

Lab 3 - Report

(Note: When we are talking about loss & accuracy, we are referring to the validation values)

Task 1a

Answer)

Without dropout layers: Loss & accuracy of 0.4349 and 0.8250. The learning curve indicates overfitting.

With dropout layers: We prevented overfitting and got a loss & accuracy of 0.4419 and 0.8100.

Task 1b

Answer)

Without dropout layers, the results in task1a were never achieved. The best results were found at epoch 10 with a loss & accuracy of 0.4905 and 0.7900. At the last epoch, the results were a loss & accuracy of 0.9767 and 0.7300.

With dropout layers, at epoch 13, the network reached the same value as task1a with a loss & accuracy of 0.4294 and 0.8300. At the last epoch, the results were a loss & accuracy of 0.7756 and 0.8000. Thus, the batch-normalization layer makes the network converge faster.

Task 1c

Answer)

Without batch-normalization layer: Loss & accuracy of 0.5182 and 0.7750.

With batch-normalization layer: Loss & accuracy of 0.4195 and 0.8400.

Task 1d

Answer)

Without batch-normalization layer: Loss & accuracy of 0.4765 and 0.8150.

With batch-normalization layer: Loss & accuracy of 0.4430 and 0.8150. (Best results at epoch 99)

Batch-normalization layer yields slightly better results, but overfits. Thus, no batch-normalization layer yields better generalization power.

Task 2a

Answer)

Without spatial dropout layer: Loss & accuracy of 0.4343 and 0.8350.

With spatial dropout layer: Loss & accuracy of 0.4907 and 0.7750.

The model without spatial dropout layer converges faster. This is because it does not drop any feature maps during training.

Task 2b

Answer)

Without spatial dropout layer: Loss & accuracy of 0.4243 and 0.8300. (Best results at epoch 200)

With spatial dropout layer: Loss & accuracy of 0.4656 and 0.8250. (Best results at epoch 220).

In general, spatial dropout layer prevents overfitting. However, the model converges a bit slower.

David Dashti
Filip Söderquist
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Task 3a

Answer) The code transforms an image.

Scale factor: Rescales the image. **Angle:** Changes rotation angle. **Low/High bound:** Changes image intensity

Task 3b

Answer) See submitted code.

Task 4

Answer) The loss and accuracy fluctuate more than earlier. This is because each epoch uses training images with a lot of differences (in terms of the specified parameters in the image data generator). Furthermore, the generated training data differs more from the validation data than earlier since these are only rescaled.

The variation in training data makes the model more resilient against overfitting. Best results were achieved at epoch 59 with a loss & accuracy of 0.4192 and 0.8200.

Task 5

Answer) Again, the loss & accuracy fluctuate more than earlier, especially the validation accuracy. However, these fluctuations became smaller as training progressed. Also, for the bone images after about 65 epochs, the model managed to get above 98% accuracy, with a best of 100%. Again, batch-normalization- and dropout layer prevented overfitting, and the augmented data improved the results. However, a large downside was that the models trained much slower than before.

Skin images: Best results at epoch 58 with a loss & accuracy of 0.3870 and 0.8500.

Bone images: Best results at epoch 65 with a loss & accuracy of 0.0061 and 1.0000.

Task 6

Answer) See submitted code.

Task 7

Answer) With transfer learning, validation & training accuracy both converged to 100 % accuracy **when applied to bone images**, after about 17 epochs, and then continued to converge towards 0 loss. It reached higher accuracy than those achieved by the network model that was implemented from scratch: Loss & accuracy of $1.4234e^{-05}$ and 1.00 compared to 0.0061 and 1.00.

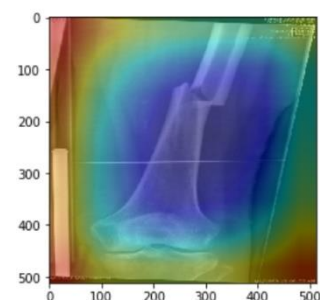
The network exhibited a similar behavior **when applied to skin-images**. However, it does not reach the same accuracy as the bone images, for reasons mentioned in lab 2. Transfer learning achieves higher accuracy when compared to the VGG16 implemented from scratch: Loss & accuracy of 0.2971 and 0.8700 compared to 0.3870 and 0.8500. The network slightly overfits when training on skin-images.

The largest difference was that the training process is many times faster than the full implementation of VGG16. This is because most of the time is spent on convolutions, which has been removed in the MLP.

One way of ensuring that the results are reliable is by visualizing the activation maps by means of heat mapping which is done in Task 8.

Task 8

Answer) With the given settings, the heatmap indicates that the model looks in the wrong regions when making predictions. Red in the corners and blue on the bone. This is reflected by the low accuracy achieved during training: Loss & (categorical) accuracy 0.7135 and: 0.500. This is a result of heavy overfitting.



David Dashti
Filip Söderquist
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