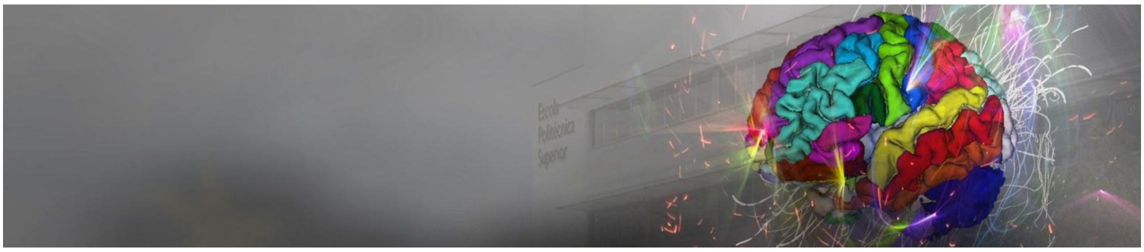
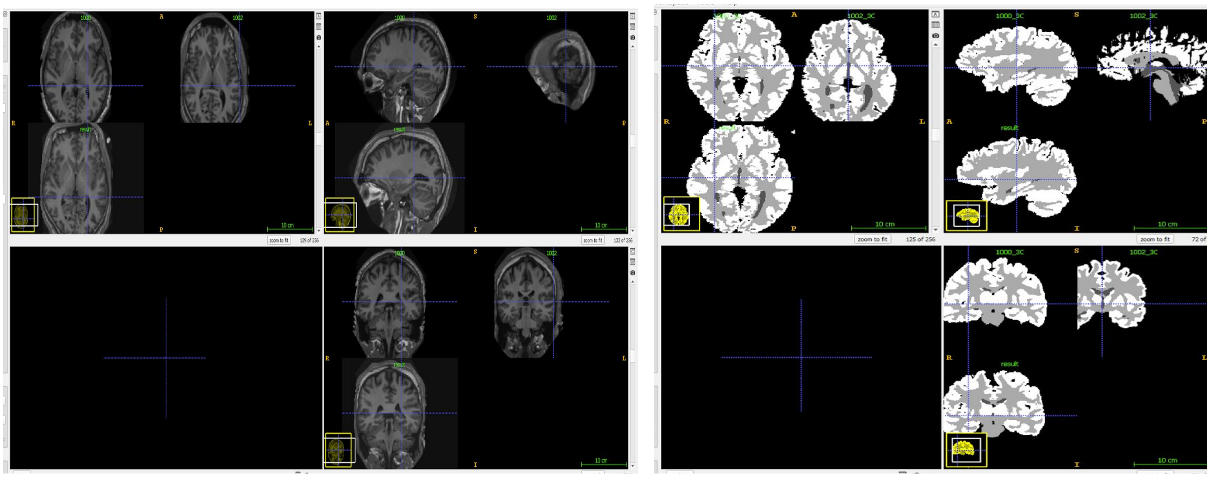
MIRA & MISA project

Atlas based segmentation
(integration to the EM algorithm)



Introduction part A (MIRA course)

The primary goal of this first part is to build a probabilistic atlas from a set of brain volumes with the available labels of three classes (WM, GM and CSF). The following figure shows two cases (1000 & 1002) before (1002) and after registration (result) (left: intensity images, right: label images).



You have to implement the algorithm to build a probabilistic atlas from the trained brain images and labels provided. For performing the registration, you can use elastix, an open source toolbox for rigid and nonrigid registration of images (http://elastix.isi.uu.nl/). The final result should be a probabilistic atlas: an intensity volume (used for registering new unsegmented volumes) and a probabilistic label volume (containing tissue probabilities at each voxel).

Guidelines:

1. Download the Elastix software, manual and example of usage (batch file). Make sure that you understand how Elastix runs and works. (see http://elastix.isi.uu.nl/download_links.php)
2. Perform a single registration as the one shown above (register intensity images and transform a label image).

Objectives

A) Information search. Teamwork.

B) To understand how to perform a single registration of two 3D volumes using rigid and nonrigid registration with elastix. See the elastix manual and the elastix example in moodle). Show 3-4 registration results with itk-Snap to illustrate that registration works as expected (qualitative evaluation) for rigid and nonrigid cases.

C) To develop an algorithm to build the probabilistic atlas. The algorithm can be developed with the programming language of your preference (Matlab, C++, Python). Discuss the assumptions and approaches taken.

D) Show 3-4 slices of the final probabilistic atlas (intensities and label probabilities) and the tissue models for each tissue class (histogram distribution).

E) Documentation.

Coursework: 2 sessions (4 hours)

A) Coursework with the following sections:

1) Introduction and problem definition.
2) Algorithm analysis.
3) Design and implementation of the proposed solution.
4) Experimental section and results analysis (qualitative analysis, speed, etc.).
5) Organization and development of the coursework (tasks, time estimations and real dedication).
6) Conclusions.

B) Source code: Elastix commands (batch files and configuration files) and atlas building code with comments.

Coursework Evaluation:

A) During the labs.

B) After the coursework.

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

Introduction part B (MISA course)

In many medical image segmentation problems, the use of an anatomic or probabilistic atlas is an essential part to guarantee spatially-consistent segmentation results. The goal of this coursework is to integrate the use of a probabilistic atlas into the EM algorithm. As done in the previous assignment, the application will be the brain tissue segmentation task, where an atlas with the three probability maps per each tissue (WM, GM and CSF) will be available.

The implemented algorithm should work under the assumption of using as models mixture of Gaussians and considering the use of multivariate data (i.e. different image modalities, such as T1-w, T2-w, PD-w). For the atlas integration, you should use your own created atlas (part A of the assignment) and compare then the obtained results with those obtained when using the well-known MNI atlas template (provided within this coursework). The algorithm will be evaluated with the provided data (coming from a MICCAI 2012 Challenge), reporting also a quantitative analysis using the Dice Similarity Coefficient (DSC) measure (Ground truth for the three tissue classes is available). You could also analyse the improvement when introducing the atlas into the EM segmentation proposal.

Guidelines:

1. Create a probabilistic atlas from the training set (part A)
2. Download the MNI atlas
3. Register both atlases to each one of the cases in the test set
4. Compute the tissue models from the training set as explained in part A and also using your EM algorithm on the training set
5. Use both the tissue models and probabilistic atlases to segment each one of the cases in the test set
6. Report <u>DSC values per class</u>

To have in mind:

- Speed up your code if needed, there are several cases to process.
- Both MNI and your own constructed atlas from the same dataset should be provided and will be evaluated.

Objectives

A) Information search. Teamwork.

B) To understand the segmentation algorithm when integrating atlas information. To design, analyse and implement the algorithm in matlab.

C) To test the algorithm at least with the provided images (training images for building the atlas and testing for providing results). To study the problems and possible improvements. To evaluate the results using the ground truth provided and the DSC. Note that DSC values should be provided per class.

D) Documentation.

Coursework: 2 sessions (4 hours)

A) Coursework with the following sections:

1) Introduction and problem definition.
2) Algorithm analysis.
3) Design and implementation of the proposed solution.
4) Experimental section and results analysis (qualitative/ quantitative analysis, speed, etc).
5) Organization and development of the coursework (tasks, time estimations and real dedication).
6) Conclusions.

B) Matlab code with comments.

Coursework Evaluation:

C) During the labs.
D) After the coursework.

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