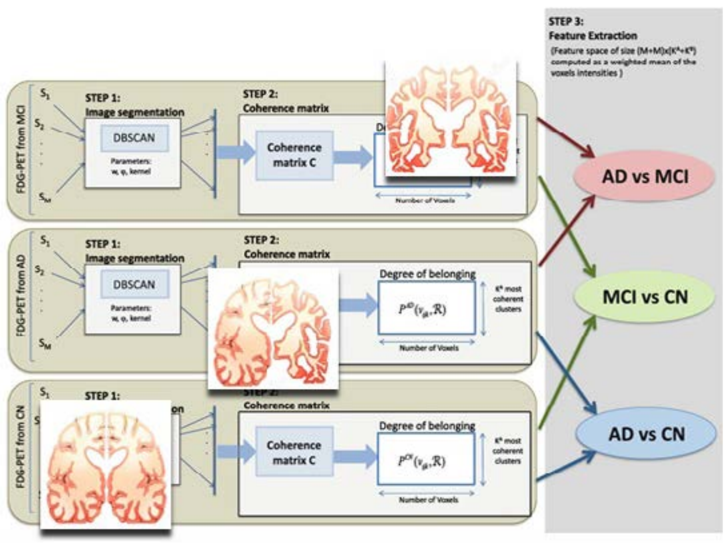
ADIAR

Alzheimer's Disease Image Analysis and Recognition

Extensive research has addressed the diagnosis of Alzheimer's disease (AD). In the ADIAR project we focused on the greater challenge of the diagnosis at the early stage, known as Mild Cognitive Impairment (MCI). By analyzing MCI and AD manifestations in both space and time dimensions, based on PET images, we were able to get a deeper insight into the disease, while producing more accurate diagnosis.



Main Project Team	
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Funding Agencies	
FCT/PTDC	**53,000€**
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Indicators	
Book Chapters	1
Conference Papers	3
Concluded PhD	1

Two Main Publications

H. Aidos, J. Duarte, A. L. N. Fred, **Identifying Regions of Interest for Discriminating Alzheimer's Disease from Mild Cognitive Impairment**, IEEE International Conf. on Image Processing - ICIP, Paris, France, pp. 21-25, October, 2014

H. Aidos, J. Duarte, A. L. N. Fred, **Diagnosing Alzheimer's Disease: Automatic Extraction and Selection of Coherent Regions in FDG-PET Images**, Chapter in, Biomedical Engineering Systems and Technologies, Springer International Publishing, 101-112, 2015

PROJECT WEBPAGE URL
https://www.it.pt/Projects/Index/1596

Fig. 1 Brain voxels and corresponding 2D representations of PET images.

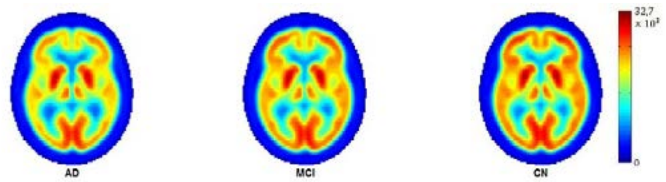

Fig. 2 Voxel intensities for the Alzheimer's Disease (AD), Mild Cognitive Impairment (MCI) and Cognitive Normal (CN).

GENERAL MOTIVATION AND OBJECTIVES

During the last decade extensive research has focused on the potential of neuroimaging for the diagnosis of Alzheimer´s disease (AD). Currently, the greater challenge is the diagnosis at the early stage known as Mild Cognitive Impairment (MCI). Early detection is important because it is when treatments that can delay the progression of the disease can have the most impact. This is however a difficult task due to the variability of spatial patterns of brain degeneration in MCI, along with changes in time, as the diseases progresses. Functional imaging modalities such as Positron Emission Tomography (PET) play an important role in detecting abnormalities useful in early diagnosis and in differentiating patients with MCI that will likely progress to AD. The goals of project ADIAR were the following: (i) to get a deeper insight into the manifestations of MCI and AD both in space and time dimensions; and, (ii) to produce more accurate diagnosis tools using PET images of the brain.

CHALLENGE

Currently the diagnosis of AD in its earlier stages of MCI, and the forecast of which MCI subjects are likely to convert to AD, represent the bigger challenge in computer aided diagnosis of AD. It is a difficult problem because the spatial pattern of brain degeneration in MCI is highly variable and changes in time as the disease progresses. This makes the analysis very complex since the MCI group is usually very heterogeneous containing subjects at different stages.

Since a brain volume contains thousands of voxels which represent variables and the number of subjects is generally smaller, this task suffers from the so called "curse of dimensionality". In these cases, traditional classifiers are not appropriate.

The IT team investigated clustering as a means for identifying discriminative regions of voxels in FDG-PET images, and methods based on the combination of classifiers and semi-supervised (constrained clustering) techniques to combine additional information from various sources.

WORK DESCRIPTION AND ACHIEVEMENTS

In this work, clustering is used as the main tool for dimensionality reduction, intrinsically finding regions of interest in FDG-PET images that can better discriminate between the populations under study. The 3D images were first segmented into clusters based on their intensity and then a coherence matrix of pairwise comparisons between subjects was constructed, where for each pair of subjects, and for each pair of clusters we count the number of voxels in common. From this matrix we identify the most coherent clusters, which correspond to the ones with a higher overlap with other clusters. Regions of interest are then created by joining all clusters with more than 50% overlap with the most coherent clusters. Finally, features are extracted from these regions. These are created by calculating a voxel degree of belonging for each identified region and then computing the product of the probability matrix with the region voxels intensities.

This approach was compared with two other methods in terms of the classification accuracies obtained with three well-known classifiers (SVM, K-NN and GNB). The other methods consisted of using voxel intensity of regions manually identified by an expert and using voxel intensity features selected with Mutual Information feature ranking. Experimental results showed that the regions found automatically are very discriminative, outperforming results with expert's defined regions and voxel intensity features.