Universidad Industrial de Santander

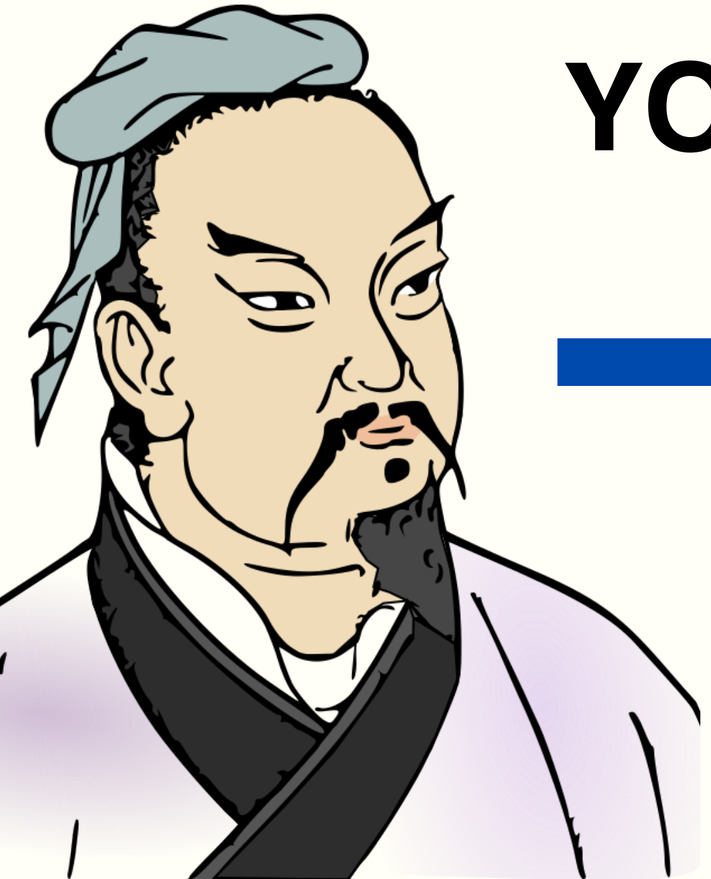
MILITARY AIRCRAFT DETECTION

Early detection of military aircraft can mean the difference between winning or losing a war.

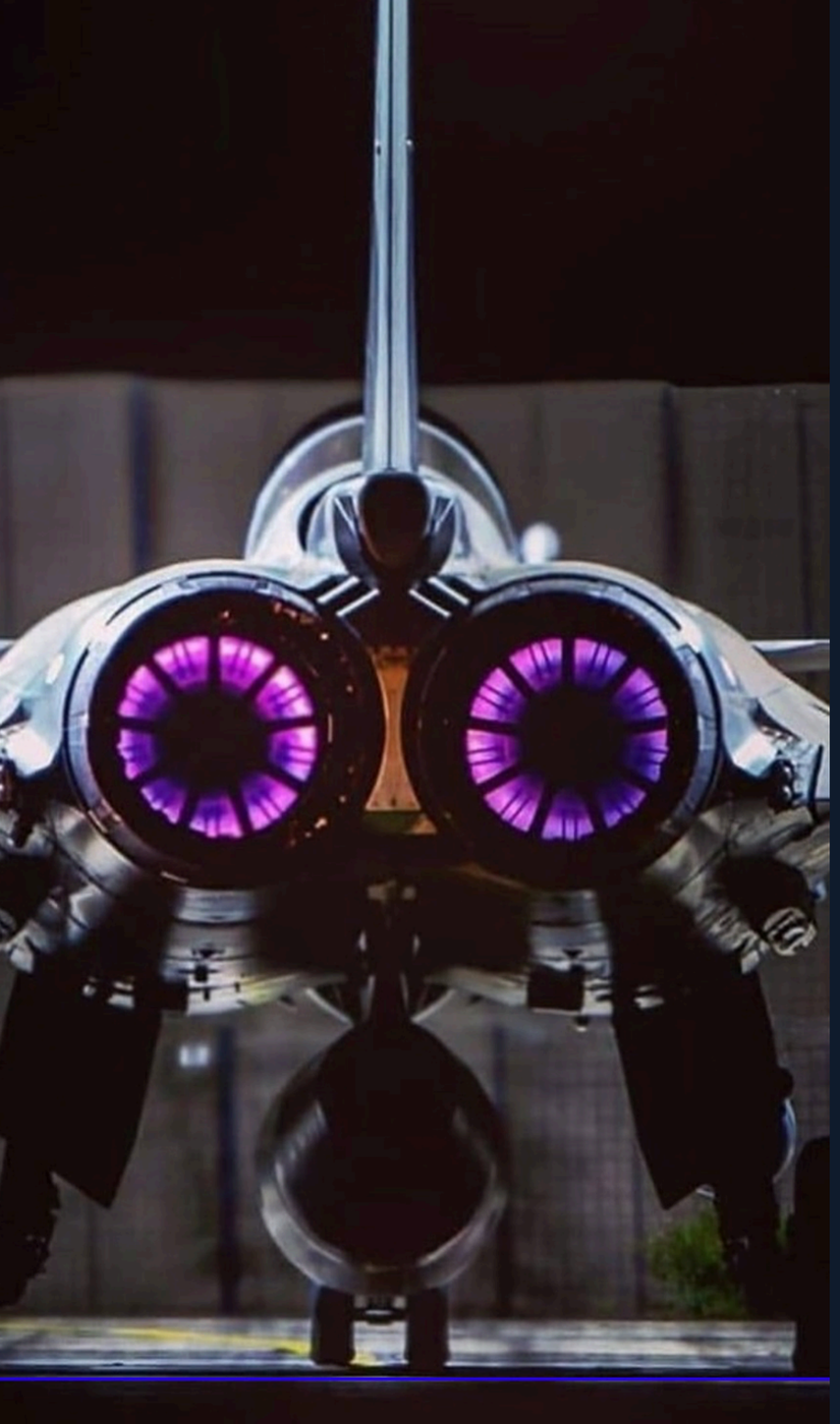
TEAM

Daniel La Rotta

KNOW THE SKY AND KNOW THE EARTH, AND YOUR VICTORY WILL BE COMPLETE



El arte de la guerra



JUSTIFICATION

Detecting military aircraft like the F-16, F-18, F-15, F-35, and C-130 is crucial for national security, intelligence, and readiness. It helps identify threats, improves surveillance, and offers insights into foreign military strategies and technologies.

OBJECTIVES

To detect military aircraft such as the F-16, F-18, F-15, F-35, and C-130 using specialized machine learning models, such as Convolutional Neural Networks (CNNs), to improve the identification and monitoring of these aircraft, thereby strengthening national security and defense capabilities.

DATASET

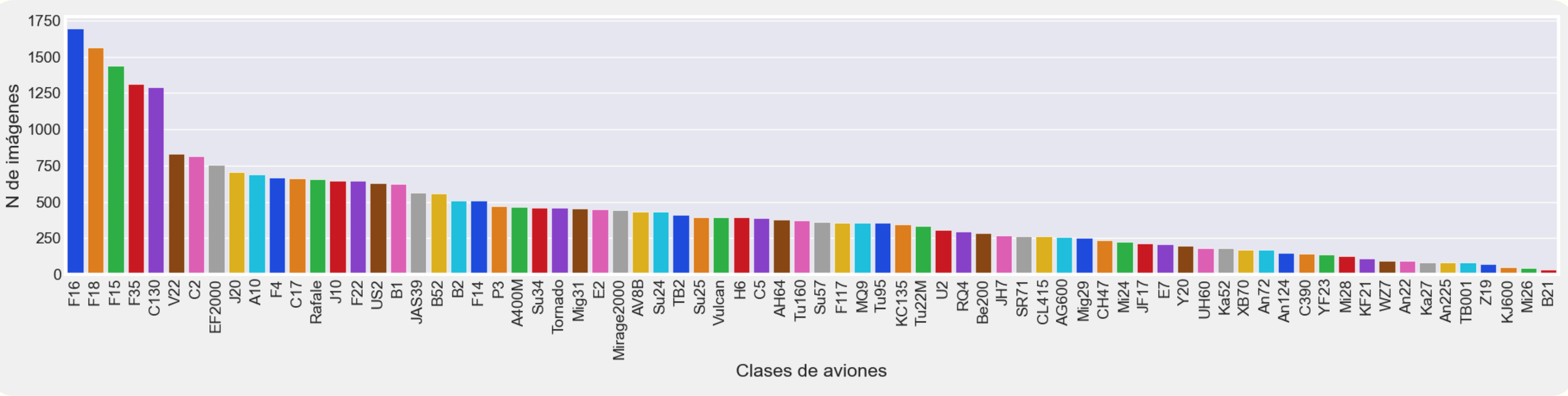
KAGGEL

T NAKAMURA - 10GB

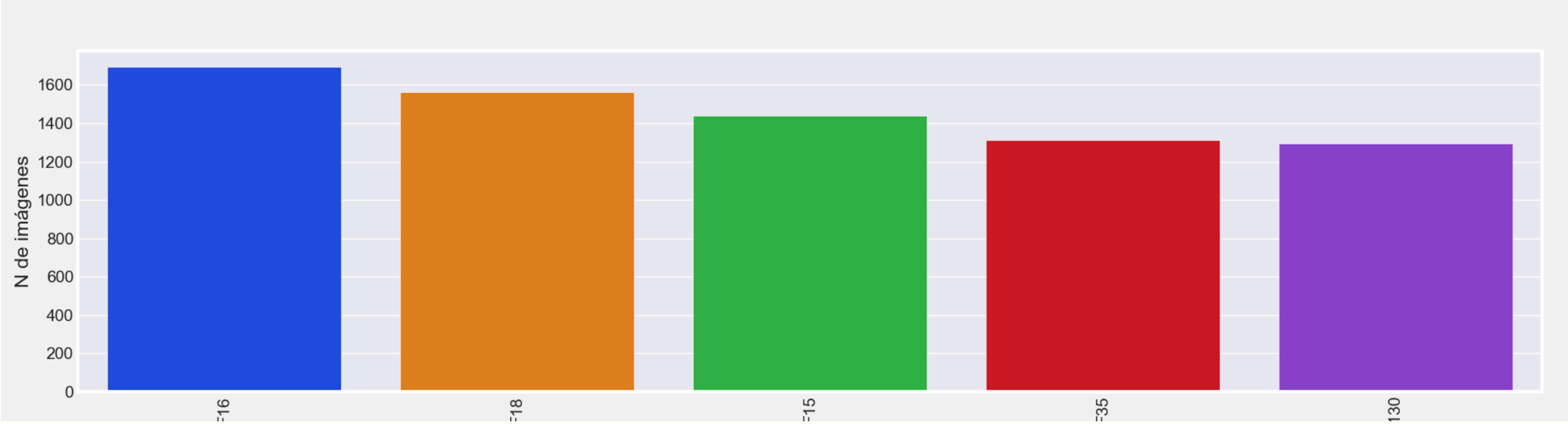
MILITARY AIRCRAFT DETECTION DATASET

- This dataset is designed for object detection of military aircraft. The dataset encompasses 74 different military aircraft types, with some types merged as one class along with their variants.

