Image Classification with CNN

25-27th September, 2024

G2

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Agenda

- Dataset Chosen
- Description of the chosen CNN architecture.
- Explanation of preprocessing steps.

  Details of the training process
- Results and analysis of models performance.
- What is your best model? Why?
- Insights gained from the experimentation process.

Datasets Avaliable

- CIFAR-10
- Animals-10

Datasets Chosen

- CIFAR-10

Datasets Chosen, why?

- CIFAR-10

Lighter

Standardize images sizes

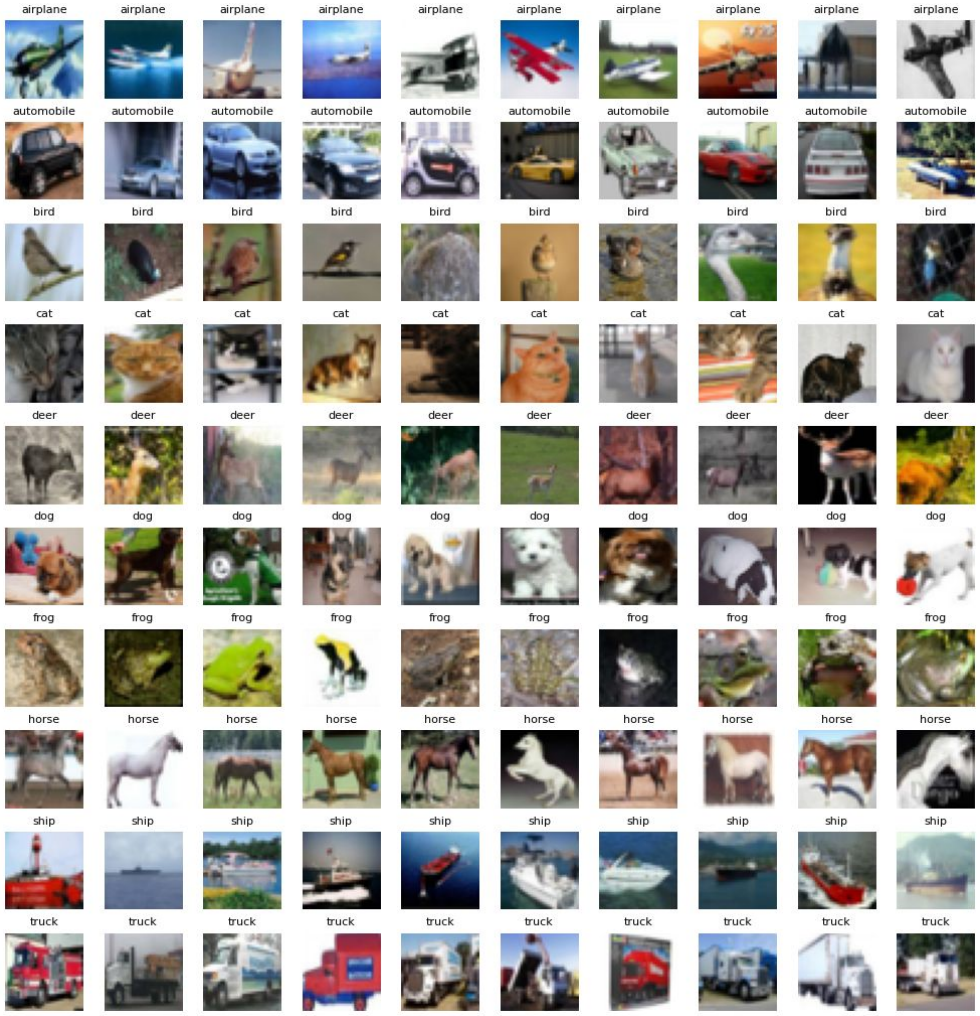
Loaded directly as NumPy array

Easy to manipulate and plot for quick reviewing

Dataset Review

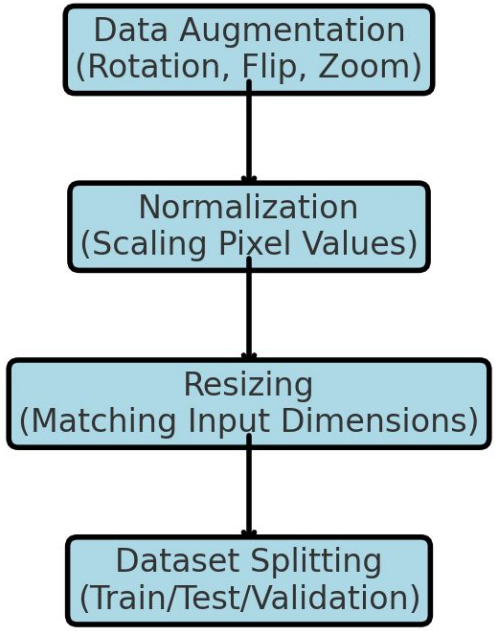
- CIFAR-10 limitations

The size could be an issue to run though too many Convolution and Max Pooling layers



