1 Overview

In this exercise sheet, you will train neural networks for semantic segmentation.

1.1 U-Net Architecture

First, we implement the U-Net Architecture.

a) Implement a custom `torch.nn.Module` class by overwriting the forward method that realizes a U-Net architecture. Inspect your architecture using learner.explaint.

b) Look at the documentatiob of `nn.MaxPool2d` to understand the parameter `return_indices`. Check how it can be combined with `torch.nn.MaxUnpool2d`. Implement the index connection in your architecture.

I needed the following time to complete the task:

1.2 Train a Segmentation Model

Next, we train a model for semantic segmentation.

a) Complete the nodebook `semantic_segmentation.ipynb` in the exercise folder.

b) Describe a strategy for hyper parameter tuning: step size, batch size, network architecture all need to be selected. Also: the input resolution of the images can be a factor. How do you plan your experiments and why?

c) Train the network and visualize or describe the results of your hyper parameter tuning as you would in a publication or project report.

I needed the following time to complete the task:

1.3 Loss Functions and Metrics

Now, we look into losses and metrics for semantic segmentations

a) Explain in your own word the difficulties when applying metrics (or loss functions) to problems with very high class imbalance.

b) In semantic segmentation, the classification of pixels right on the border between two classes depend on discretization. Define and implement a loss function that uses the idea to assign a weight to each pixel based on its distance to a border of two classes.

c) Following a similiar idea, misclassification that changes the topology of the result can be very bad in some situations. Define and implement a cost function based on the idea to identify connected components in the segmentation result (remember our exercises of particle detection) and introduce a penalty term if components are incorrectly connected or separated.

d) Describe in your own words the consequences of using your functions from b) and c) as either metric or loss function.

e) Make a report as you would in a publication evaluating the results of your functions from b) and c) when used as loss.

I needed the following time to complete the task: