L2-Regularization: Model Summary

Model: "sequential\_6"

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

=================================================================

conv2d\_30 (Conv2D) (None, 55, 55, 96) 34944

activation\_30 (Activation) (None, 55, 55, 96) 0

batch\_normalization\_30 (Bat (None, 55, 55, 96) 384

chNormalization)

max\_pooling2d\_18 (MaxPoolin (None, 27, 27, 96) 0

g2D)

conv2d\_31 (Conv2D) (None, 27, 27, 256) 614656

activation\_31 (Activation) (None, 27, 27, 256) 0

batch\_normalization\_31 (Bat (None, 27, 27, 256) 1024

chNormalization)

max\_pooling2d\_19 (MaxPoolin (None, 13, 13, 256) 0

g2D)

conv2d\_32 (Conv2D) (None, 13, 13, 384) 885120

activation\_32 (Activation) (None, 13, 13, 384) 0

batch\_normalization\_32 (Bat (None, 13, 13, 384) 1536

chNormalization)

conv2d\_33 (Conv2D) (None, 13, 13, 384) 1327488

activation\_33 (Activation) (None, 13, 13, 384) 0

batch\_normalization\_33 (Bat (None, 13, 13, 384) 1536

chNormalization)

conv2d\_34 (Conv2D) (None, 13, 13, 256) 2457856

activation\_34 (Activation) (None, 13, 13, 256) 0

batch\_normalization\_34 (Bat (None, 13, 13, 256) 1024

chNormalization)

max\_pooling2d\_20 (MaxPoolin (None, 6, 6, 256) 0

g2D)

flatten\_6 (Flatten) (None, 9216) 0

dense\_18 (Dense) (None, 4096) 37752832

dropout\_20 (Dropout) (None, 4096) 0

dense\_19 (Dense) (None, 4096) 16781312

dropout\_21 (Dropout) (None, 4096) 0

dense\_20 (Dense) (None, 351) 1438047

=================================================================

Total params: 61,297,759

Trainable params: 61,295,007

Non-trainable params: 2,752

L1-Regularization: Model Summary

Model: "sequential\_7"

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

=================================================================

conv2d\_35 (Conv2D) (None, 55, 55, 96) 34944

activation\_35 (Activation) (None, 55, 55, 96) 0

batch\_normalization\_35 (Bat (None, 55, 55, 96) 384

chNormalization)

max\_pooling2d\_21 (MaxPoolin (None, 27, 27, 96) 0

g2D)

conv2d\_36 (Conv2D) (None, 27, 27, 256) 614656

activation\_36 (Activation) (None, 27, 27, 256) 0

batch\_normalization\_36 (Bat (None, 27, 27, 256) 1024

chNormalization)

max\_pooling2d\_22 (MaxPoolin (None, 13, 13, 256) 0

g2D)

conv2d\_37 (Conv2D) (None, 13, 13, 384) 885120

activation\_37 (Activation) (None, 13, 13, 384) 0

batch\_normalization\_37 (Bat (None, 13, 13, 384) 1536

chNormalization)

conv2d\_38 (Conv2D) (None, 13, 13, 384) 1327488

activation\_38 (Activation) (None, 13, 13, 384) 0

batch\_normalization\_38 (Bat (None, 13, 13, 384) 1536

chNormalization)

conv2d\_39 (Conv2D) (None, 13, 13, 256) 2457856

activation\_39 (Activation) (None, 13, 13, 256) 0

batch\_normalization\_39 (Bat (None, 13, 13, 256) 1024

chNormalization)

max\_pooling2d\_23 (MaxPoolin (None, 6, 6, 256) 0

g2D)

flatten\_7 (Flatten) (None, 9216) 0

dense\_21 (Dense) (None, 4096) 37752832

dropout\_22 (Dropout) (None, 4096) 0

dense\_22 (Dense) (None, 4096) 16781312

dropout\_23 (Dropout) (None, 4096) 0

dense\_23 (Dense) (None, 351) 1438047

=================================================================

Total params: 61,297,759

Trainable params: 61,295,007

Non-trainable params: 2,752

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Default model (just dropout performance):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

=================================================================

conv2d\_14 (Conv2D) (None, 32, 32, 32) 896

batch\_normalization\_21 (Bat (None, 32, 32, 32) 128

chNormalization)

activation\_21 (Activation) (None, 32, 32, 32) 0

dropout\_19 (Dropout) (None, 32, 32, 32) 0

max\_pooling2d\_14 (MaxPoolin (None, 16, 16, 32) 0

g2D)

conv2d\_15 (Conv2D) (None, 16, 16, 64) 18496

batch\_normalization\_22 (Bat (None, 16, 16, 64) 256

chNormalization)

activation\_22 (Activation) (None, 16, 16, 64) 0

dropout\_20 (Dropout) (None, 16, 16, 64) 0

max\_pooling2d\_15 (MaxPoolin (None, 8, 8, 64) 0

g2D)

flatten\_7 (Flatten) (None, 4096) 0

dense\_12 (Dense) (None, 1024) 4195328

batch\_normalization\_23 (Bat (None, 1024) 4096

chNormalization)

activation\_23 (Activation) (None, 1024) 0

dropout\_21 (Dropout) (None, 1024) 0

dense\_13 (Dense) (None, 351) 359775

=================================================================

Total params: 4,578,975

Trainable params: 4,576,735

Non-trainable params: 2,240

Default model (L1 regularized):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

=================================================================

conv2d\_14 (Conv2D) (None, 32, 32, 32) 896

batch\_normalization\_21 (Bat (None, 32, 32, 32) 128

chNormalization)

activation\_21 (Activation) (None, 32, 32, 32) 0

dropout\_19 (Dropout) (None, 32, 32, 32) 0

max\_pooling2d\_14 (MaxPoolin (None, 16, 16, 32) 0

g2D)

conv2d\_15 (Conv2D) (None, 16, 16, 64) 18496

batch\_normalization\_22 (Bat (None, 16, 16, 64) 256

chNormalization)

activation\_22 (Activation) (None, 16, 16, 64) 0

dropout\_20 (Dropout) (None, 16, 16, 64) 0

max\_pooling2d\_15 (MaxPoolin (None, 8, 8, 64) 0

g2D)

flatten\_7 (Flatten) (None, 4096) 0

dense\_12 (Dense) (None, 1024) 4195328

batch\_normalization\_23 (Bat (None, 1024) 4096

chNormalization)

activation\_23 (Activation) (None, 1024) 0

dropout\_21 (Dropout) (None, 1024) 0

dense\_13 (Dense) (None, 351) 359775

=================================================================

Total params: 4,578,975

Trainable params: 4,576,735

Non-trainable params: 2,240

Default model (L2 regularized)

Model: "sequential\_6"

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

=================================================================

conv2d\_12 (Conv2D) (None, 32, 32, 32) 896

batch\_normalization\_18 (Bat (None, 32, 32, 32) 128

chNormalization)

activation\_18 (Activation) (None, 32, 32, 32) 0

dropout\_16 (Dropout) (None, 32, 32, 32) 0

max\_pooling2d\_12 (MaxPoolin (None, 16, 16, 32) 0

g2D)

conv2d\_13 (Conv2D) (None, 16, 16, 64) 18496

batch\_normalization\_19 (Bat (None, 16, 16, 64) 256

chNormalization)

activation\_19 (Activation) (None, 16, 16, 64) 0

dropout\_17 (Dropout) (None, 16, 16, 64) 0

max\_pooling2d\_13 (MaxPoolin (None, 8, 8, 64) 0

g2D)

flatten\_6 (Flatten) (None, 4096) 0

dense\_10 (Dense) (None, 1024) 4195328

batch\_normalization\_20 (Bat (None, 1024) 4096

chNormalization)

activation\_20 (Activation) (None, 1024) 0

dropout\_18 (Dropout) (None, 1024) 0

dense\_11 (Dense) (None, 351) 359775

=================================================================

Total params: 4,578,975

Trainable params: 4,576,735

Non-trainable params: 2,240

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes:

* Dropout rates can affect the training and validation accuracy quite significantly, especially if the training dataset is small. Decreasing dropout increases training and validation accuracy

References:

1. Pandiyan, Vigneashwara & Tjahjowidodo, Tegoeh & Caesarendra, Wahyu & Murugan, Pushparaja. (2019). “In-process virtual verification of weld seam removal in robotic abrasive belt grinding process using deep learning”. Robotics and Computer-Integrated Manufacturing. 57. 477–487. 10.1016/j.rcim.2019.01.006 (For VGG implementation) - <https://ai.plainenglish.io/vggnet-with-tensorflow-transfer-learning-with-vgg16-included-7e5f6fa9479a>