Dataset Preprocessing

- Batch Normalisation
- Labels 1-Hot-Encoding
- Data Augmentation



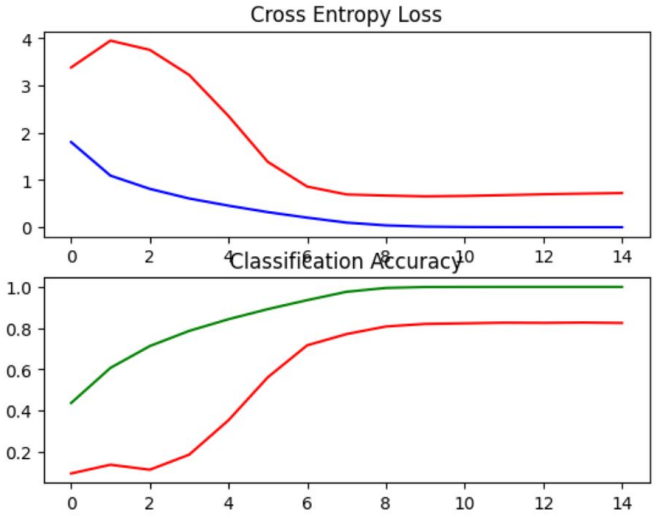
Models Architectures

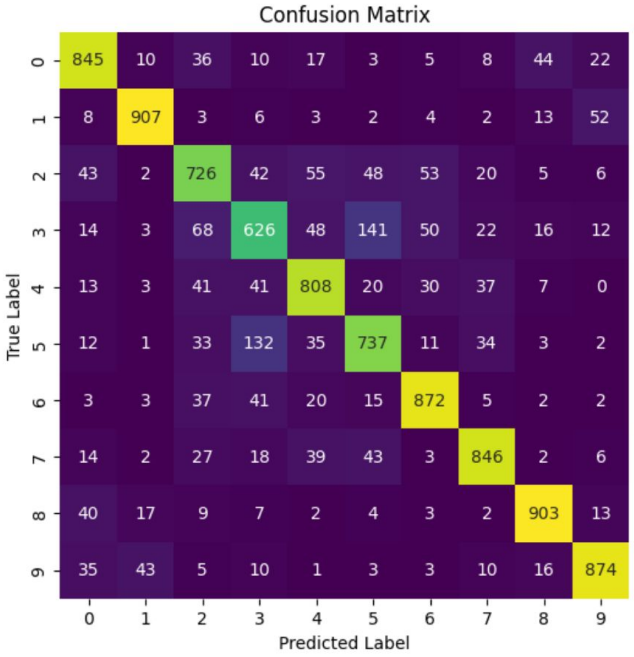
- Homemade classifier
- Transfer learning / Fine Tuning VGG16
- Transfer learning / Fine Tunni ResNet50

- CNN Architecture (no data augmentation)

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_6 (Conv2D)           (None, 32, 32, 64)        1792

 conv2d_7 (Conv2D)           (None, 32, 32, 64)        36928

 max_pooling2d_3 (MaxPoolin  (None, 16, 16, 64)        0
 g2D)

 conv2d_8 (Conv2D)           (None, 16, 16, 128)       73856

 conv2d_9 (Conv2D)           (None, 16, 16, 128)       147584

 max_pooling2d_4 (MaxPoolin  (None, 8, 8, 128)         0
 g2D)

 conv2d_10 (Conv2D)          (None, 8, 8, 256)         295168

 conv2d_11 (Conv2D)          (None, 8, 8, 256)         590080

 max_pooling2d_5 (MaxPoolin  (None, 4, 4, 256)         0
 g2D)

 flatten_1 (Flatten)         (None, 4096)              0

 dense_2 (Dense)             (None, 256)               1048832

 dense_3 (Dense)             (None, 10)                2570

=================================================================
Total params: 2196810 (8.38 MB)
Trainable params: 2196810 (8.38 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

- Optimizer/Loss: Adam / Cat. Crossentropy
- Epochs: 15
- Test accuracy: 0.81
- Test loss: 0.77
- F1-score and recall: 0.81



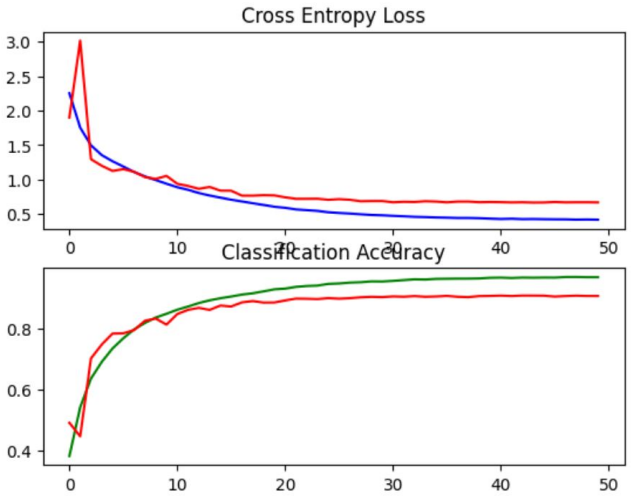


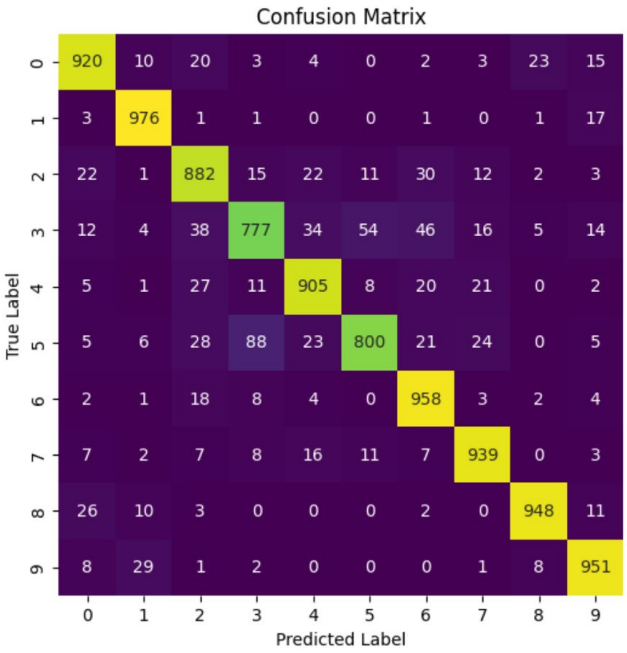
- Optimizer/Loss: Adam / Cat. Crossentropy
- Epochs: 15
- Test accuracy: 0.81
- Test loss: 0.77
- F1-score and recall: 0.81

