Image Segmentation

Project 2

Deep Learning in Computer Vision

June 2023

In this project, you will be working with two different datasets for image segmentation:

- The skin lesion segmentation dataset PH2
- The retinal blood vessel segmentation dataset DRIVE

Your task is to design a generic segmentation architecture that you apply to both tasks, and perform a thorough validation of your algorithm, including multiple metrics for segmentation performance as well as an ablation study illustrating how different choices of parameters, loss functions, etc impact the performance of your network at your given task.

Finally, you will compare your architecture to the Segment Anything [**?**] algorithm on a small test set.

Your tasks are as follows:

1. Locate the two datasets at `/dtu/datasets1/02514` and describe them in terms of size, pre-assigned splits, etc. You will have to make choices on how to create training/validation/test splits based on how the datasets are structured from scratch, and you will have to write data loaders for both datasets. Use the data loader given in the segmentation exercise as a starting point to do this.

2. Implement a simple baseline segmentation CNN, and implement the following metrics for validating segmentation performance: Dice overlap, Intersection over Union, Accuracy, Sensitivity, and Specificity. You should use this set of metrics for each of your tasks below; please comment on the strengths and weaknesses of the different performance measures, both generally and for the specific cases.

   Report your results with respect to the metrics on both datasets.

3. Implement a U-net architecture to segment the images, and train and test it using the same train/validation/test splits as above. Please report the five performance measures on all three splits. *Tip: You may have to adapt the U-net architecture to a new size image. Choose your resampled image size wisely to avoid losing too much resolution, but still have a well functioning U-net. Sketch your U-net and the size of the feature image of each layer, and verify that the shape at each layer in your implementation matches.*

4. Perform an ablation study where you try to improve the segmentation, e.g. using data augmentation, different loss functions (cross entropy, focal loss, cross entropy with positive weights to make up for class imbalance), or various optimization tools or learning rates. Describe what you did, and report result across parameters and modelling choices.

5. For each dataset, select a test set of at least 10 images and apply the Segment Anything model to it. It is up to you whether you want to do this by hand using their demo, or whether you get their code to run – but in case you do the former, it's fine to use a small test set! Please include results of Segment Anything compared to your own best model on the small test set, making sure you haven't trained your own model on the test data. Please comment on what you see, and on your experience with the Segment Anything model.

6. Did you use ChatGPT or similar tools? If yes, please briefly describe how you used it and how they were useful.

Your process, performance evaluation and results should be documented and discussed in a PDF poster to be uploaded on DTU Learn.