_loss: 0.4323 - val_accuracy: 0.8007
 Epoch 65/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4651 -
 accuracy: 0.7815 - val_loss: 0.4017 - val_accuracy: 0.8186
 Epoch 66/100
 616/616 [=====] - 20s 32ms/step - loss: 0.4666 -
 accuracy: 0.7810 - val_loss: 0.3862 - val_accuracy: 0.8259
 Epoch 67/100
 616/616 [=====] - 19s 32ms/step - loss: 0.4680 -
 accuracy: 0.7760 - val_loss: 0.4201 - val_accuracy: 0.8046
 Epoch 68/100
 616/616 [=====] - 20s 33ms/step - loss: 0.4648 -
 accuracy: 0.7811 - val_loss: 0.4517 - val_accuracy: 0.7869
 Epoch 69/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4649 -
 accuracy: 0.7778 - val_loss: 0.3734 - val_accuracy: 0.8425
 Epoch 70/100
 616/616 [=====] - 20s 33ms/step - loss: 0.4627 -
 accuracy: 0.7813 - val_loss: 0.3874 - val_accuracy: 0.8276
 Epoch 71/100
 616/616 [=====] - 19s 31ms/step - loss: 0.4544 -

accuracy: 0.7868 - val_loss: 0.3899 - val_accuracy: 0.8296
Epoch 72/100
616/616 [=====] - 20s 33ms/step - loss: 0.4574 -
accuracy: 0.7846 - val_loss: 0.3869 - val_accuracy: 0.8299
Epoch 73/100
616/616 [=====] - 20s 33ms/step - loss: 0.4561 -
accuracy: 0.7847 - val_loss: 0.4393 - val_accuracy: 0.7970
Epoch 74/100
616/616 [=====] - 19s 31ms/step - loss: 0.4573 -
accuracy: 0.7846 - val_loss: 0.3681 - val_accuracy: 0.8335
Epoch 75/100
616/616 [=====] - 20s 32ms/step - loss: 0.4616 -
accuracy: 0.7782 - val_loss: 0.3849 - val_accuracy: 0.8273
Epoch 76/100
616/616 [=====] - 19s 31ms/step - loss: 0.4502 -
accuracy: 0.7852 - val_loss: 0.3914 - val_accuracy: 0.8273
Epoch 77/100
616/616 [=====] - 20s 33ms/step - loss: 0.4556 -
accuracy: 0.7858 - val_loss: 0.3740 - val_accuracy: 0.8358
Epoch 78/100
616/616 [=====] - 19s 31ms/step - loss: 0.4541 -
accuracy: 0.7876 - val_loss: 0.4394 - val_accuracy: 0.7981
Epoch 79/100
616/616 [=====] - 20s 33ms/step - loss: 0.4483 -
accuracy: 0.7895 - val_loss: 0.3798 - val_accuracy: 0.8273
Epoch 80/100
616/616 [=====] - 19s 30ms/step - loss: 0.4582 -
accuracy: 0.7827 - val_loss: 0.4051 - val_accuracy: 0.8189
Epoch 81/100
616/616 [=====] - 20s 32ms/step - loss: 0.4557 -
accuracy: 0.7868 - val_loss: 0.4033 - val_accuracy: 0.8077
Epoch 82/100
616/616 [=====] - 19s 31ms/step - loss: 0.4477 -
accuracy: 0.7897 - val_loss: 0.3849 - val_accuracy: 0.8287
Epoch 83/100
616/616 [=====] - 20s 33ms/step - loss: 0.4411 -
accuracy: 0.7927 - val_loss: 0.4350 - val_accuracy: 0.8043
Epoch 84/100
616/616 [=====] - 19s 31ms/step - loss: 0.4449 -
accuracy: 0.7895 - val_loss: 0.3852 - val_accuracy: 0.8223
Epoch 85/100
616/616 [=====] - 20s 32ms/step - loss: 0.4472 -
accuracy: 0.7870 - val_loss: 0.4573 - val_accuracy: 0.7810
Epoch 86/100
616/616 [=====] - 21s 34ms/step - loss: 0.4354 -
accuracy: 0.7984 - val_loss: 0.3733 - val_accuracy: 0.8271
Epoch 87/100
616/616 [=====] - 19s 31ms/step - loss: 0.4418 -

```

accuracy: 0.7945 - val_loss: 0.4070 - val_accuracy: 0.8127
Epoch 88/100
616/616 [=====] - 21s 33ms/step - loss: 0.4405 -
accuracy: 0.7921 - val_loss: 0.3508 - val_accuracy: 0.8428
Epoch 89/100
616/616 [=====] - 19s 32ms/step - loss: 0.4381 -
accuracy: 0.7940 - val_loss: 0.3993 - val_accuracy: 0.8184
Epoch 90/100
616/616 [=====] - 19s 31ms/step - loss: 0.4361 -
accuracy: 0.7935 - val_loss: 0.4422 - val_accuracy: 0.7987
Epoch 91/100
616/616 [=====] - 20s 33ms/step - loss: 0.4376 -
accuracy: 0.7955 - val_loss: 0.3692 - val_accuracy: 0.8389
Epoch 92/100
616/616 [=====] - 19s 31ms/step - loss: 0.4409 -
accuracy: 0.7969 - val_loss: 0.4385 - val_accuracy: 0.8015
Epoch 93/100
616/616 [=====] - 20s 33ms/step - loss: 0.4375 -
accuracy: 0.7970 - val_loss: 0.3943 - val_accuracy: 0.8226
Epoch 94/100
616/616 [=====] - 19s 31ms/step - loss: 0.4365 -
accuracy: 0.7964 - val_loss: 0.4417 - val_accuracy: 0.7908
Epoch 95/100
616/616 [=====] - 20s 33ms/step - loss: 0.4367 -
accuracy: 0.7969 - val_loss: 0.3627 - val_accuracy: 0.8433
Epoch 96/100
616/616 [=====] - 20s 32ms/step - loss: 0.4346 -
accuracy: 0.7958 - val_loss: 0.3883 - val_accuracy: 0.8262
Epoch 97/100
616/616 [=====] - 20s 32ms/step - loss: 0.4314 -
accuracy: 0.7981 - val_loss: 0.3664 - val_accuracy: 0.8344
Epoch 98/100
616/616 [=====] - 21s 34ms/step - loss: 0.4352 -
accuracy: 0.7972 - val_loss: 0.3577 - val_accuracy: 0.8431
Epoch 99/100
616/616 [=====] - 19s 31ms/step - loss: 0.4285 -
accuracy: 0.8008 - val_loss: 0.3558 - val_accuracy: 0.8526
Epoch 100/100
616/616 [=====] - 20s 33ms/step - loss: 0.4333 -
accuracy: 0.7981 - val_loss: 0.3697 - val_accuracy: 0.8369

```

```
[ ]: <keras.callbacks.History at 0x7f0f598e8280>
```

```

[ ]: #Cargar la extension de tensorboard de colab
%load_ext tensorboard
#Ejecutar tensorboard e indicarle que lea la carpeta "logs"
%tensorboard --logdir logs

```



```
The tensorboard extension is already loaded. To reload it, use:  
%reload_ext tensorboard
```

```
Reusing TensorBoard on port 6006 (pid 13098), started 1:48:24 ago. (Use '!kill_  
↳13098' to kill it.)
```

```
<IPython.core.display.Javascript object>
```

El modelo más corercto sería el cnn2 ya que vemos el acurracy llega al casi 85% y la perdida descende igual entre entrenamineto y test por lo tanto no hay un sobreajuste

```
[ ]:
```