CNN Architecture - With data augmentation

Layer (type)	Output Shape	Param #
conv2d_18 (Conv2D)	(None, 32, 32, 64)	1792
batch_normalization_18 (BatchNormalization)	(None, 32, 32, 64)	256
conv2d_19 (Conv2D)	(None, 32, 32, 64)	36928
batch_normalization_19 (BatchNormalization)	(None, 32, 32, 64)	256
max_pooling2d_9 (MaxPooling2D)	(None, 16, 16, 64)	0
conv2d_20 (Conv2D)	(None, 16, 16, 128)	73856
batch_normalization_20 (BatchNormalization)	(None, 16, 16, 128)	512
conv2d_21 (Conv2D)	(None, 16, 16, 128)	147584
batch_normalization_21 (BatchNormalization)	(None, 16, 16, 128)	512
max_pooling2d_10 (MaxPooling2D)	(None, 8, 8, 128)	0
conv2d_22 (Conv2D)	(None, 8, 8, 256)	295168
batch_normalization_22 (BatchNormalization)	(None, 8, 8, 256)	1024
conv2d_23 (Conv2D)	(None, 8, 8, 256)	590080
batch_normalization_23 (BatchNormalization)	(None, 8, 8, 256)	1024
max_pooling2d_11 (MaxPooling2D)	(None, 4, 4, 256)	0
flatten_3 (Flatten)	(None, 4096)	0
dense_6 (Dense)	(None, 256)	1048832
dropout_6 (Dropout)	(None, 256)	0
dense_7 (Dense)	(None, 10)	2570

Total params: 2200394 (8.39 MB)
Trainable params: 2198602 (8.39 MB)
Non-trainable params: 1792 (7.00 KB)





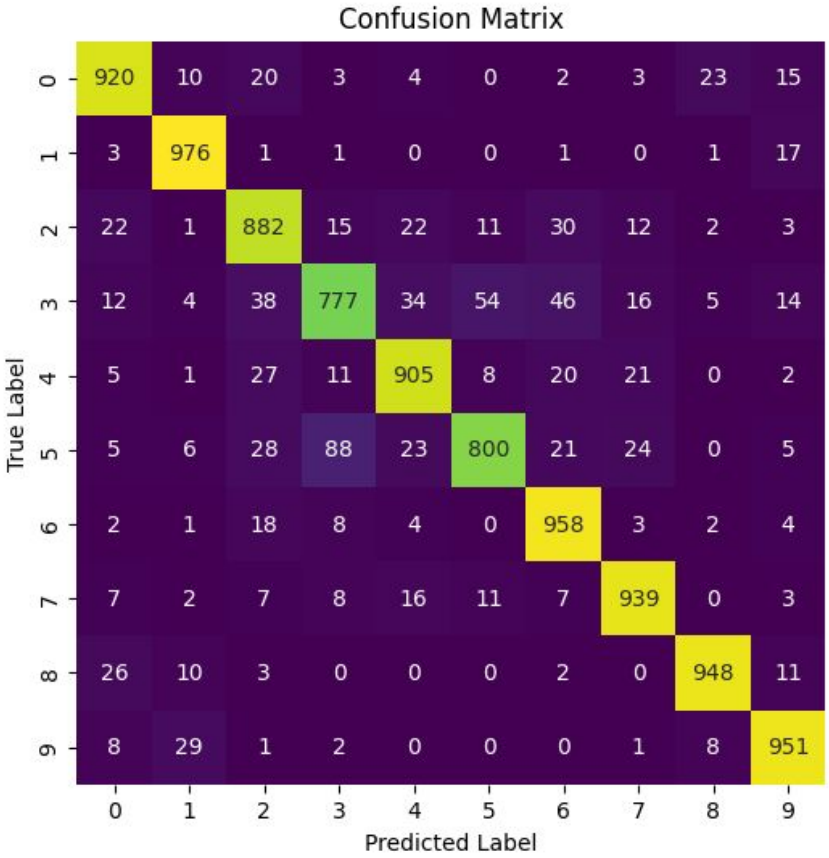
- Optimizer/Loss: Adam / Cat. Crossentropy
- Epochs: 50
- Test accuracy: 0.91
- Test loss: 0.67
- F1-score and recall: 0.91

Models Architectures

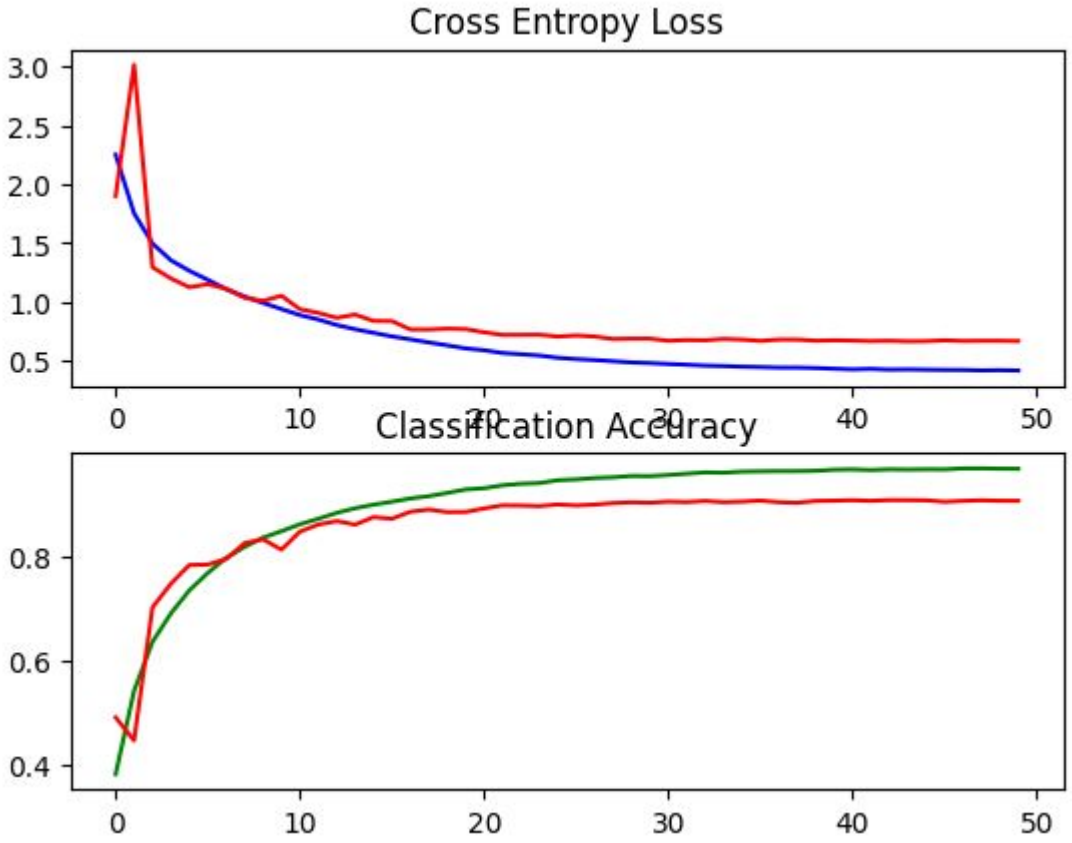
- Homemade classifier

Test Acc.	Test Loss	Parameters
0.91	0.67	2,200,394

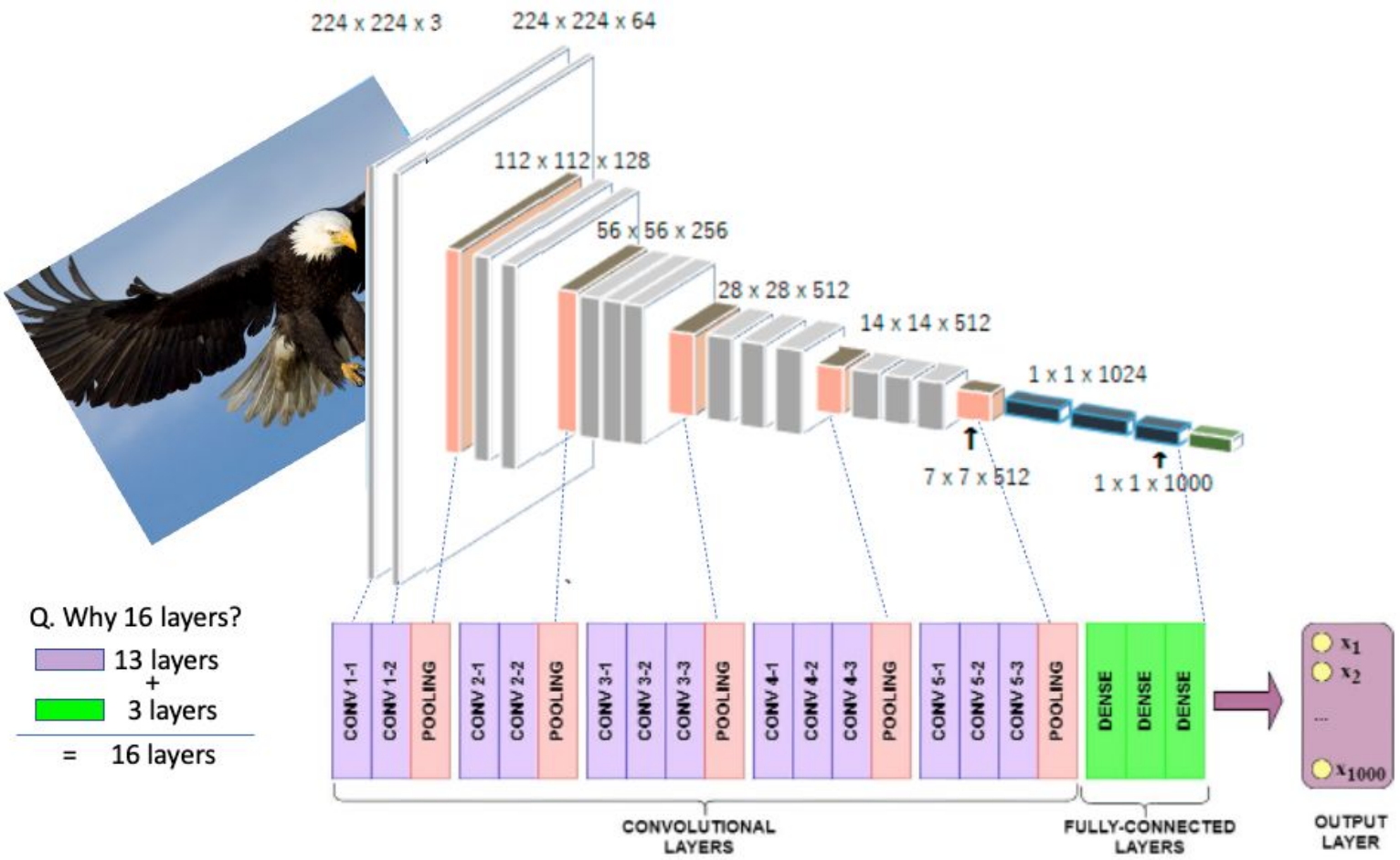
Models Architectures



Models Architectures



VGG16

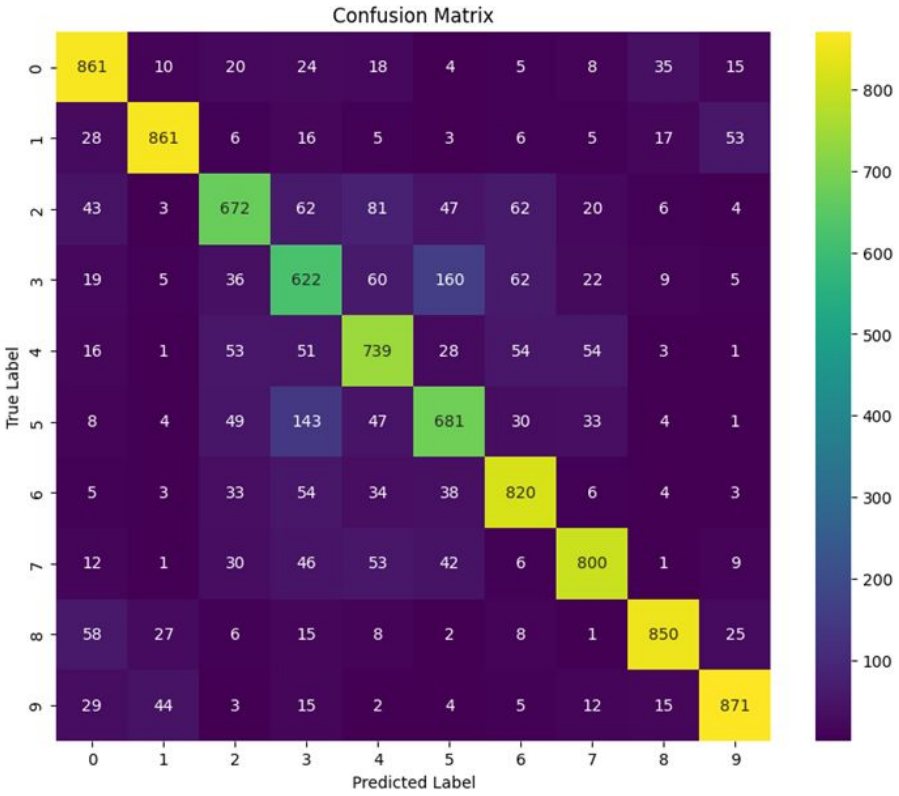

224 x 224 x 3
224 x 224 x 64
112 x 112 x 128
56 x 56 x 256
28 x 28 x 512
14 x 14 x 512
1 x 1 x 1024
7 x 7 x 512
1 x 1 x 1000
Q. Why 16 layers?
13 layers
+
3 layers
=
16 layers
CONV 1-1
CONV 1-2
POOLING
CONV 2-1
CONV 2-2
POOLING
CONV 3-1
CONV 3-2
CONV 3-3
POOLING
CONV 4-1
CONV 4-2
CONV 4-3
POOLING
CONV 5-1
CONV 5-2
CONV 5-3
POOLING
DENSE
DENSE
DENSE
x1
x2
...
x1000
CONVOLUTIONAL LAYERS
FULLY-CONNECTED LAYERS
OUTPUT LAYER

Models Architectures

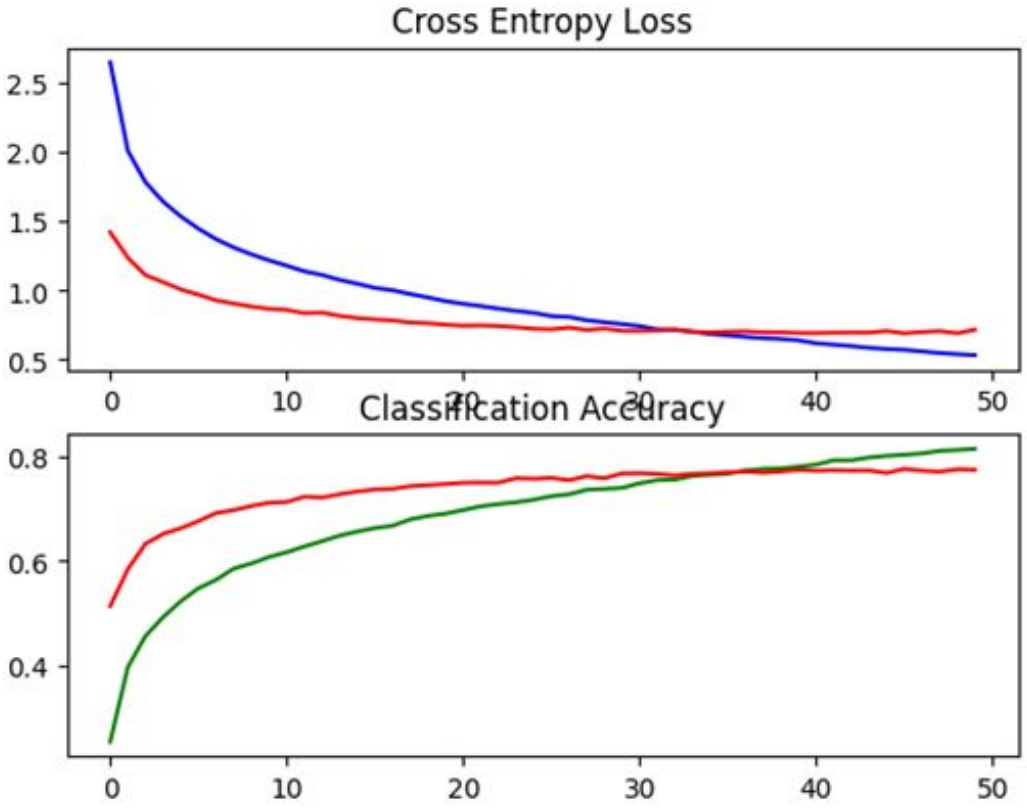
- Transfer learning / Fine Tuning VGG16 KK

Test Acc.	Test Loss	Parameters
0.84	0.54	41,071,690

Models Architectures



Models Architectures

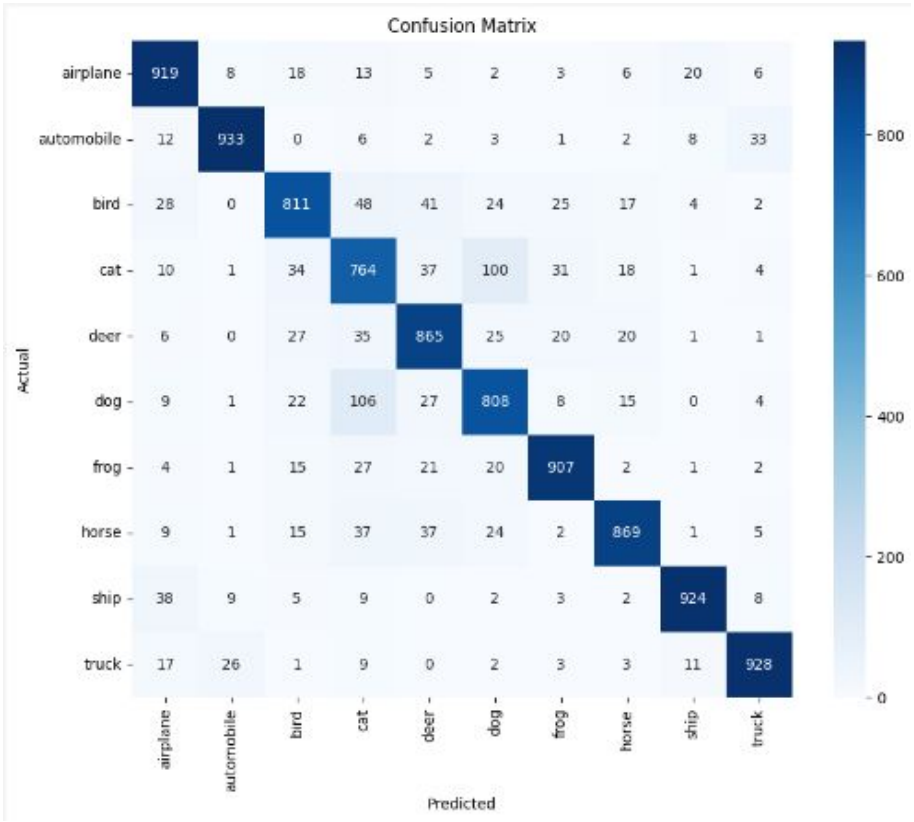


Models Architectures

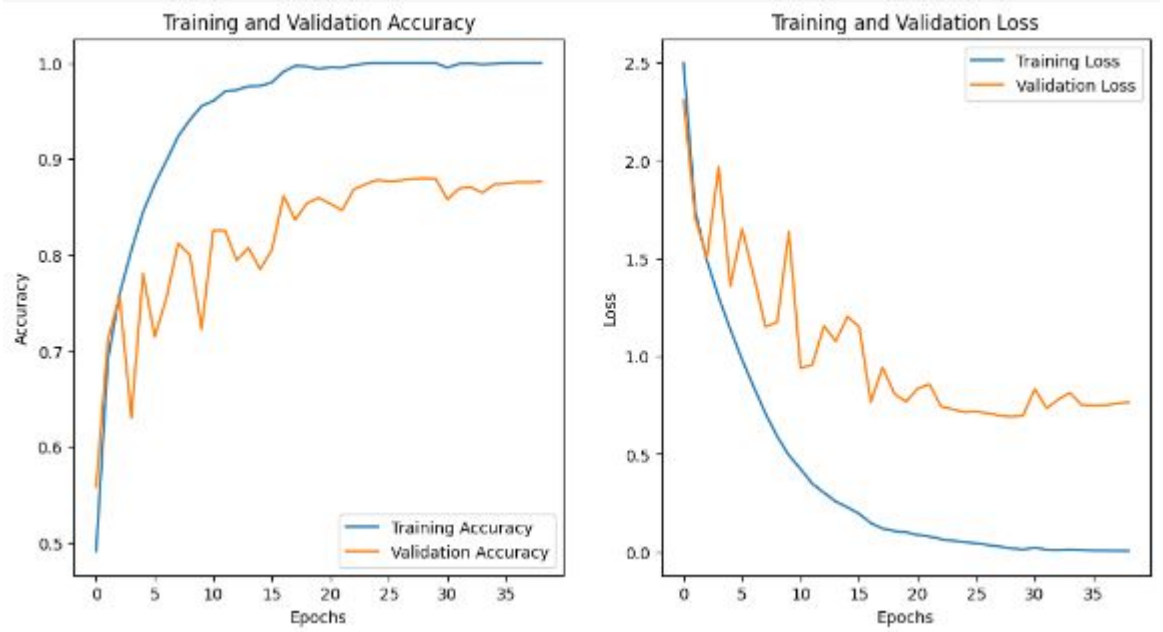
- Transfer learning / Fine Tuning VGG16 Freddy