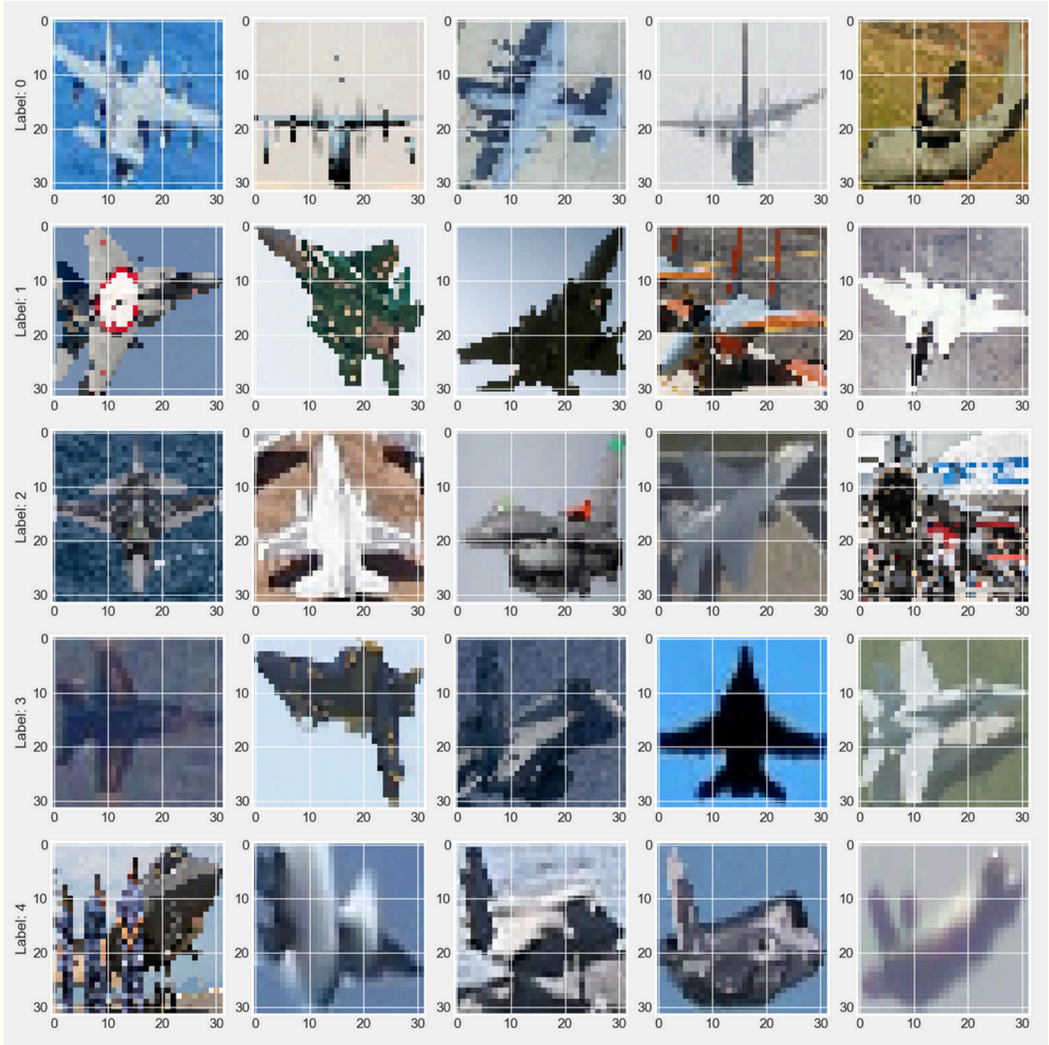
DATASET


N de imágenes
1750
1500
1250
1000
750
500
250
0
F16
F18
F15
F35
C130
V22
C2
EF2000
J20
A10
F4
C17
Rafale
J10
F22
US2
B1
JAS39
B52
B2
F14
P3
A400M
Su34
Tornado
Mig31
E2
Mirage2000
AV8B
Su24
TB2
Su25
Vulcan
H6
C5
AH64
Tu160
Su57
F117
MQ9
Tu95
KC135
Tu22M
U2
RQ4
Be200
JH7
SR71
CL415
AG600
Mig29
CH47
Mi24
JF17
E7
Y20
UH60
Ka52
XB70
An72
An124
C390
YF23
Mi28
KF21
WZ7
An22
Ka27
An225
TB001
Z19
KJ600
Mi26
B21
Clases de aviones

DATASET FINAL



DATASET FINAL

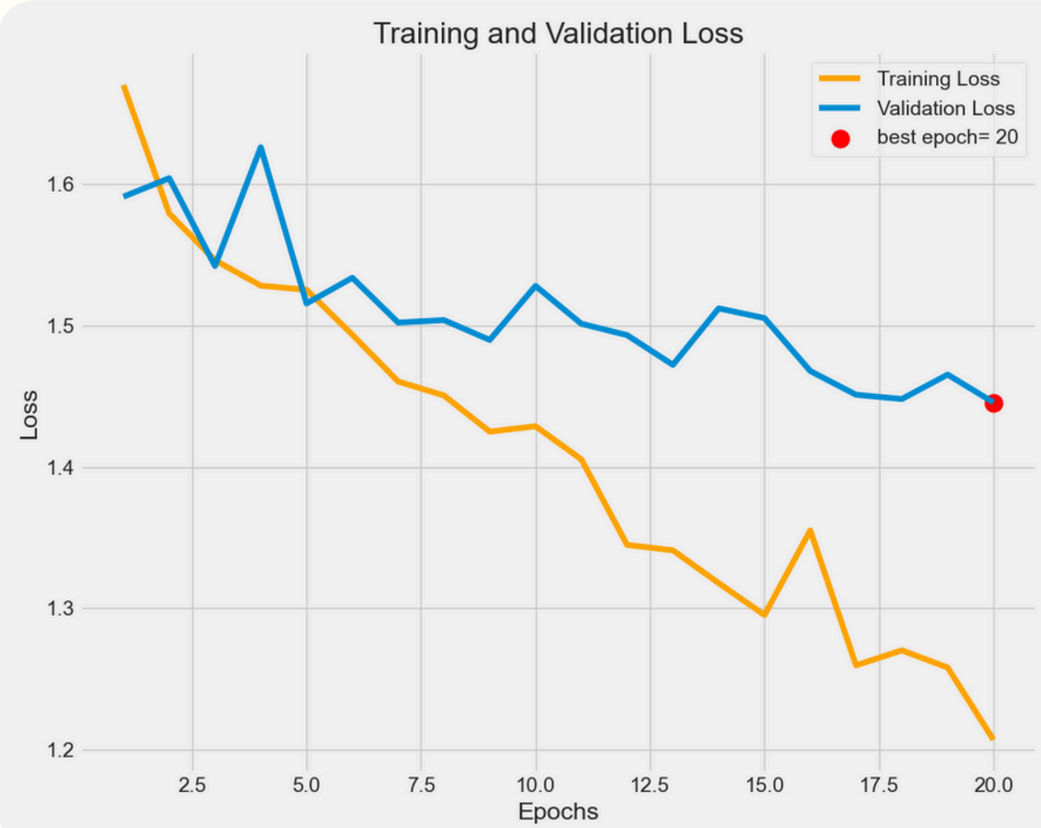


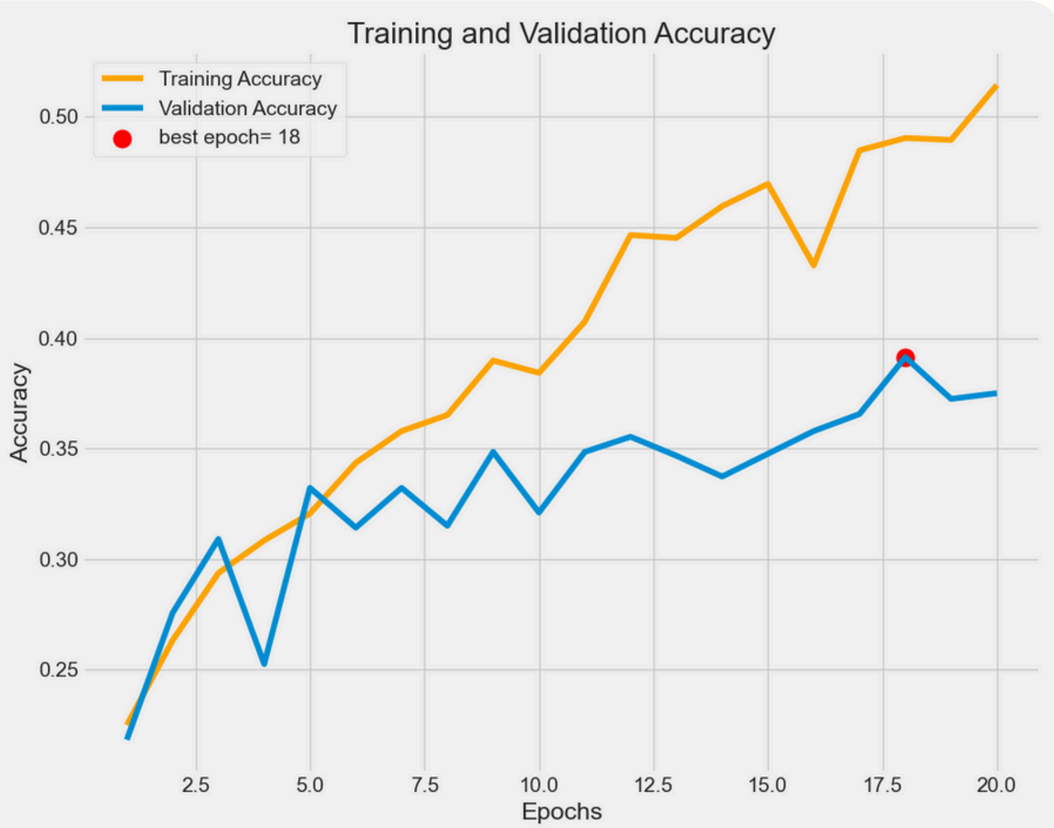
RESULTS

DNN BASE

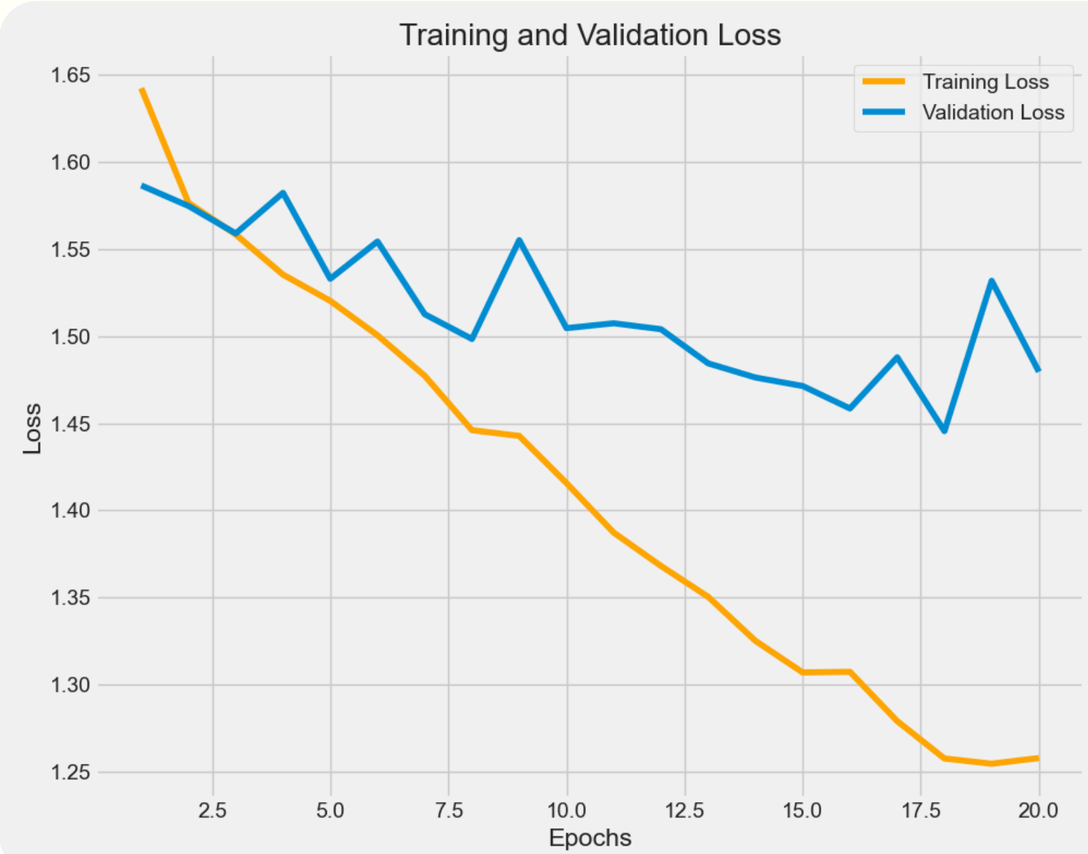
Layer (type)	Output Shape	Param #
flatten_1 (Flatten)	(None, 3072)	0
dense_3 (Dense)	(None, 128)	393,344
dense_4 (Dense)	(None, 256)	33,024
dense_5 (Dense)	(None, 5)	1,285

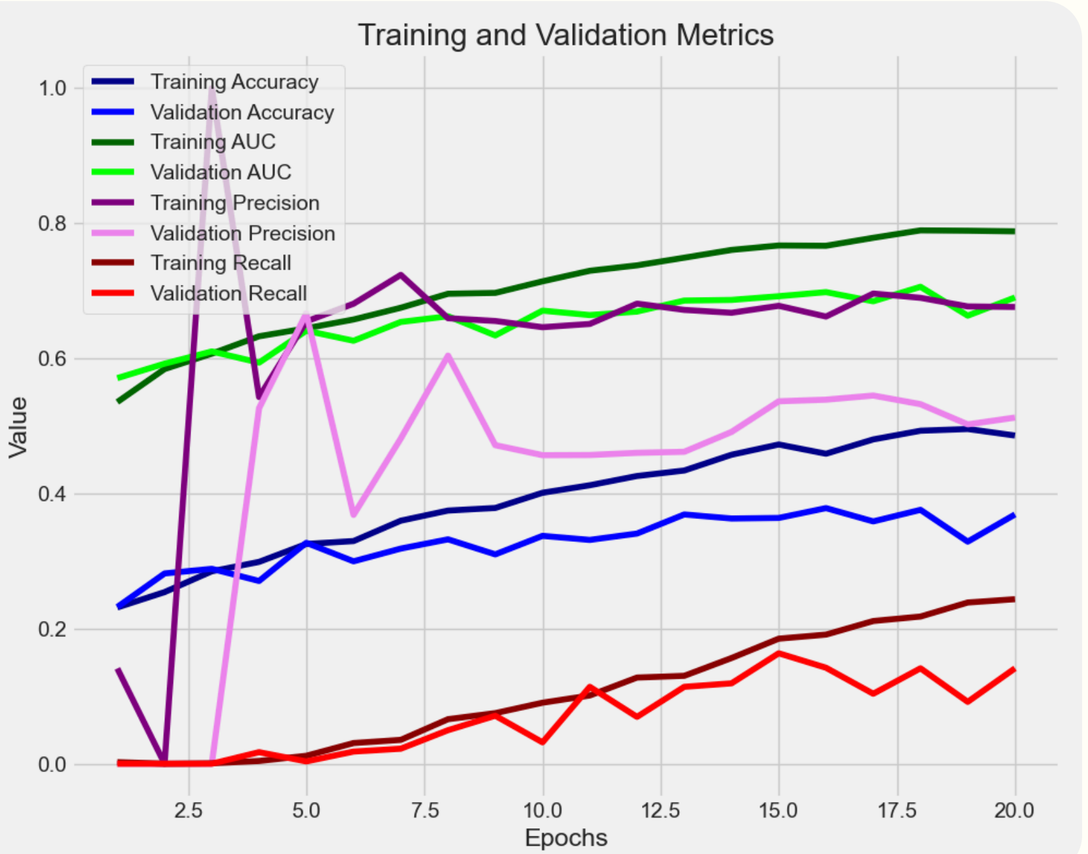
DNN BASE


Training and Validation Loss
Training Loss
Validation Loss
best epoch= 20
Loss
1.6
1.5
1.4
1.3
1.2
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Epochs

