Medical Image Segmentation and applications

Tissue segmentation project (IBSR18 dataset)

Introduction

In this coursework, and following the line of previous assignments, the goal is to develop tissue (WM, GM and CSF) segmentation methods in brain MRI images.

This is an open project in which you can choose any of the strategies seen during the course to solve the problem, such as clustering and region based methods, atlas-based approaches or even supervised strategies based on deep learning. Note that previous implementations could be a starting point.

The proposed solutions will be evaluated on the well-known IBSR18 dataset. This is one of the standard datasets for tissue quantification and segmentation evaluation. As its name indicates, the dataset consists of 18 MRI volumes (see Figure 1). We have divided the original set into: training (ten), validation (five), and testing (three). For the training and validation images, you will have the corresponding ground truth (GT), while for the testing set it will not be available. We will use your results in this testing set to perform a competition with all the other groups. The ranking will take into account the performance of the algorithm based on Dice (DSC), Hausdorff distance (HD) and average volumetric difference (AVD), as commonly defined in other challenges (e.g. MICCAI2012, MRBrainS13, and iSeg2017). We will have a submission link for the masks of the three testing volumes (each group will submit them at most once).

For reporting the results of your approaches, you should use the validation set and the mentioned similarity/distance measures. Note that the validation images cannot be used for training. On the other hand, you are free to use the training images for any purpose (ex. train a supervised system, build an atlas, or implement a multi-atlas approach).

The IBSR18 dataset includes skull-stripped T1-w images and contains cases with different spatial resolutions (pixel spacing). Moreover, there is also a heterogeneity in image intensities which hinders segmentation.

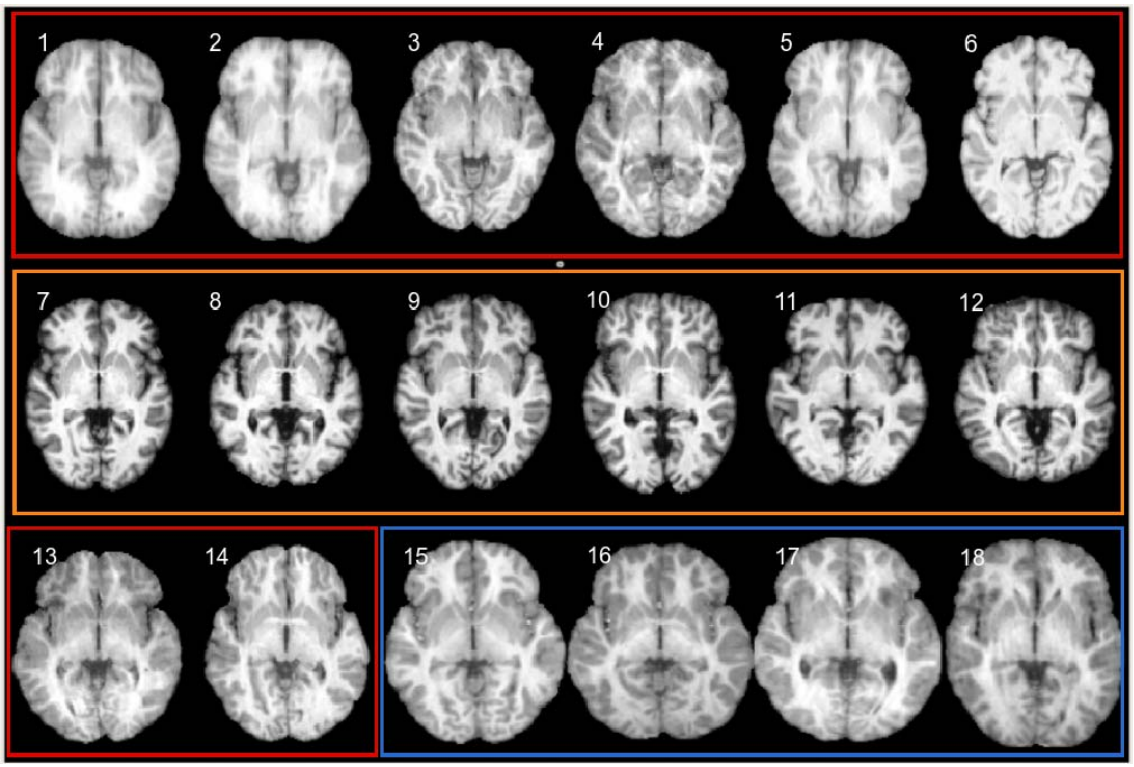

Figure 1. Axial slice of the 18 cases from the IBSR18. Different groups of images (in colour in the plot) have different image resolution (pixel spacing).

Project guidelines:

- The segmentation labelling must agree with the dataset standard (i.e. 0: background, 1: CSF, 2: GM, 3: WM).
- Analyse all the images and start with simple approaches.
- Report all the trials and experiments.
- Highlight quantitatively and qualitatively the performance of the considered approaches and improvements.

Objectives

A Information search. Teamwork.
B To design, analyse and implement approaches for brain tissue segmentation.
C To test implementations at least with the provided images. To study problems and possible improvements. To evaluate results using provided ground truth and similarity/distance measures. To submit a final segmentation result for the testing set (competition).
D Documentation.

Coursework: 4 sessions (8 hours)

A Coursework with the following sections:
  1 Introduction and problem definition.
  2 Proposal analysis.
  3 Design and implementation of the proposed solutions.
  4 Experimental section and results analysis (qualitative/ quantitative analysis, speed, etc). Results should be provided for the validation set. You could also show preliminary results from the training set if needed.
  5 Organization and development of the coursework (tasks, time estimations and real dedication).
  6 Conclusions.
B Code with comments.
C Tissue masks for the three testing volumes.

Coursework evaluation:

A During the labs.
B After the coursework.
C Final ranking of the competition results will be also considered.

DEADLINE: It will be the one indicated in the moodle submission link. Late submission will be penalised.