Test Acc.	Test Loss	Parameters
0.88	0.76	4.101.450

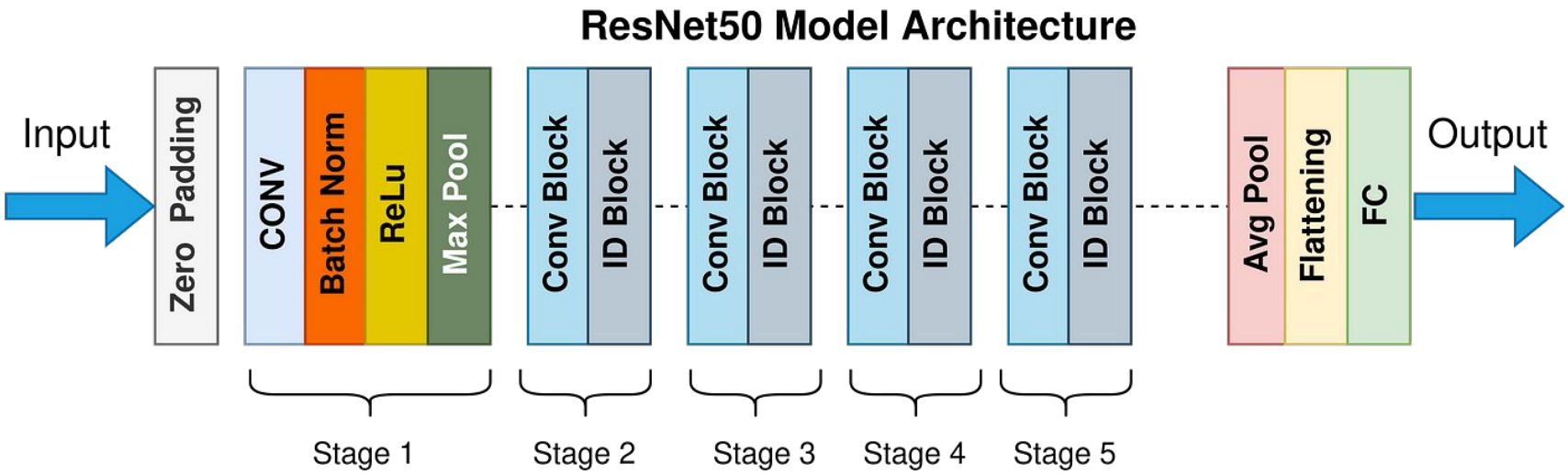
Models Architectures



Models Architectures



ResNet50

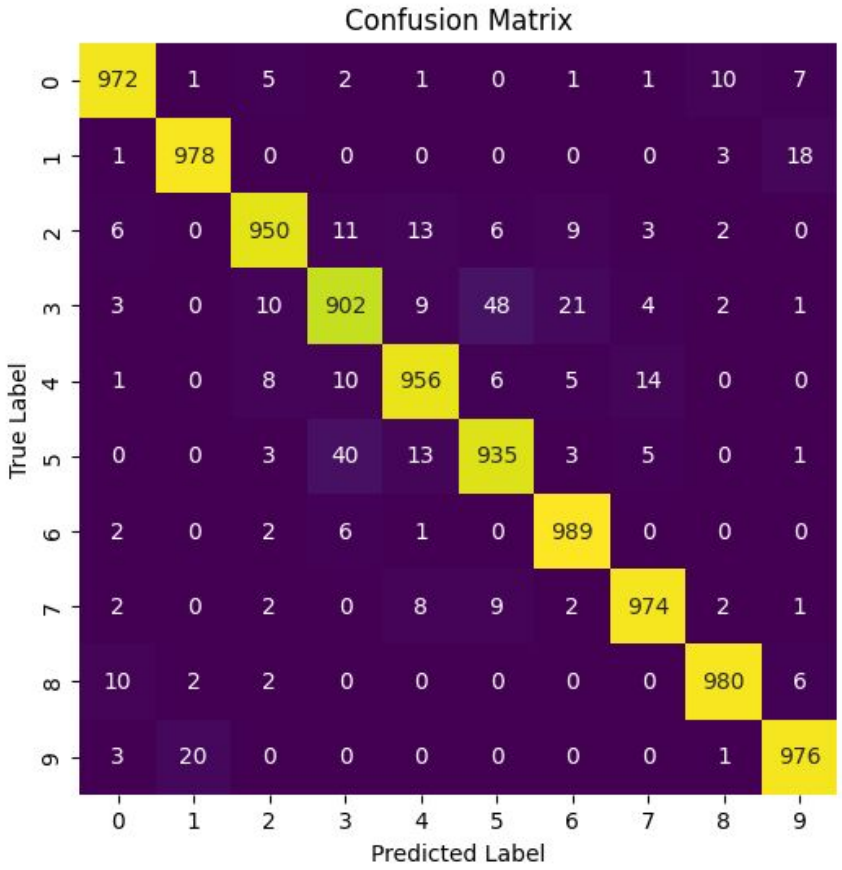

ResNet50 Model Architecture
Input
Zero Padding
CONV
Batch Norm
ReLu
Max Pool
Conv Block
ID Block
Conv Block
ID Block
Conv Block
ID Block
Conv Block
ID Block
Avg Pool
Flattening
FC
Output
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5

