Exercise Sheet 6

Neural Computation
University of Birmingham

Week 6 2025

Exercise 1. You are designing a convolutional autoencoder for images and trying different architectures (similar to a UNet), using an encoder with multiple layers of convolutions and pooling, and a decoder using upsampling and convolutions.

1. You find that a deeper network (more pooling and upsampling operations) paradoxically increases the loss on the training set and validation set. The best loss is achieved by an architecture that uses no pooling and upsampling at all, but only convolutions. Why could this be the case?

2. In order to improve the reconstruction loss for deeper networks, you decide to introduce skip-connections between the encoder and decoder (like in a UNet). What should you consider?

Exercise 2. You want to train and test an image classifier that can diagnose a type of liver disease from an ultrasound scan. You can find three public datasets, which you want to use to train and test your neural network. The data from hospital A comes from routine liver scans and only about 5% of the patients have the disease. The data from hospital B comes from a study focussing on the liver disease and 95% of patients in the dataset suffer from the disease. The data from hospital C comes from another targeted study and includes roughly 50% of both; positive and negative patients. All three hospitals use different scanning equipment from different manufacturers. To avoid overfitting and use as much training data as possible, you combine all three datasets together and shuffle them, hoping that this will enable the network to generalise over the different scanner types.

Part A: Is this a good approach? What do you have to consider to make sure that the classifier will work reliably with data from all three scanners?

Part B: Consider the case where the task is not image classification, but semantic segmentation with the goal of segmenting the liver, which can change its shape when affected by the disease. Do we have to consider the same issues as for classification?