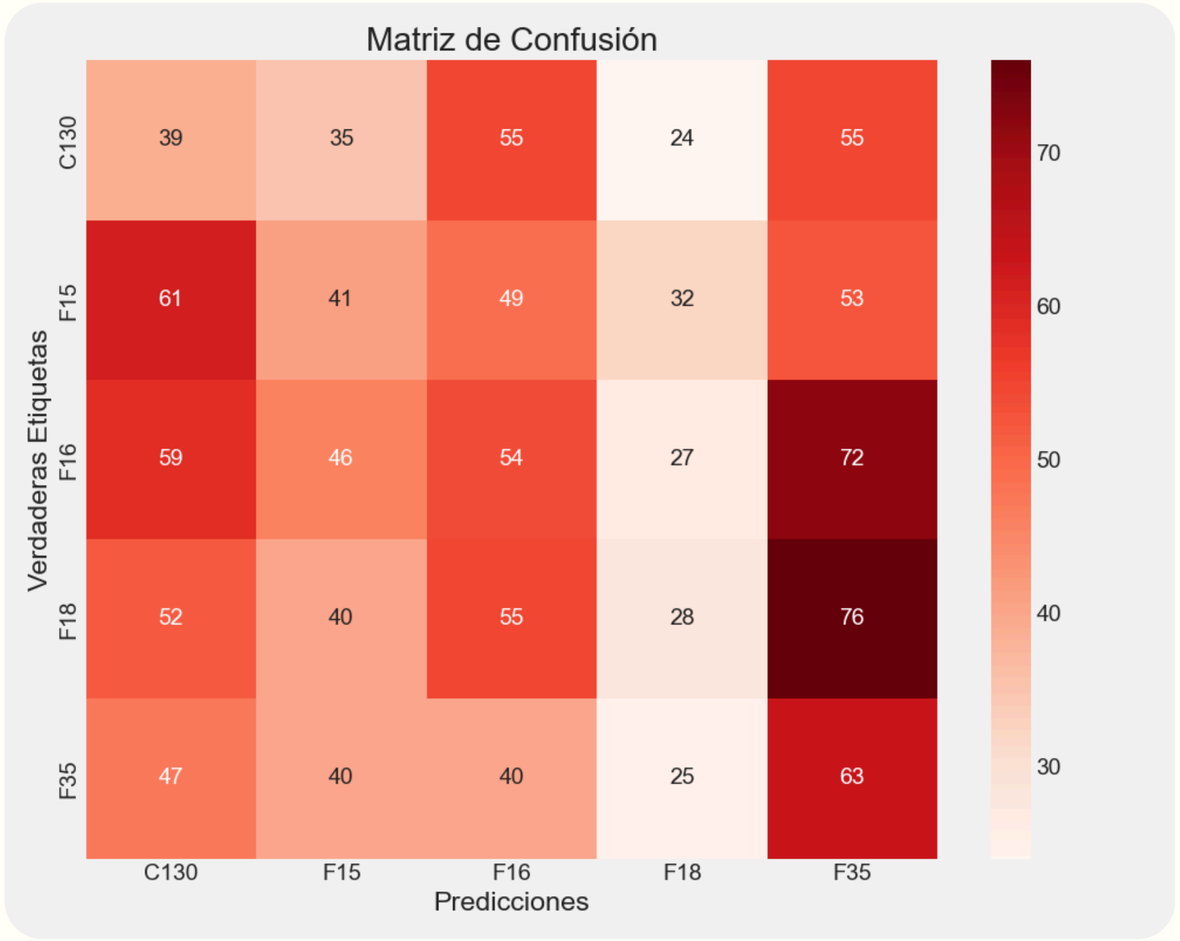

Training and Validation Accuracy
Training Accuracy
Validation Accuracy
best epoch= 18
Accuracy
0.50
0.45
0.40
0.35
0.30
0.25
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Epochs

DNN BASE


Training and Validation Loss
Training Loss
Validation Loss
Loss
Epochs
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Training and Validation Metrics
Training Accuracy
Validation Accuracy
Training AUC
Validation AUC
Training Precision
Validation Precision
Training Recall
Validation Recall
Value
Epochs
1.0
0.8
0.6
0.4
0.2
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

DNN BASE


Matriz de Confusión
Verdaderas Etiquetas
C130
F15
F16
F18
F35
39
35
55
24
55
61
41
49
32
53
59
46
54
27
72
52
40
55
28
76
47
40
40
25
63
C130
F15
F16
F18
F35
Predicciones
70
60
50
40
30

DNN BASE

```
Reporte de Clasificación:
              precision    recall  f1-score   support

        C130       0.15      0.19      0.17       208
         F15       0.20      0.17      0.19       236
         F16       0.21      0.21      0.21       258
         F18       0.21      0.11      0.14       251
         F35       0.20      0.29      0.24       215

    accuracy                           0.19      1168
   macro avg       0.19      0.20      0.19      1168
weighted avg       0.20      0.19      0.19      1168

Reporte de clasificación guardado en: model1_DNN_classification_report.txt
```

DNN VARIANTES

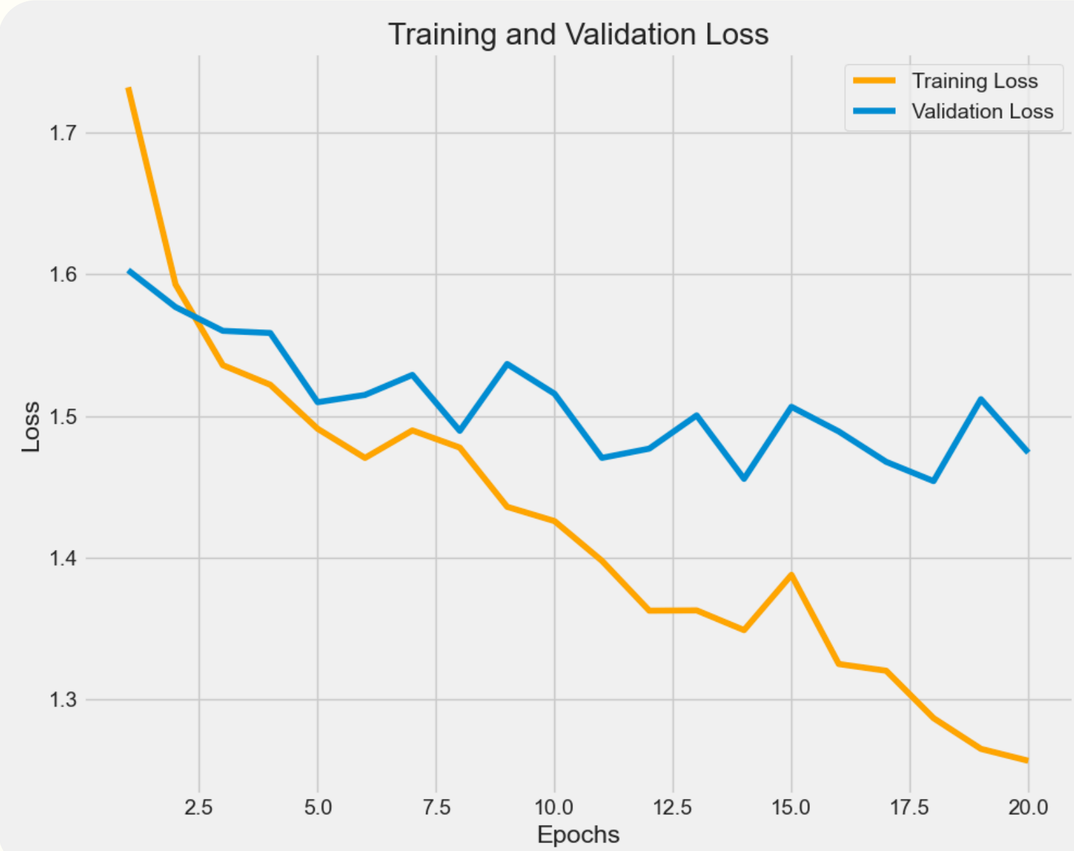
DNN BASE

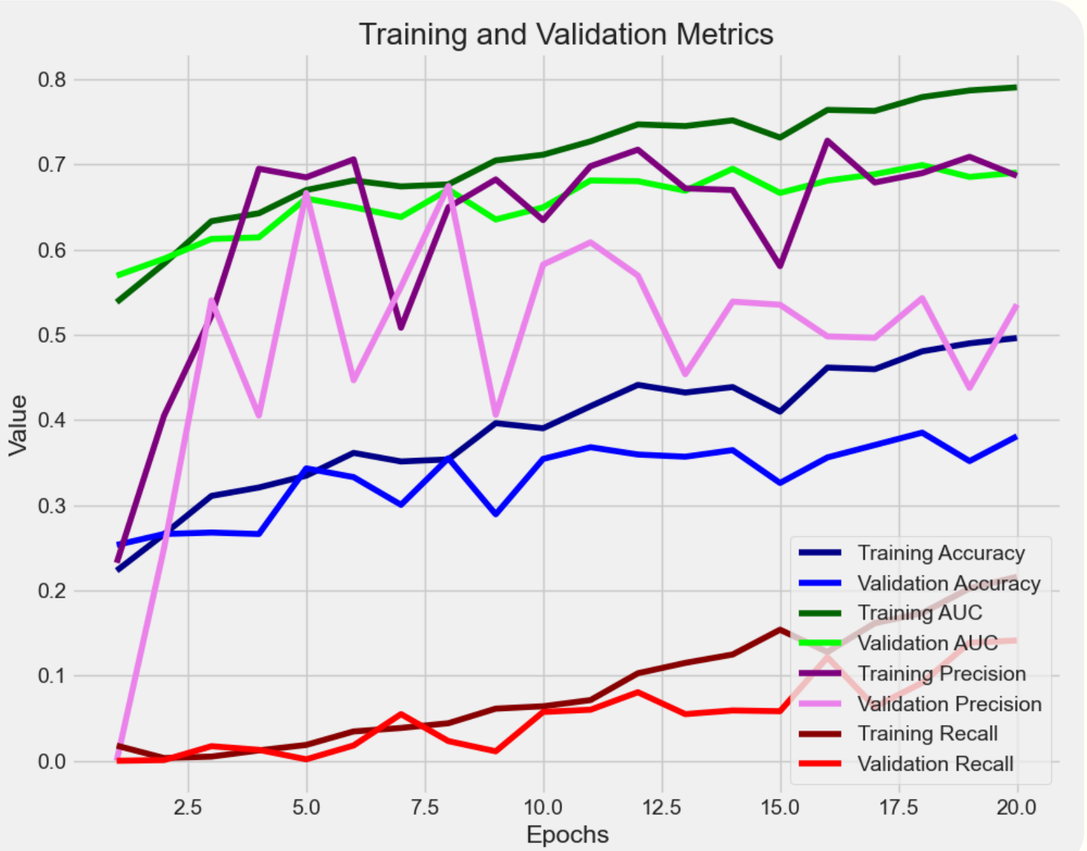
Layer (type)	Output Shape	Param #
flatten_1 (Flatten)	(None, 3072)	0
dense_3 (Dense)	(None, 128)	393,344
dense_4 (Dense)	(None, 256)	33,024
dense_5 (Dense)	(None, 5)	1,285

DNN INVERSA

Layer (type)	Output Shape	Param #
flatten_4 (Flatten)	(None, 3072)	0
dense_12 (Dense)	(None, 256)	786,688
dense_13 (Dense)	(None, 128)	32,896
dense_14 (Dense)	(None, 5)	645

DNN INVERSA


Training and Validation Loss
Training Loss
Validation Loss
Loss
1.7
1.6
1.5
1.4
1.3
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Epochs


Training and Validation Metrics
Value
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Training Accuracy
Validation Accuracy
Training AUC
Validation AUC
Training Precision
Validation Precision
Training Recall
Validation Recall
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Epochs

DNN VARIANTES

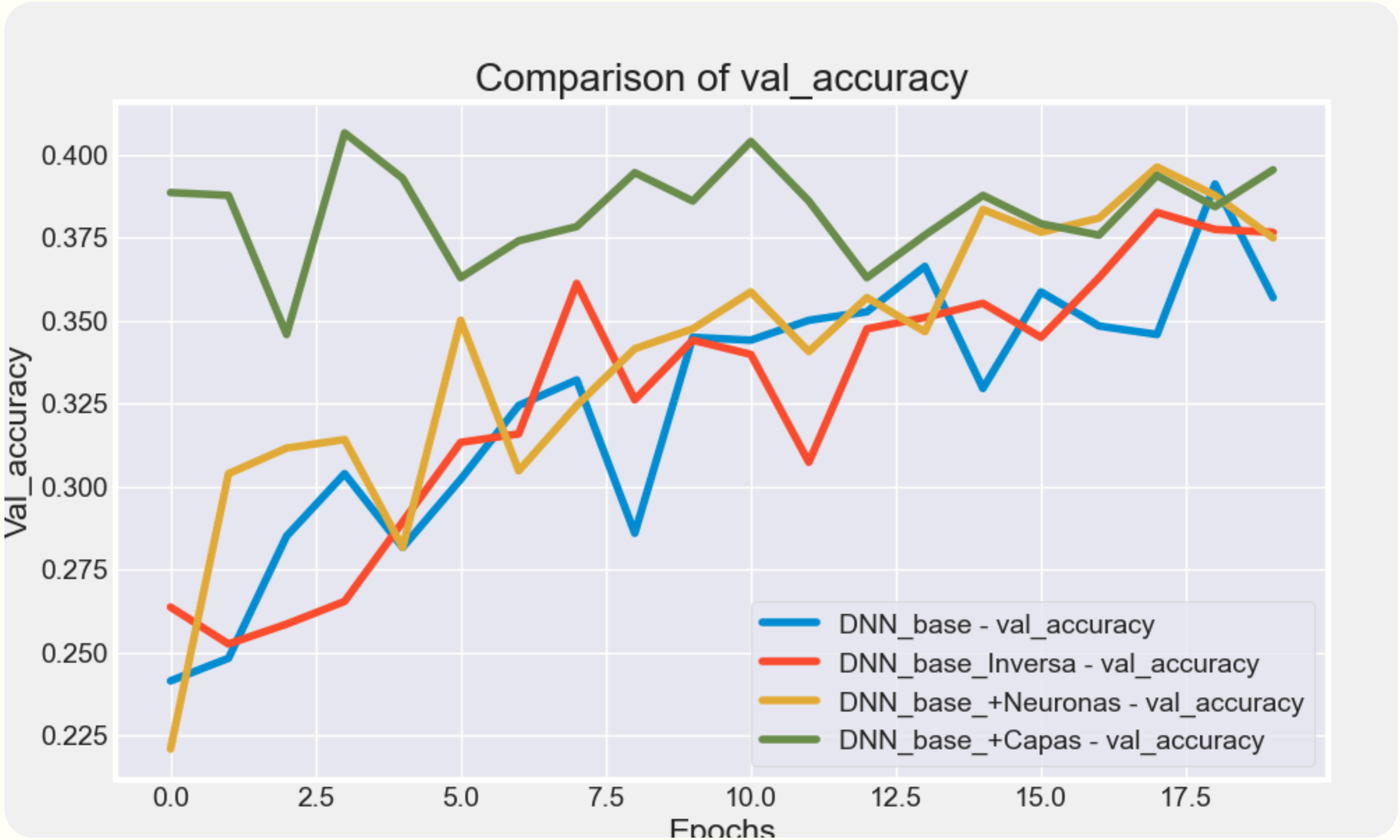
DNN + NEURONAS

Layer (type)	Output Shape	Param #
flatten_11 (Flatten)	(None, 3072)	0
dense_33 (Dense)	(None, 128)	393,344
dense_34 (Dense)	(None, 256)	33,024
dense_35 (Dense)	(None, 512)	131,584
dense_36 (Dense)	(None, 5)	2,565

DNN + CAPAS

Layer (type)	Output Shape	Param #
flatten_12 (Flatten)	(None, 3072)	0
dense_37 (Dense)	(None, 32)	98,336
dense_38 (Dense)	(None, 72)	2,376
dense_39 (Dense)	(None, 128)	9,344
dense_40 (Dense)	(None, 512)	66,048
dense_41 (Dense)	(None, 5)	2,565

DNN VARIANTES

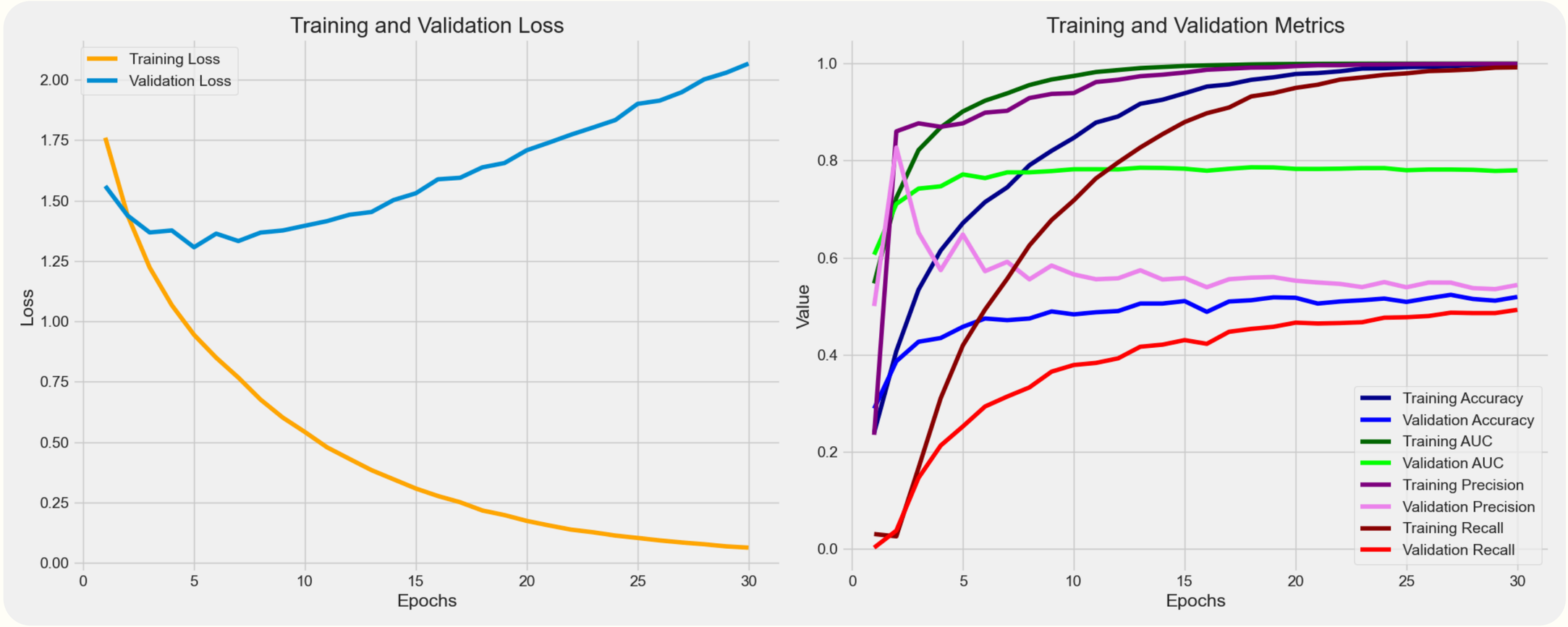


CNN CUSTOM

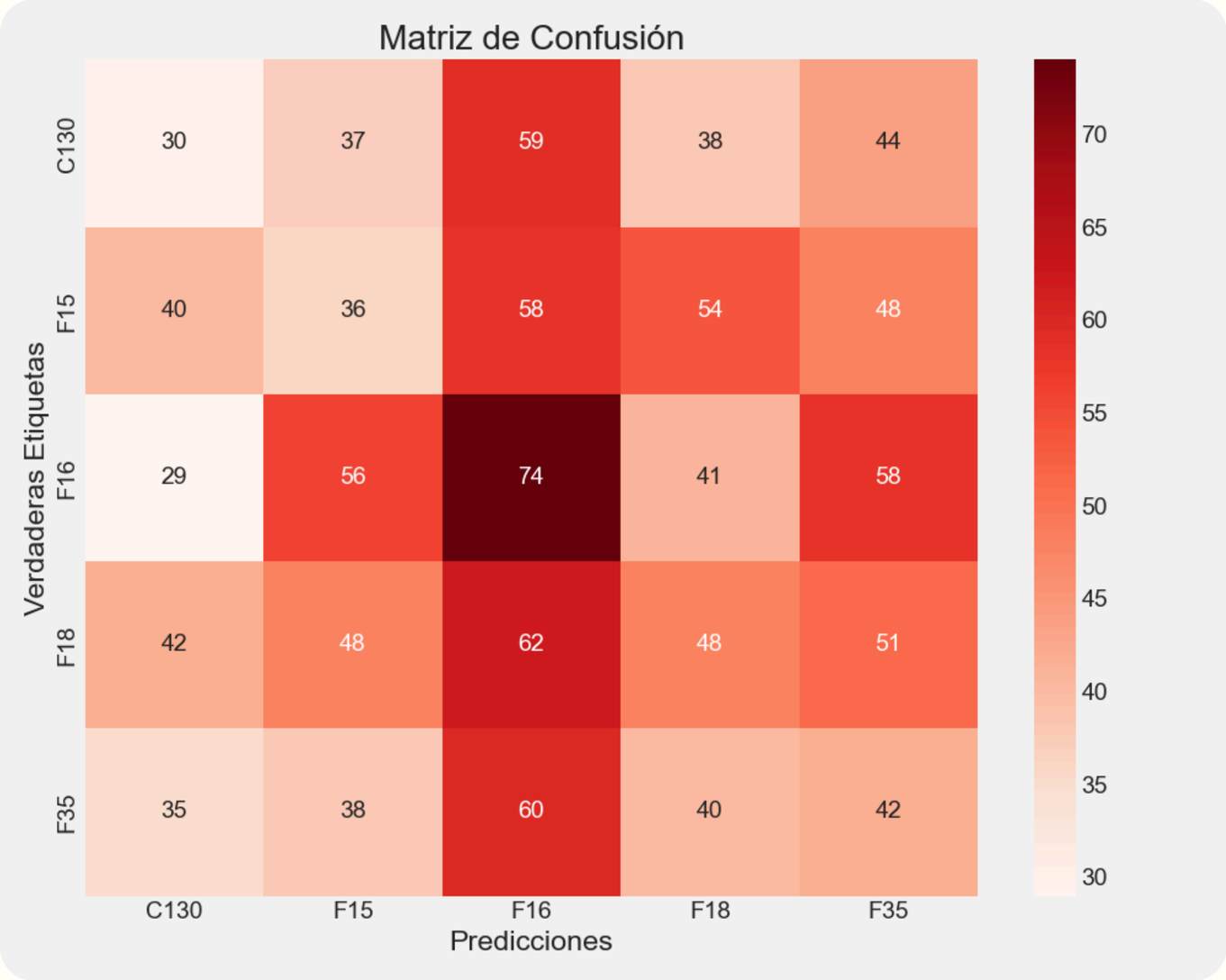
CNN BASE

Layer (type)	Output Shape	Param #
conv2d_2 (Conv2D)	(None, 30, 30, 75)	2,100
flatten_19 (Flatten)	(None, 67500)	0
dense_59 (Dense)	(None, 5)	337,505

CNN BASE


Training and Validation Loss
Training Loss
Validation Loss
Loss
Epochs
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
0
5
10
15
20
25
30
Training and Validation Metrics
Value
Epochs
0.0
0.2
0.4
0.6
0.8
1.0
Training Accuracy
Validation Accuracy
Training AUC
Validation AUC
Training Precision
Validation Precision
Training Recall
Validation Recall

CNN BASE


Matriz de Confusión
Verdaderas Etiquetas
C130
F15
F16
F18
F35
30 37 59 38 44
40 36 58 54 48
29 56 74 41 58
42 48 62 48 51
35 38 60 40 42
C130
F15
F16
F18
F35
Predicciones
70
65
60
55
50
45
40
35
30