Models Architectures

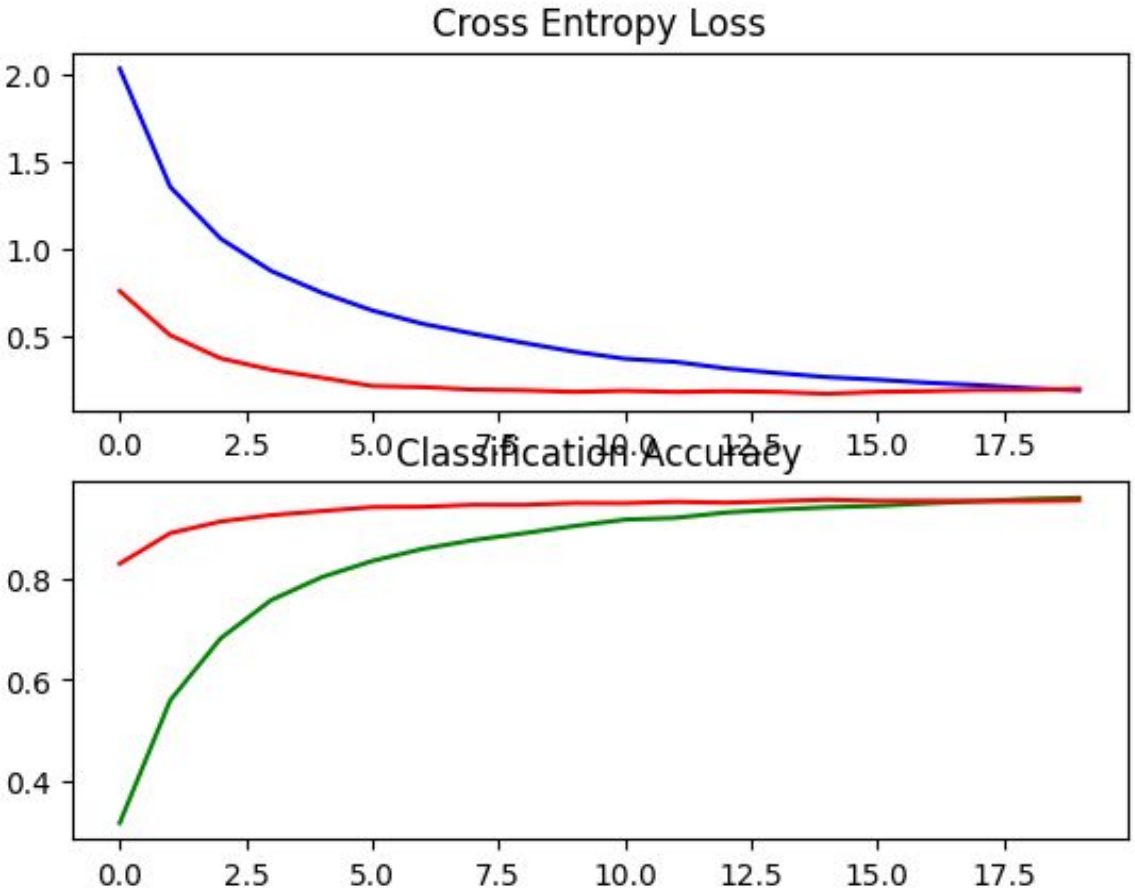
- Transfer learning / ResNet50

Test Acc.	Test Loss	Parameters
0.95	0.17	49,723,082

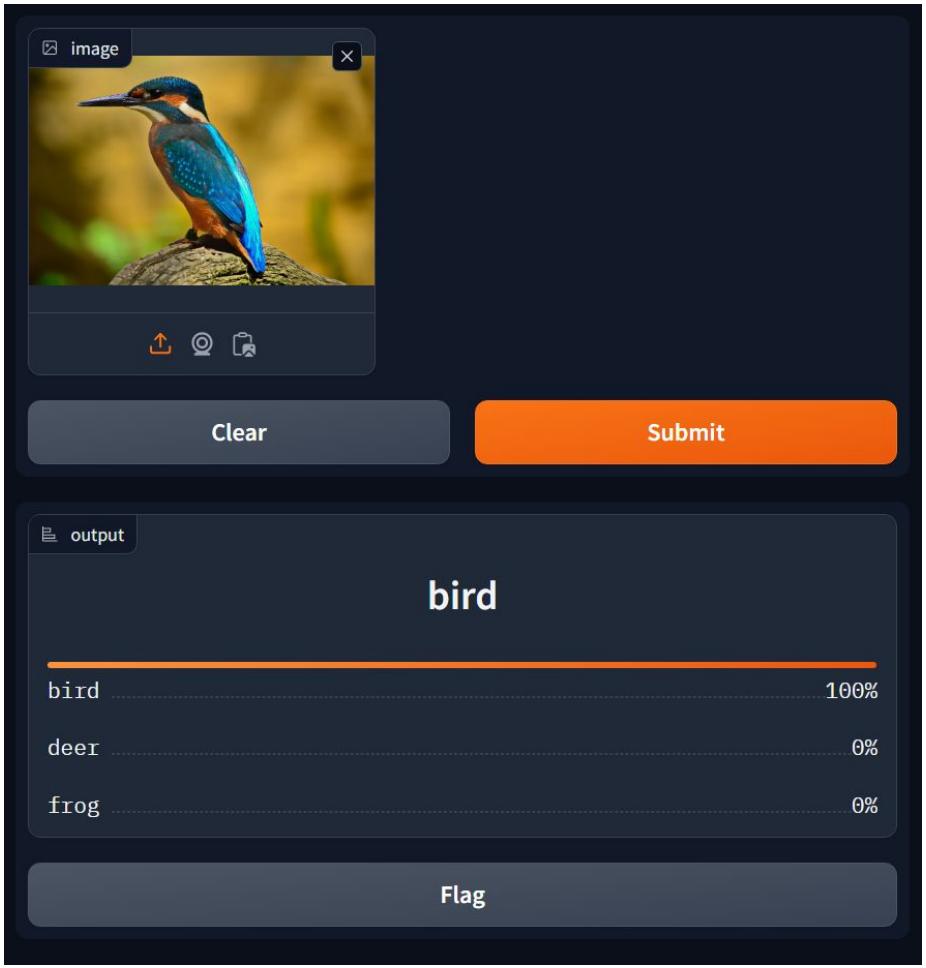
Models Architectures



Models Architectures



Deployment



https://8678cdb3961f955800.gradio.live/

Conclusion

Model Architecture	Dev	Total Layers	Dense	Params	Epochs	DataAug.	BatchNorm.	Dropout	Optimizer	Loss	Test Acc	Test Loss	f1-score	recall
Home-made CNN (v3)	Alexandre	18	2	2,196,810.00	15		X		Adam	cat_cross	0.81	0.77	0.81	0.81
Home-made CNN (v4)	Alexandre	19	2	2,200,394.00	20	X	X	X	Adam	cat_cross	0.91	0.67	0.91	0.91
Home-made CNN	Freddy	12	2	4,101,450.00	50	X	X	X	Adam w/Scheduler	cat_cross	0.8195	1.1084	0.81	0.81
Home-made CNN	KK	18	2	3,514,698.00	50	X	X	X	Adam	cat_cross	0.9	0.35	0.9	0.9
VGG16 TransferLearn	KK	25	3	41,071,690.00	50		X	X	Adam	cat_cross	0.78	0.69	0.78	0.78
VGG16 Finetuning	KK	25	3	41,071,690.00	30		X	X	Adam	cat_cross	0.84	0.54	0.84	0.84
VGG16 TransferLearn- DA	KK	25	3	41,071,690.00	100	X	X	X	Adam	cat_cross	0.68	0.89	0.68	0.68
VGG16 Finetuning - DA	KK	25	3	41,071,690.00	50	X	X	X	Adam	cat_cross	0.78	0.65	0.78	0.78
VGG16 TransLearn	Freddy	12	3	4,101,450.00	50	X	X	X	Adam/wscheduler	cat_cross	0.87	0.99	0.87	0.87
ResNet50 TransLearn	Alexandre	188	4	49,723,082.00	20	X	X	X	RMSProp	cat_cross	0.95	0.17	0.95	0.95
ResNet50 TransLearn	Alexandre	188	4	49,723,082.00	24	X	X	X	RMSProp	cat_cross	0.96	0.15	0.96	0.96

Thank You :)

Questions??