DD2424 - Group 36 : Matthieu Giral, Milan Clerc, Hannah Gelblat

Project Title : Nerves detection on ultrasound images using U-Net

Our project will focus on segmenting ultrasound images of the neck in order to localize nerves. The inspiration for this project came from a challenge on the Kaggle platform that also provides a dataset of ultrasound images of nerve structures in humans' neck [1]. Nerves localization using Deep Learning allows to determine nerve structures without any surgical procedure. These nerve structures are involved in pain feeling and therefore have a major impact on surgical operation as they might allow to avoid anaesthetic drugs - if well understood.

In order to solve this issue, we plan on performing the segmentation with the convolutional neural network method U-Net from the Computer Vision Group of Freiburg [2]. The datasets of ultrasound images of neck provided on the Kaggle platform will be used to perform training, validation and testing.

After preprocessing the training data, we will search for modifications of the parameters of a U-net neural network aiming at improving its accuracy in this specific application. This project will be performed in python with tensorflow.

The first set of experiment will consist in implementing simple version of the U-Net neural network and to train it using different parameters in order to make a first assessment of its efficiency on the segmentation of the ultrasound images. This first set of experiments will determine which parameters could be modified to improve the efficiency of U-Net on this specific application.

In order to assess the success of our neural network, we will compare the baseline version that we will implement in the first place with the optimized version. This comparison will be based on two of the three types of error metrics that were used in Ronnenberg et al. (2015) and that were used by the ISBI'12 challenge[3] :
-pixel error : assesses the number of incorrectly classified pixels.
-Rand error : assesses a score based on the probabilities that a pixel of the predicted segmentation belongs to the ground truth segmentation and vice-versa.

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1 https://www.kaggle.com/c/ultrasound-nerve-segmentation/rules

2 Ronneberger O., Fischer P., Brox T. (2015) *U-Net: Convolutional Networks for Biomedical Image Segmentation*. Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015. Lecture Notes in Computer Science, vol 9351. Springer, Cham

3 https://www.frontiersin.org/articles/10.3389/fnana.2015.00142/full

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Skills/knowledge that the group members aim to acquire from completing the project.

-Hannah: I study bioengineering/medical engineering. I am already familiar with programming but I would like to take this learning further with the deep learning tool - which I am discovering with this course.That's why I chose this subject directly applied to medicine, I would like to understand better how this tool works and to be able to use it later on in medical imaging but also in more varied things.

-Matthieu Giral: I study applied mathematics. I am a bit familiar with deep learning and I'm interested in discovering the new field of image segmentation. An experience in working in group on a complex project and reproduce state of the art models is also very appealing.

-Milan Clerc: I intend on doing my master thesis in bioinformatics. However, I have no previous experience with deep learning. I would therefore like to reach an advanced comprehension of learning networks and on how to manipulate them fluently.

Grade we are aiming to reach: A