CNN VARIANTES

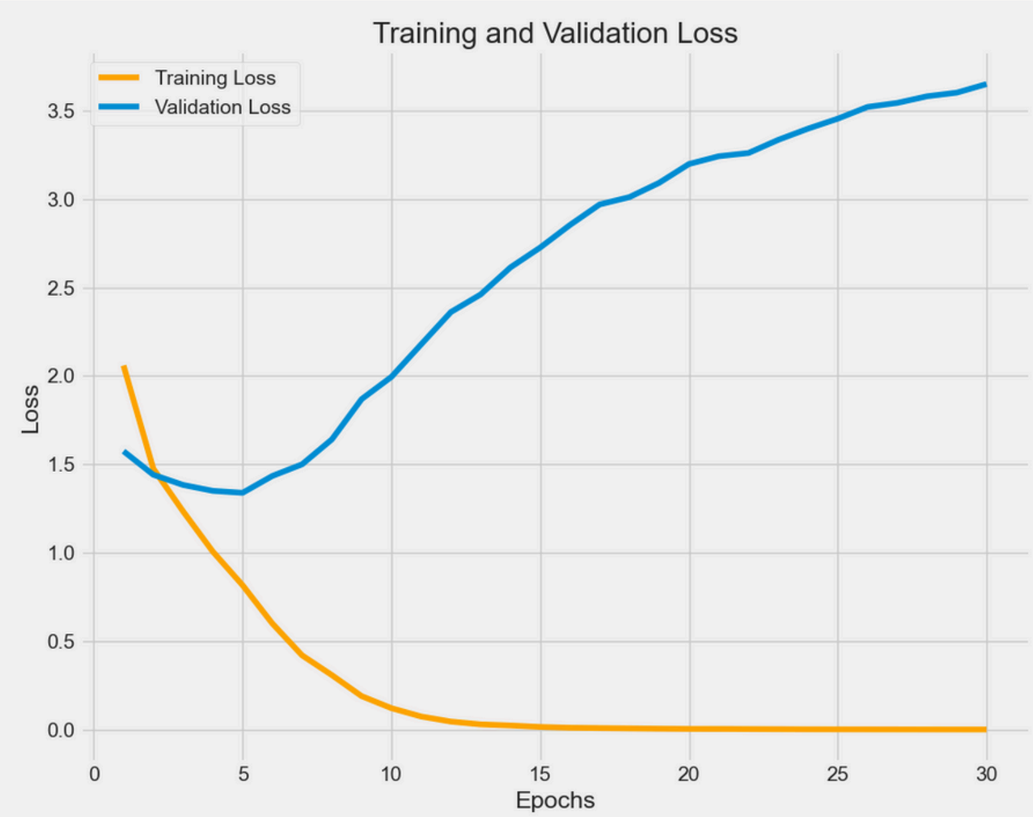
CNN + CAPAS

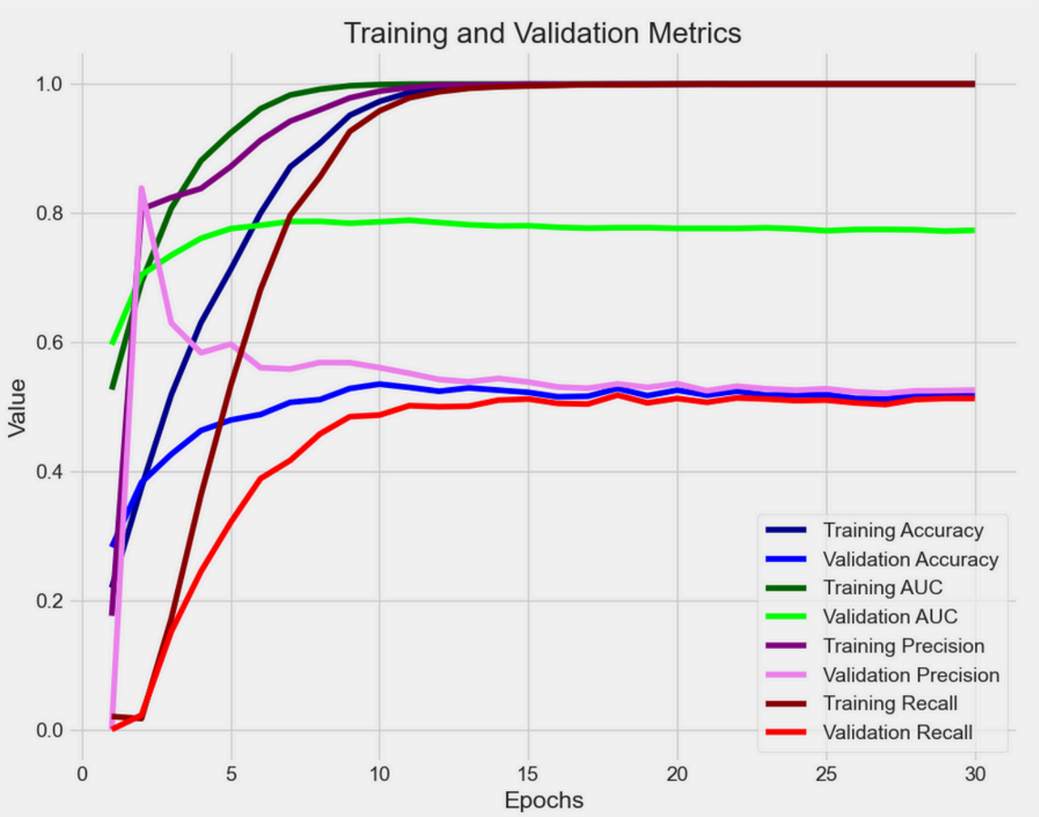
Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 30, 30, 75)	2,100
flatten_5 (Flatten)	(None, 67500)	0
dense_16 (Dense)	(None, 256)	17,280,256
dense_17 (Dense)	(None, 128)	32,896
dense_18 (Dense)	(None, 5)	645

CNN + CAPAS + DROPOUT

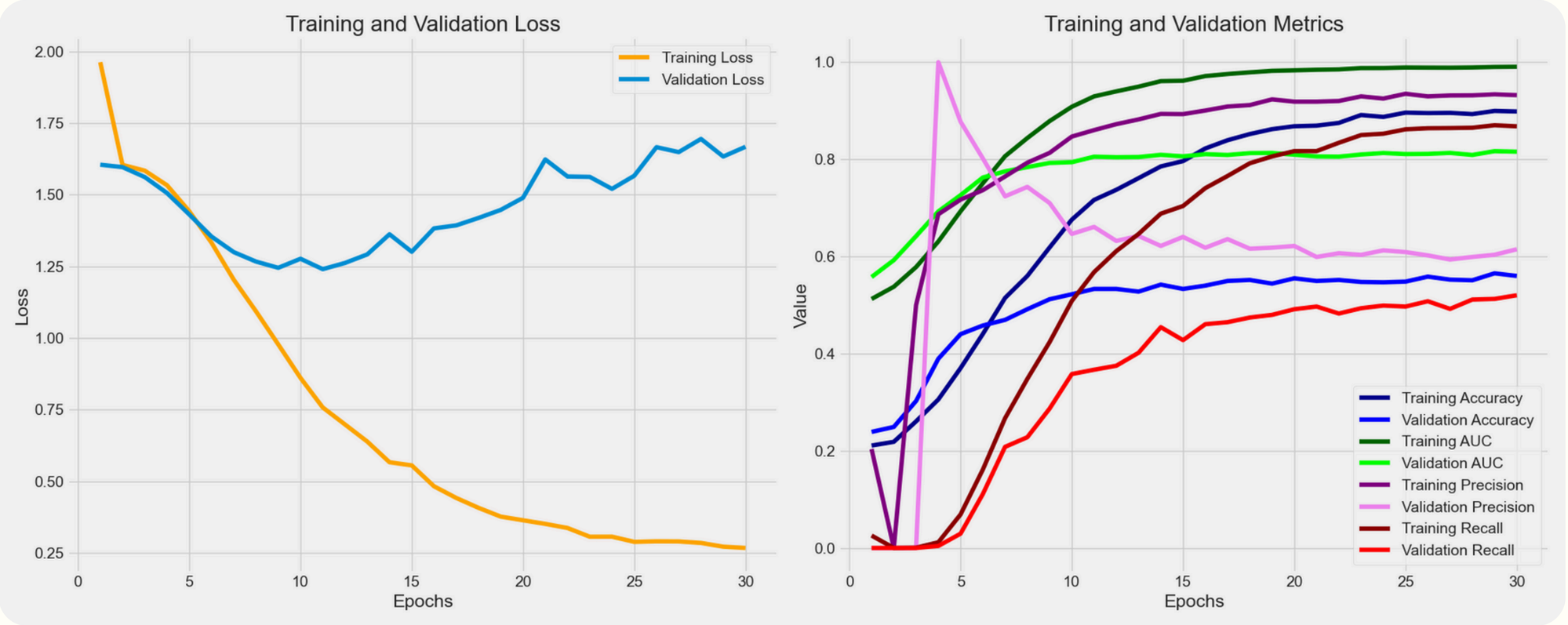
Layer (type)	Output Shape	Param #
conv2d_3 (Conv2D)	(None, 30, 30, 75)	2,100
flatten_7 (Flatten)	(None, 67500)	0
dense_22 (Dense)	(None, 256)	17,280,256
dropout (Dropout)	(None, 256)	0
dense_23 (Dense)	(None, 128)	32,896
dropout_1 (Dropout)	(None, 128)	0
dense_24 (Dense)	(None, 5)	645

CNN + CAPAS

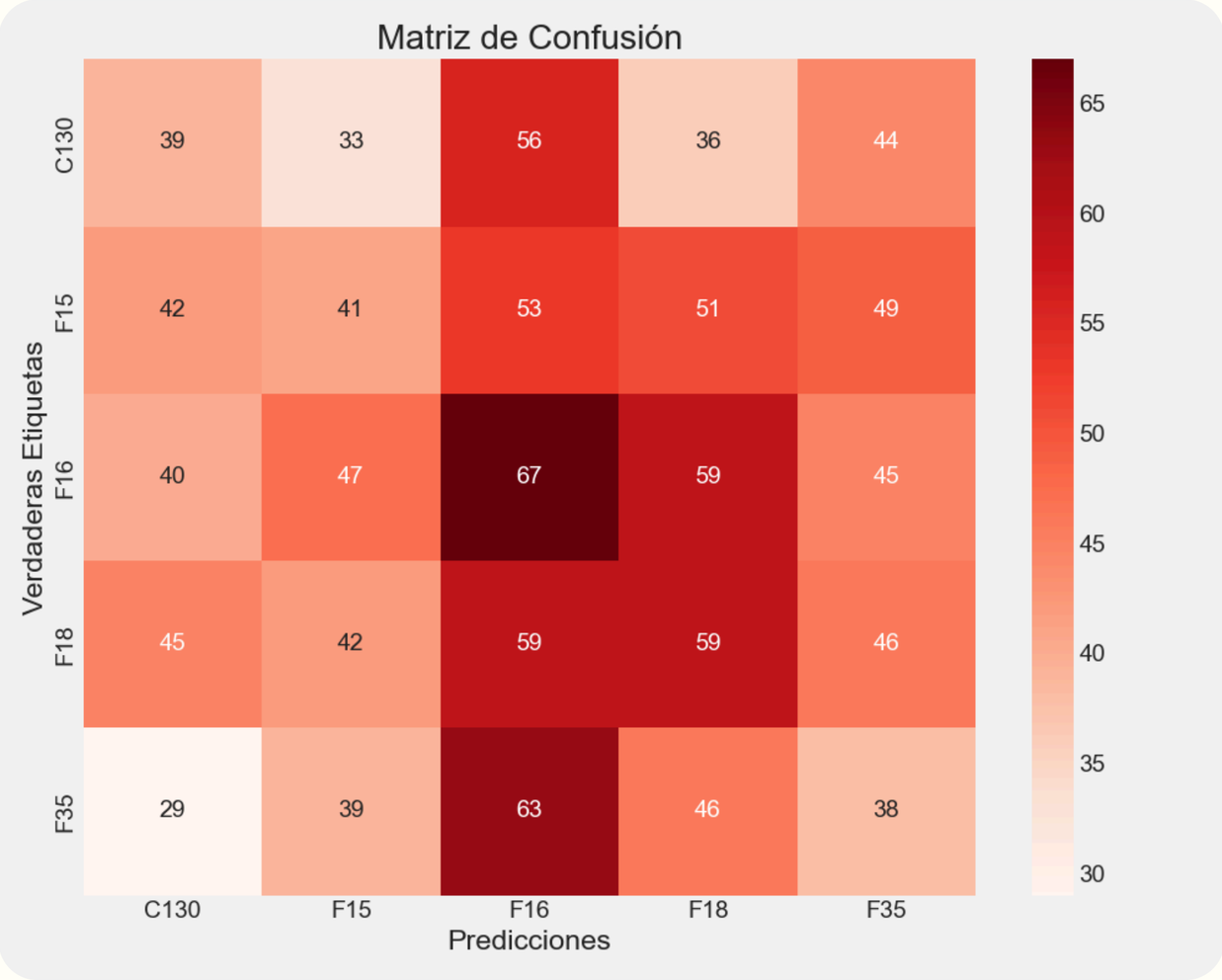

Training and Validation Loss
Training Loss
Validation Loss
Loss
Epochs
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
5
10
15
20
25
30


