

```
96 input_shape=(224, 224, 3)
97 )
98
99 # Congelar las capas convolucionales (entrenamos solo la parte final)
100 base_model.trainable = False
101
102 # =====
103 # CLASIFICADOR PERSONALIZADO
104 # =====
105 model = models.Sequential([
106     base_model,
107     layers.Flatten(),
108     layers.Dense( units=256, activation='relu'),
109     layers.Dropout(0.5),
110     layers.Dense( units=128, activation='relu'),
111     layers.Dropout(0.3),
112     layers.Dense( units=10, activation='softmax')
113 ])
114
115 # =====
```

Primera versión

IMAGE_SIZE = (224, 224)

BATCH_SIZE = 64

SIN CALLBACKS

Unicamente DropOut para controlar Overfitting

Aprox 30 minutos entrenando

```
Epoch 9: val_accuracy did not improve from 0.97919
2173/2173 [=====] - 446s 205ms/step - loss: 0.1517 - accuracy: 0.9500 - val_loss: 0.0737 - val_accuracy: 0.9778 - lr: 1.0000e-04
Epoch 10/20
2173/2173 [=====] - ETA: 0s - loss: 0.1459 - accuracy: 0.9528
Epoch 10: val_accuracy improved from 0.97919 to 0.98130, saving model to mejor_modelo.h5
2173/2173 [=====] - 451s 207ms/step - loss: 0.1459 - accuracy: 0.9528 - val_loss: 0.0589 - val_accuracy: 0.9813 - lr: 1.0000e-04
Epoch 11/20
2173/2173 [=====] - ETA: 0s - loss: 0.1398 - accuracy: 0.9537
Epoch 11: val_accuracy did not improve from 0.98130
2173/2173 [=====] - 451s 207ms/step - loss: 0.1398 - accuracy: 0.9537 - val_loss: 0.1194 - val_accuracy: 0.9607 - lr: 1.0000e-04
Epoch 12/20
2173/2173 [=====] - ETA: 0s - loss: 0.1390 - accuracy: 0.9552
Epoch 12: val_accuracy did not improve from 0.98130
2173/2173 [=====] - 453s 208ms/step - loss: 0.1390 - accuracy: 0.9552 - val_loss: 0.0691 - val_accuracy: 0.9784 - lr: 1.0000e-04
Epoch 13/20
2173/2173 [=====] - ETA: 0s - loss: 0.1346 - accuracy: 0.9569
Epoch 13: val_accuracy did not improve from 0.98130
Restoring model weights from the end of the best epoch: 10.

Epoch 13: ReduceLROnPlateau reducing learning rate to 4.999999873689376e-05.
2173/2173 [=====] - 450s 207ms/step - loss: 0.1346 - accuracy: 0.9569 - val_loss: 0.0989 - val_accuracy: 0.9681 - lr: 1.0000e-04
Epoch 13: early stopping

Process finished with exit code 0
```

CALLBACKS: EarlyStopping, Checkpoint y ReduceLR

IMAGE_SIZE = (224, 224)

BATCH_SIZE = 32

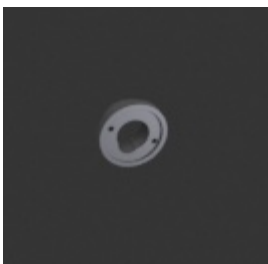
Capa de BatchNormalization después de cada capa densa

Aprox 1:40 entrenando

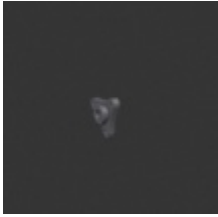
```
== Métricas globales ==
Accuracy: 0.9809 | F1-macro: 0.9809

== Classification report ==
```

	precision	recall	f1-score	support
0	0.97	0.96	0.97	1982
1	0.99	1.00	0.99	1996
2	0.96	0.97	0.97	1980
3	1.00	0.99	1.00	2000
4	0.99	0.97	0.98	1999
5	0.95	0.99	0.97	2000
6	1.00	0.98	0.99	1999
7	0.99	0.96	0.97	1947
8	0.98	0.99	0.98	1998
9	0.98	0.99	0.99	1991
accuracy			0.98	19892
macro avg	0.98	0.98	0.98	19892
weighted avg	0.98	0.98	0.98	19892



Error más grave: y_true : thread, y_pred : engine part cooler round con probabilidad del 0.99, sin embargo, se clasifica como error por falta de información discriminativa, no es un error propio del modelo pues la imagen no presenta información como rosca interna que permita diferenciar su clase real de la predicha. Se presentaron varios errores de este tipo.



Otro tipo de error que se encontró es de indecisión entre clases con estructuras similares, estos errores se pueden atribuir al reescalado aplicado a las imágenes que ocasiona que los objetos se vean pequeños pese al recorte realizado para aumentar su proporción.