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Influence of the Training Library Composition on a Patch-based label fusion method: Application to Hippocampus Segmentation on the ADNI dataset

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* Data used in the preparation of this article were obtained from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database (www.loni.ucla.edu/ADNI). As such, the investigators within the ADNI contributed to the design and implementation of ADNI and/or provided data but did not participate in analysis or writing of this report. ADNI investigators include (complete listing available at www.loni.ucla.edu/ADNI/Collaboration/ADNI Author ship list.pdf).

Learning objectives:

1. To investigate the accuracy of a patch-based label fusion method for hippocampus segmentation on the ADNI database.
2. To evaluate the influence of the composition of the training library on the segmentation accuracy of a patch-based label fusion method.

Topic area: Early detection and tracking

Keywords: hippocampus, biomarkers, early detection, magnetic resonance imaging

Background: The atrophy of medial temporal lobe structures is may serve as early biomarkers of Alzheimer's disease. The evaluation of hippocampus (HC) atrophy is estimated by volumetric studies requiring a segmentation step that can be very time consuming when done manually. This limitation can be overcome by using automatic segmentation methods. In this study, we propose to validate our nonlocal patch-based method [1] on the Alzheimer's Disease Neuroimaging Initiative (ADNI) database by segmenting the HC of Cognitively Normal (CN) subjects and patients with early Alzheimer's Disease (AD).

Method: We used images obtained from the ADNI database. For our experiments, we randomly selected 10 MRI of CN and 10 MRI of AD. The first experiment was designed to evaluate the accuracy of our segmentation method on a group constituting of CN and AD (8 CN and 8 AD). The second experiment was designed to investigate the impact of the composition of the training library. Three different training populations were built (i.e., the CN population: 8 CN, the AD population: 8 AD, and the mixed AD / CN population: 4 CN and 4 AD). Through a leave-one-out procedure, our automatic segmentation method was applied on each of the 20 MRI scans. The quality of the obtained automatic segmentations was evaluated by estimating the Dice Kappa similarity index.

Results: For the first experiment, the median Dice Kappa values are presented in Table 1. The segmentation accuracy was significantly better (p-value=0.002) for CN (median k=0.883 for both HC) than for AD (median k=0.838 for both HC). For the second experiment, Figure 1 and Table 2 show the Dice Kappa similarity index for both studied populations according to the training library composition. For both populations, the best median Kappa values were obtained with the mixed CN / AD training library (k=0.875 for CN and k=0.835 AD).

Conclusion: First, we demonstrated that our patch-based method provides high segmentation accuracy for both CN and AD populations. Second, we showed that the characteristic of the training library has a significant impact on the segmentation accuracy.

1. Coupe, P., et al., Neuroimage, 2011. **54**(2): p. 940-54.

Table 1. Results of the first experiment using 16 templates in the training library.

Median Kappa values	Left HC	Right HC	Both HC
CN population	0.891	0.866	0.883
AD population	0.830	0.858	0.838

Table 2. Results of the second experiment using different training libraries. The symbol * is used to indicate a significant difference at 95% of confidence between a group and the two others.

Median Kappa values	8 CN in training library	4 AD / 4 CN in training library	8 AD in training library
CN Population	0.874	0.875	0.855*
AD Population	0.824*	0.835	0.833

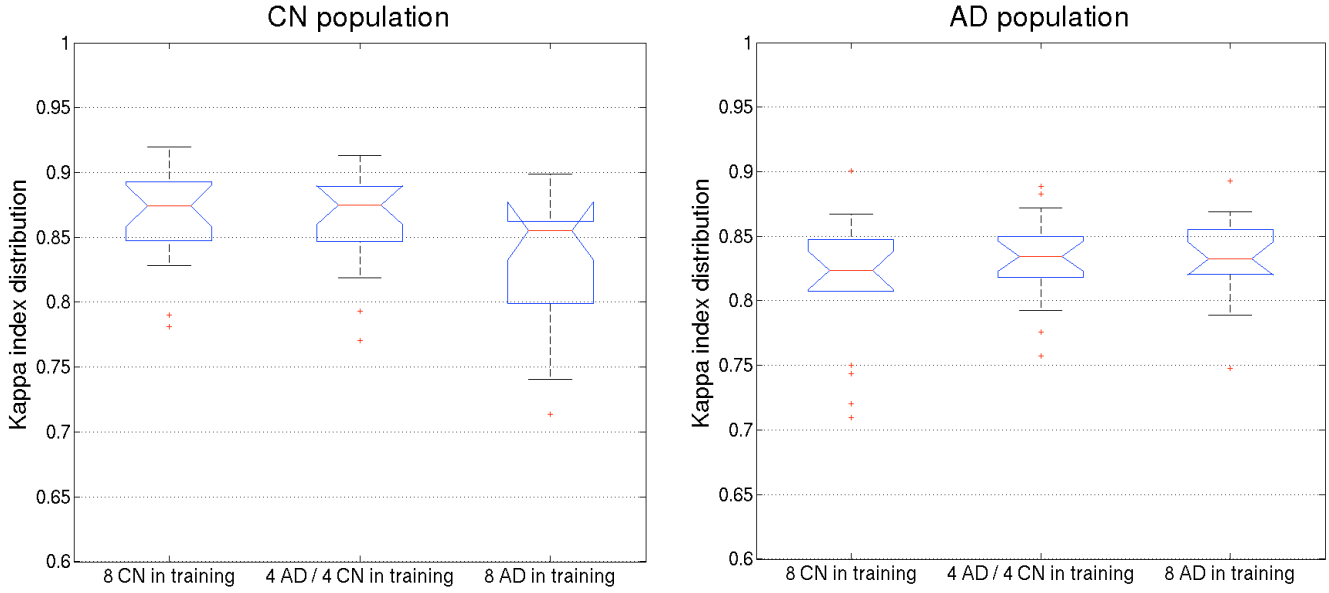


Figure 1: Kappa index distribution according to the composition of the training library for both studied populations.