Training and Validation Metrics
Value
Epochs
Training Accuracy
Validation Accuracy
Training AUC
Validation AUC
Training Precision
Validation Precision
Training Recall
Validation Recall
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30

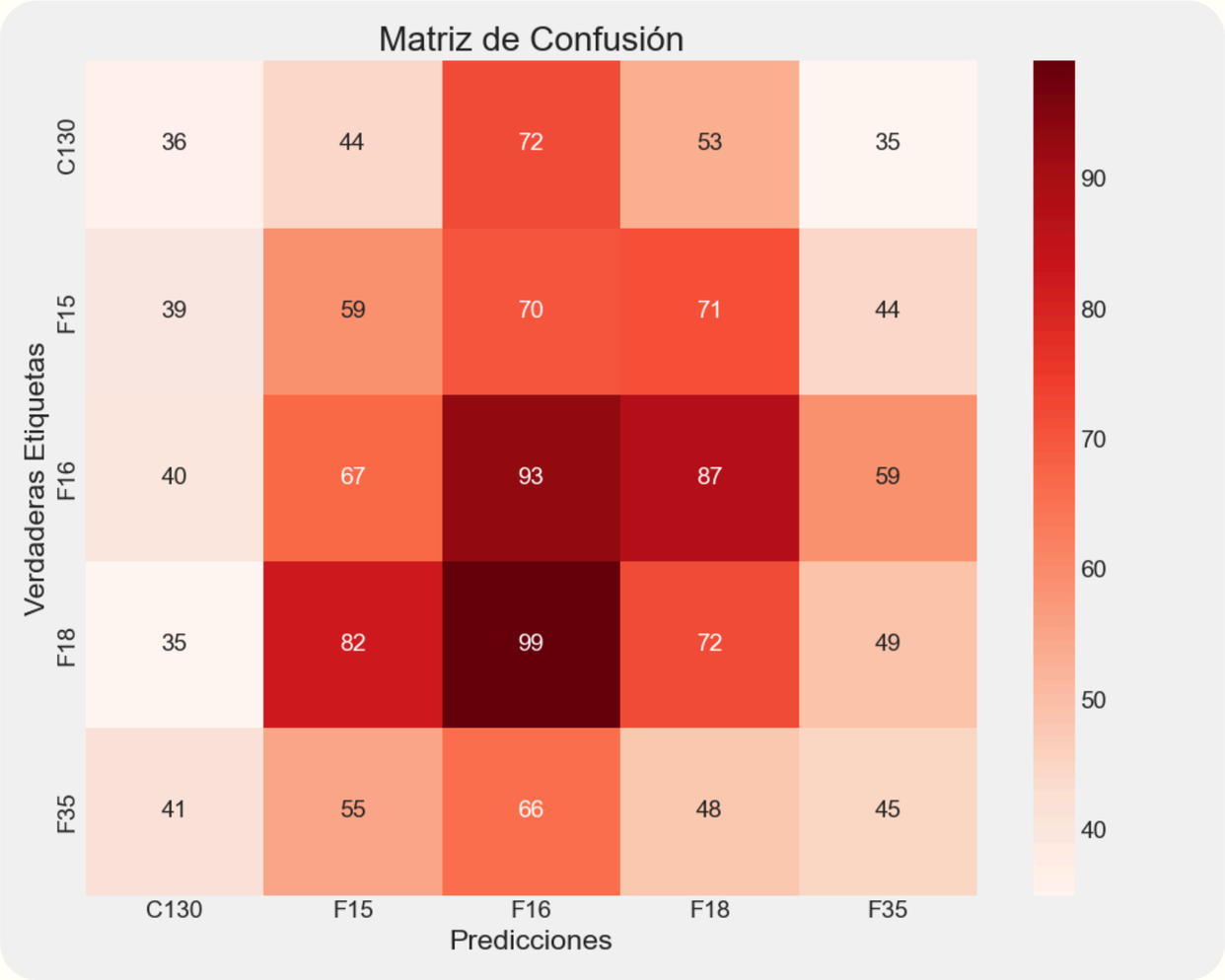
CNN + CAPAS + DROPOUT



CNN + CAPAS


Matriz de Confusión
Verdaderas Etiquetas
C130
F15
F16
F18
F35
39 33 56 36 44
42 41 53 51 49
40 47 67 59 45
45 42 59 59 46
29 39 63 46 38
C130
F15
F16
F18
F35
Predicciones
65
60
55
50
45
40
35
30

CNN + CAPAS + DROPOUT



CNN VARIANTES

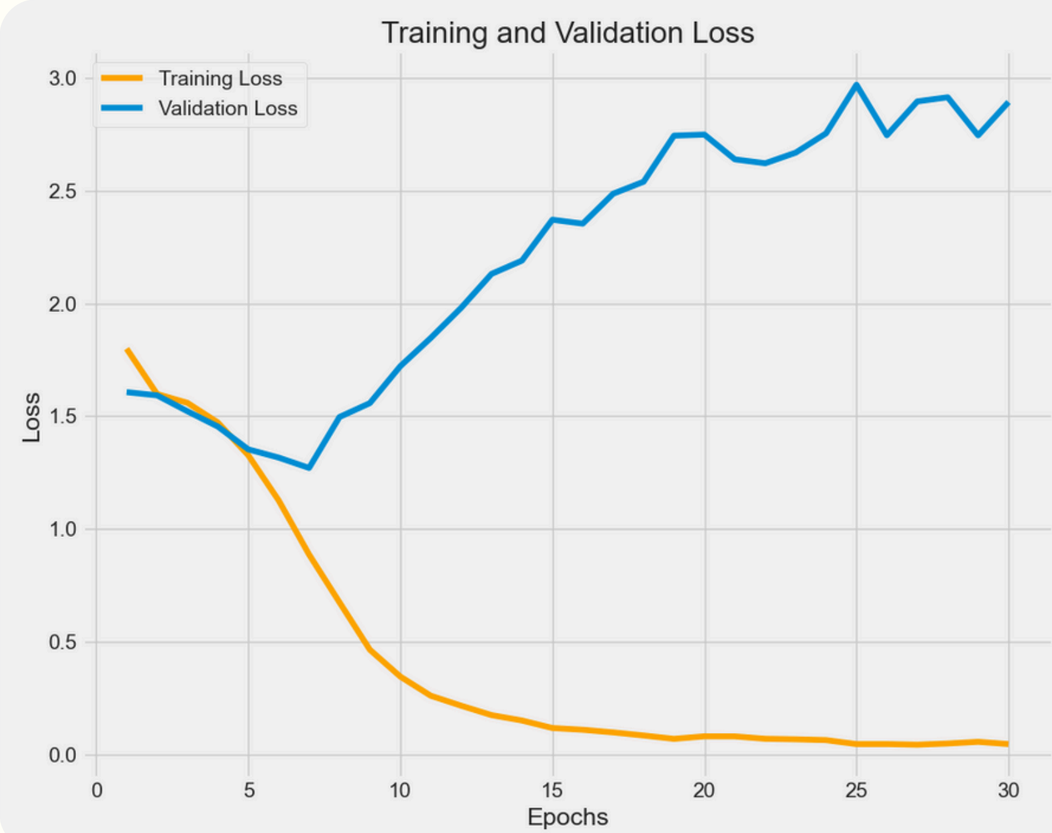
CNN + CONV + CAPAS + DROPOUT

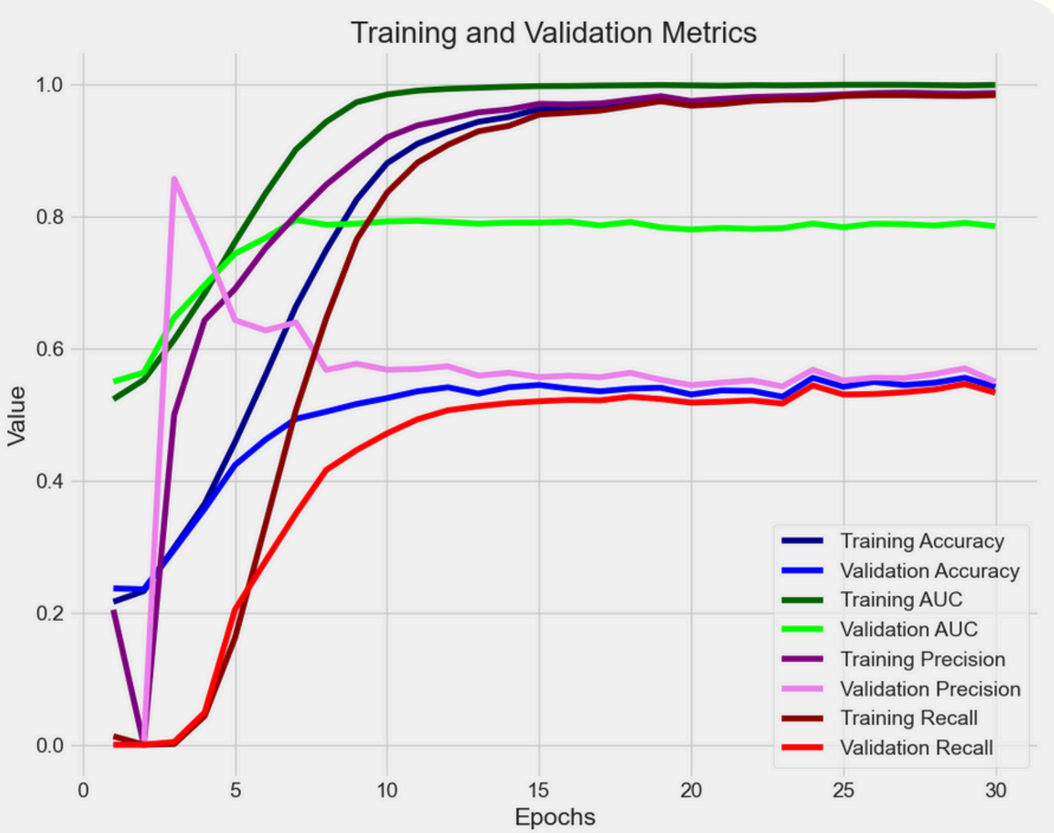
Layer (type)	Output Shape	Param #
conv2d_12 (Conv2D)	(None, 31, 31, 32)	416
dropout_12 (Dropout)	(None, 31, 31, 32)	0
conv2d_13 (Conv2D)	(None, 30, 30, 64)	8,256
dropout_13 (Dropout)	(None, 30, 30, 64)	0
conv2d_14 (Conv2D)	(None, 29, 29, 128)	32,896
flatten_18 (Flatten)	(None, 107648)	0
dense_56 (Dense)	(None, 256)	27,558,144
dropout_14 (Dropout)	(None, 256)	0
dense_57 (Dense)	(None, 128)	32,896
dropout_15 (Dropout)	(None, 128)	0
dense_58 (Dense)	(None, 5)	645

CNN + CONV + CAPAS + DROPOUT + MAXPOLING

Layer (type)	Output Shape	Param #
conv2d_18 (Conv2D)	(None, 30, 30, 32)	896
max_pooling2d (MaxPooling2D)	(None, 15, 15, 32)	0
dropout_20 (Dropout)	(None, 15, 15, 32)	0
conv2d_19 (Conv2D)	(None, 13, 13, 64)	18,496
max_pooling2d_1 (MaxPooling2D)	(None, 6, 6, 64)	0
dropout_21 (Dropout)	(None, 6, 6, 64)	0
conv2d_20 (Conv2D)	(None, 4, 4, 128)	73,856
max_pooling2d_2 (MaxPooling2D)	(None, 2, 2, 128)	0
flatten_20 (Flatten)	(None, 512)	0
dense_62 (Dense)	(None, 256)	131,328
dropout_22 (Dropout)	(None, 256)	0
dense_63 (Dense)	(None, 128)	32,896
dropout_23 (Dropout)	(None, 128)	0
dense_64 (Dense)	(None, 5)	645

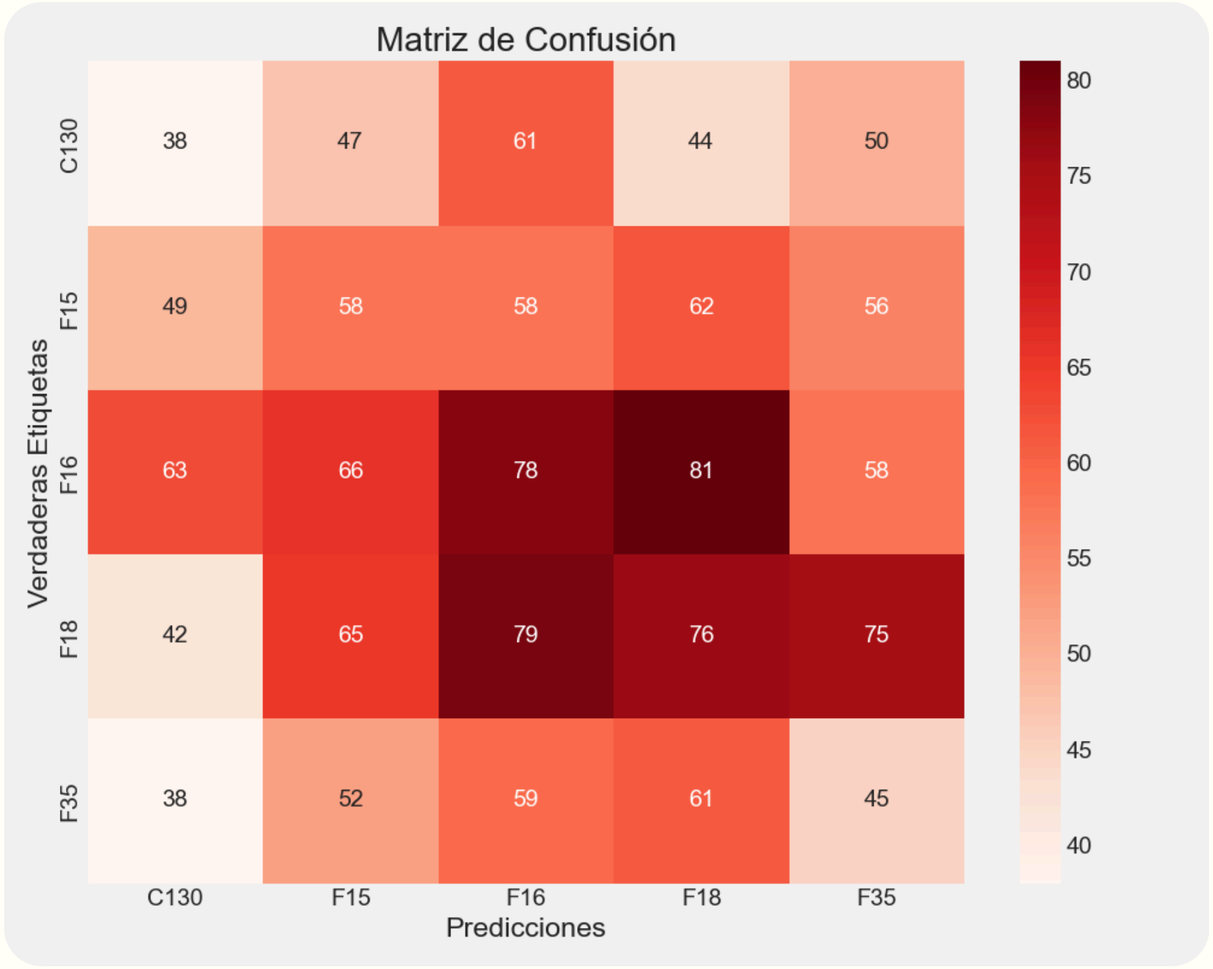
CNN + CONV + CAPAS + DROPOUT



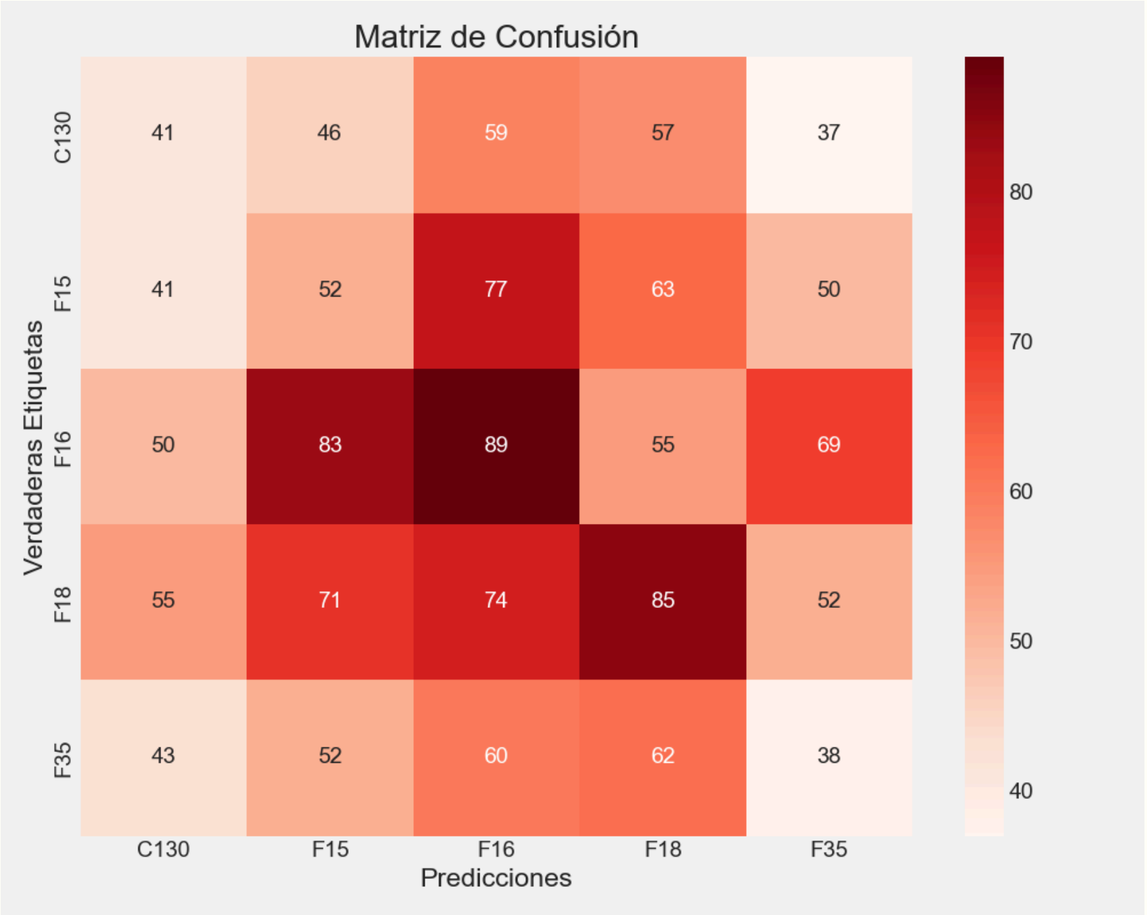


CNN + CONV + CAPAS + DROPOUT + MAXPOOLING

CNN + CONV + CAPAS + DROPOUT



CNN + CONV + CAPAS + DROPOUT + MAXPOOLING



TRANSFER LEARNING

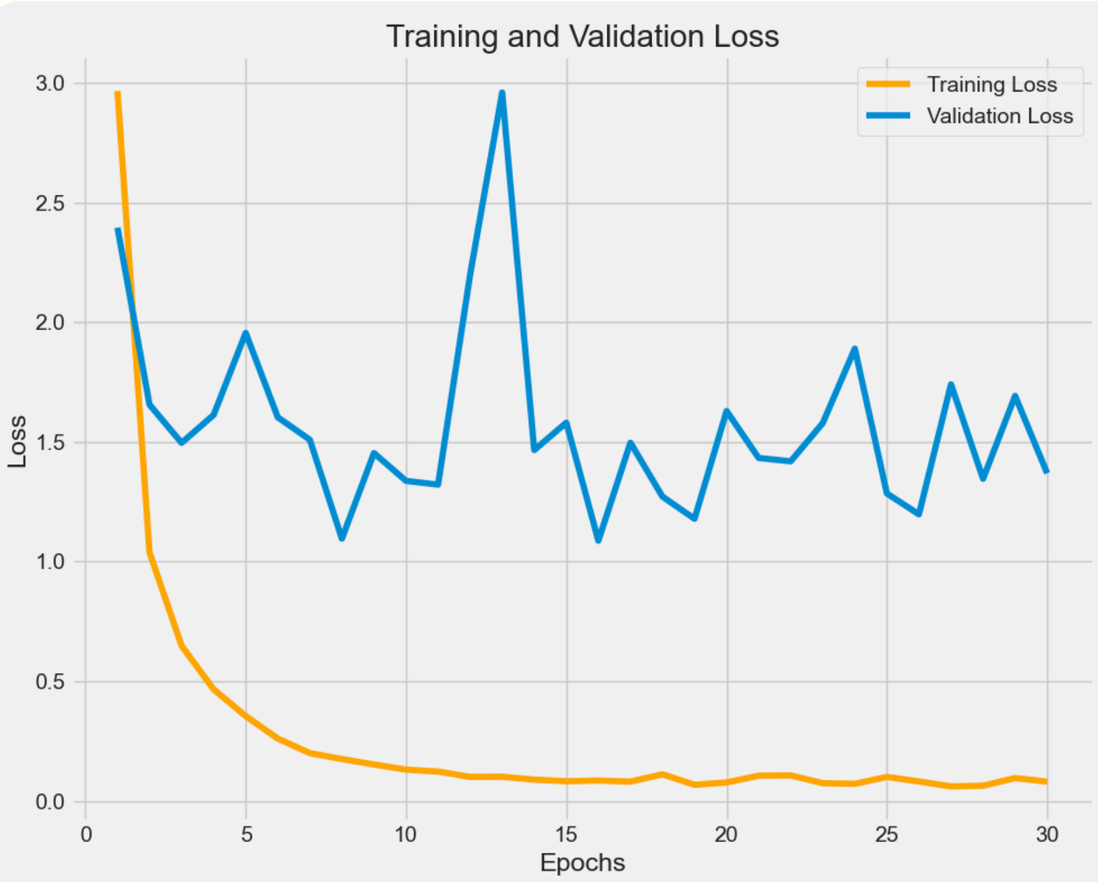
INCEPTION V3

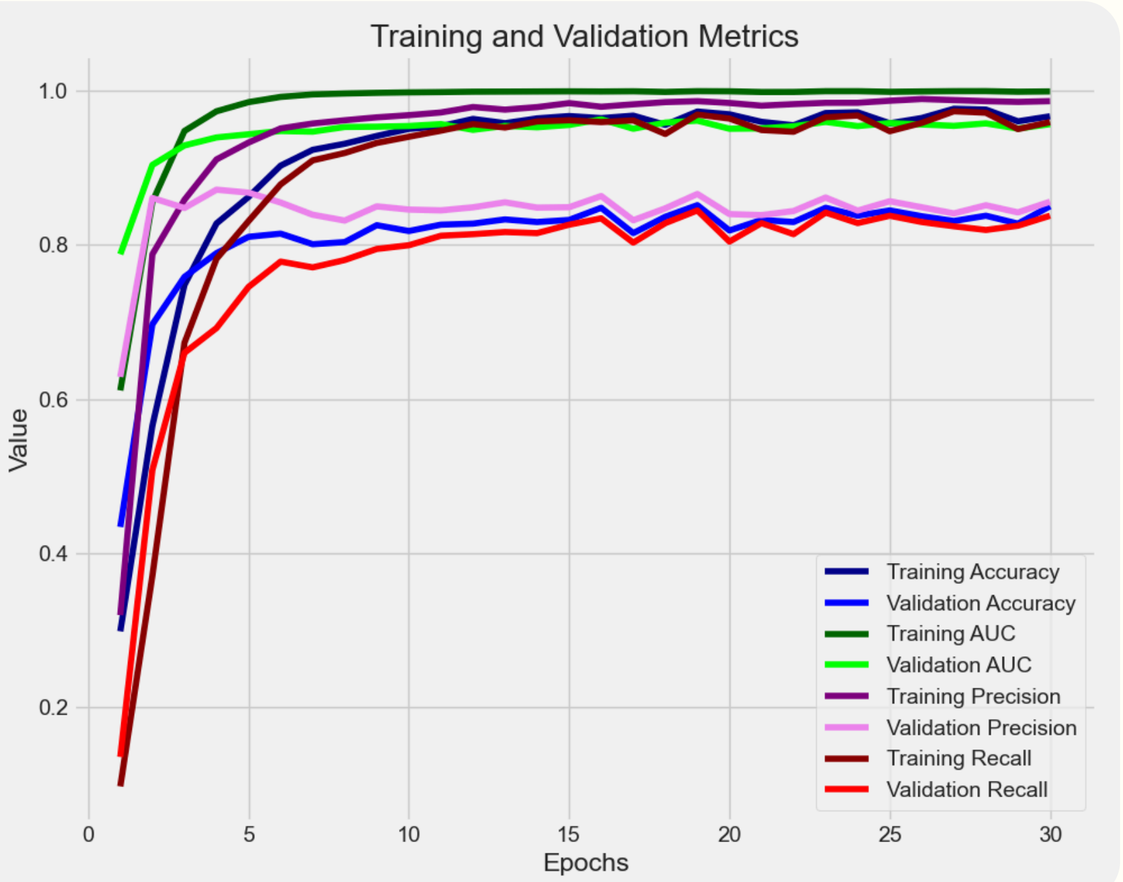
```
Total params: 37,385,893 (142.62 MB)

Trainable params: 28,410,629 (108.38 MB)

Non-trainable params: 8,975,264 (34.24 MB)
```

EfficientNetB3

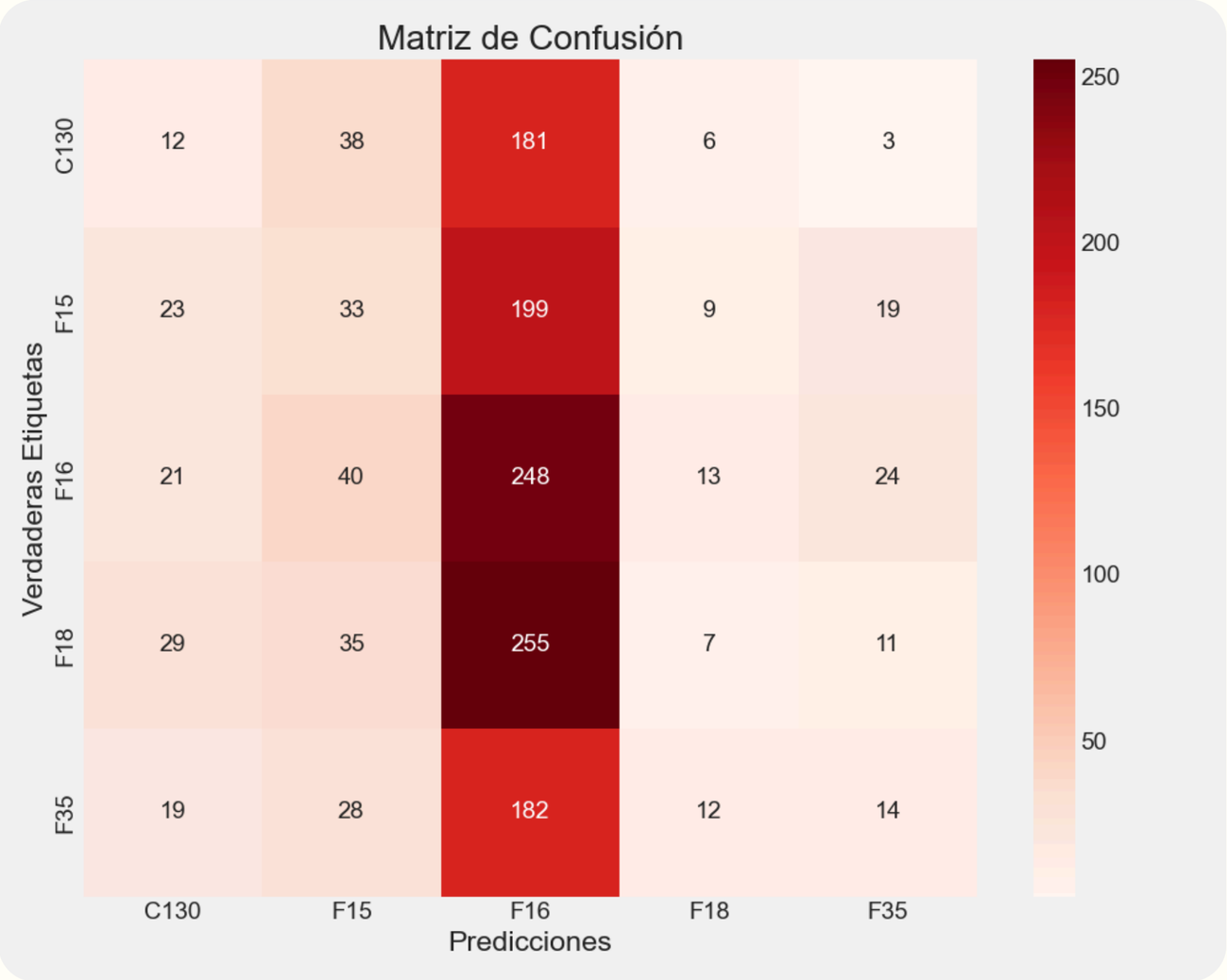
Layer (type)	Output Shape	Param #
conv2d_3 (Conv2D)	(None, 30, 30, 75)	2,100
flatten_7 (Flatten)	(None, 67500)	0
dense_22 (Dense)	(None, 256)	17,280,256
dropout (Dropout)	(None, 256)	0
dense_23 (Dense)	(None, 128)	32,896
dropout_1 (Dropout)	(None, 128)	0
dense_24 (Dense)	(None, 5)	645

INCEPTION V3



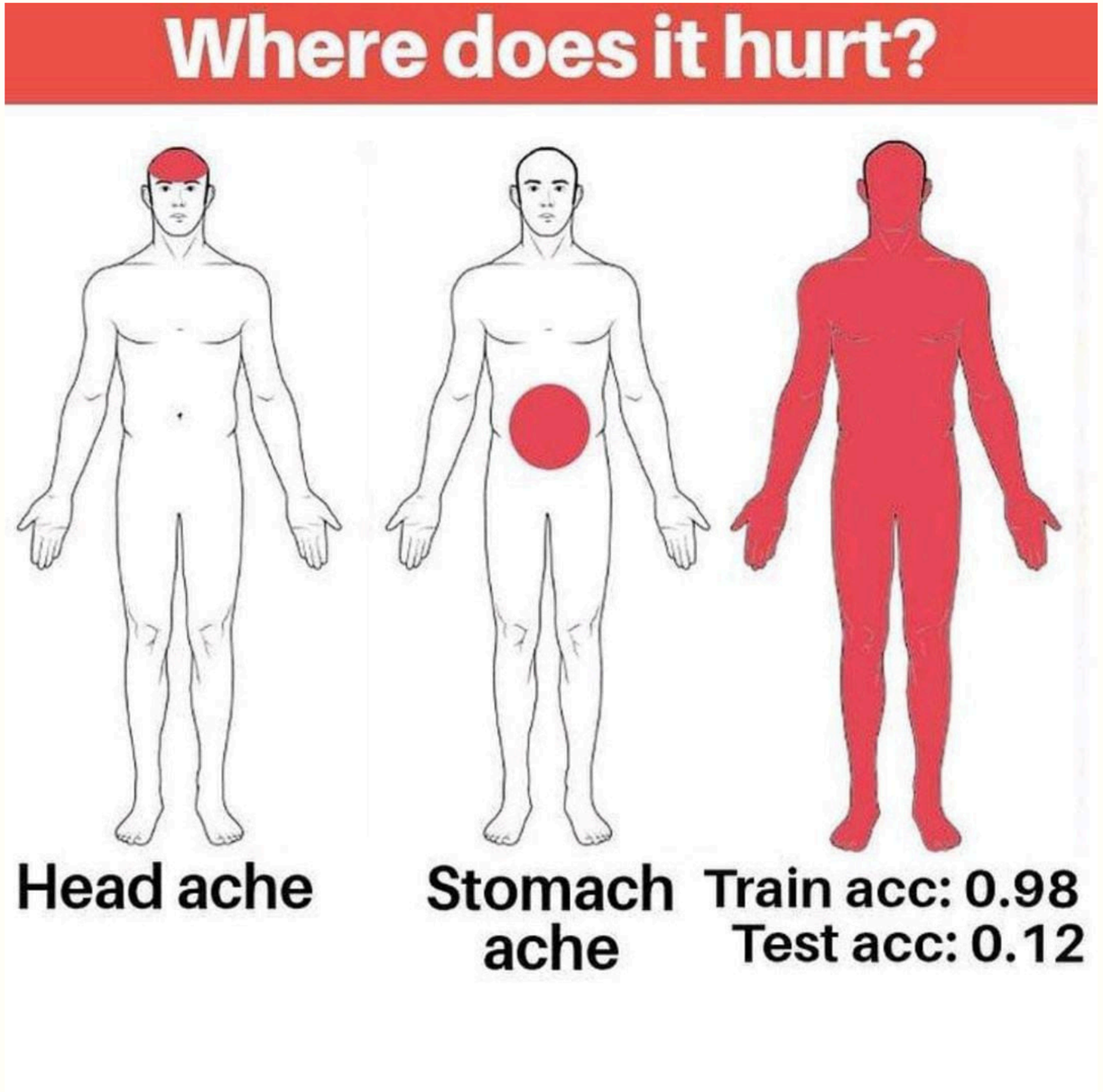


INCEPTION V3

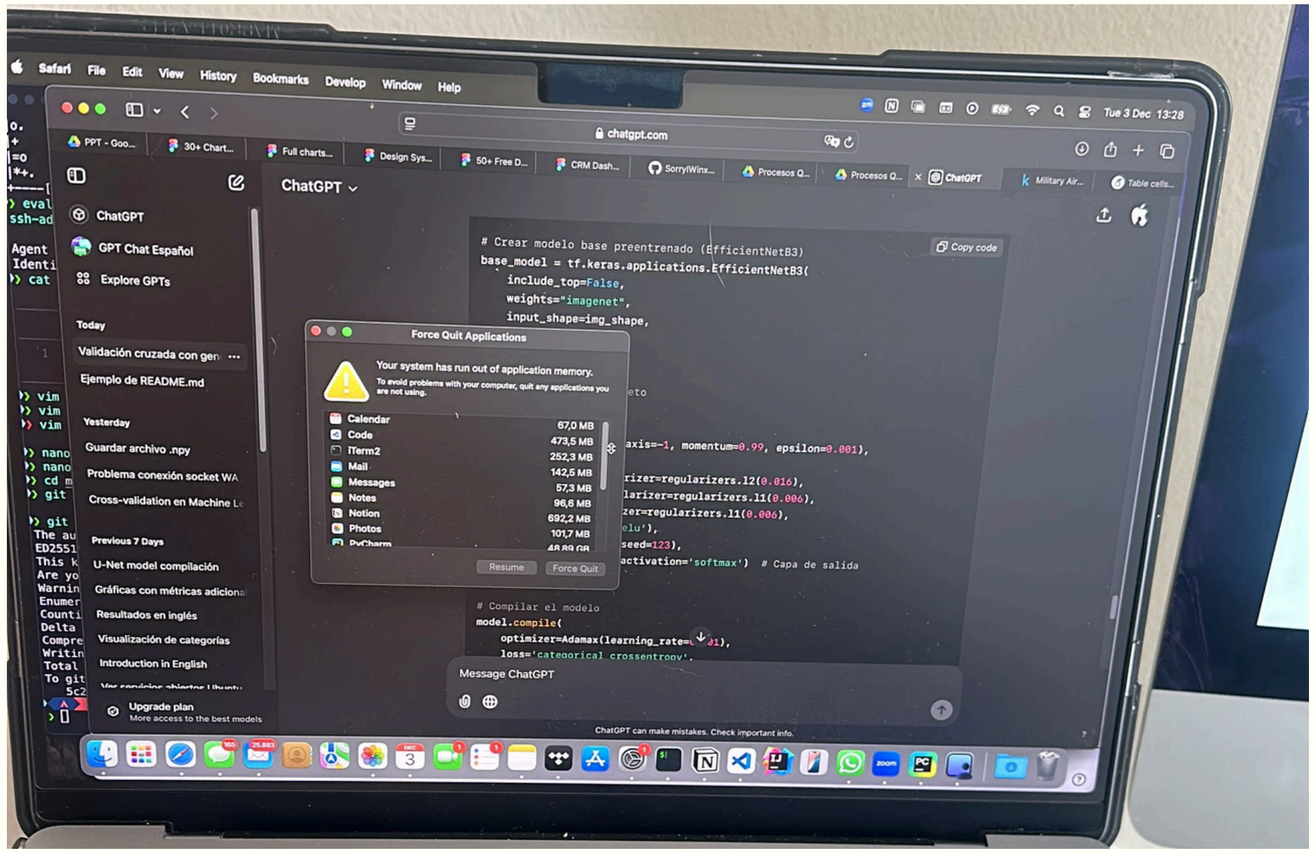


INCEPTION V3

	precision	recall	f1-score	support
C130	0.12	0.05	0.07	240
F15	0.19	0.12	0.14	283
F16	0.23	0.72	0.35	346
F18	0.15	0.02	0.04	337
F35	0.20	0.05	0.09	255
accuracy			0.21	1461
macro avg	0.18	0.19	0.14	1461
weighted avg	0.18	0.21	0.15	1461


Where does it hurt?
Head ache
Stomach ache
Train acc: 0.98
Test acc: 0.12

EFFICIENTNETB3



EFFICIENTNETB3

RESULTADOS

Metrics / Models	acuraccy	auc	precision	recall
DNN base	0.4285	0.7184	0.5593	0.2163
DNN Inversa	0.4073	0.7195	0.5944	0.1896
DNN + Neuronas	0.4079	0.7189	0.5392	0.2307
DNN + Capas	0.4401	0.7403	0.5143	0.3450

RESULTADOS

Metrics / Models	acuraccy	auc	precision	recall
CNN base	0.5133	0.7830	0.5353	0.4771
CNN + Capas	0.5270	0.7625	0.5340	0.5209
CNN + Capas + Dropout	0.5633	0.8090	0.6005	0.5277
CNN + Conv + Capas + Dropout	0.5202	0.7720	0.5659	0.4846
+ MaxPooling	0.6194	0.8633	0.6477	0.5927
CNN V2	0.6735	0.8922	0.7638	0.5667

RESULTADOS

Metrics / Models	acuraccy	auc	precision	recall
Inception V3	0.8323	0.9511	0.8385	0.8282
EfficientNetB3	Error	Error	Error	Error

Gachas.