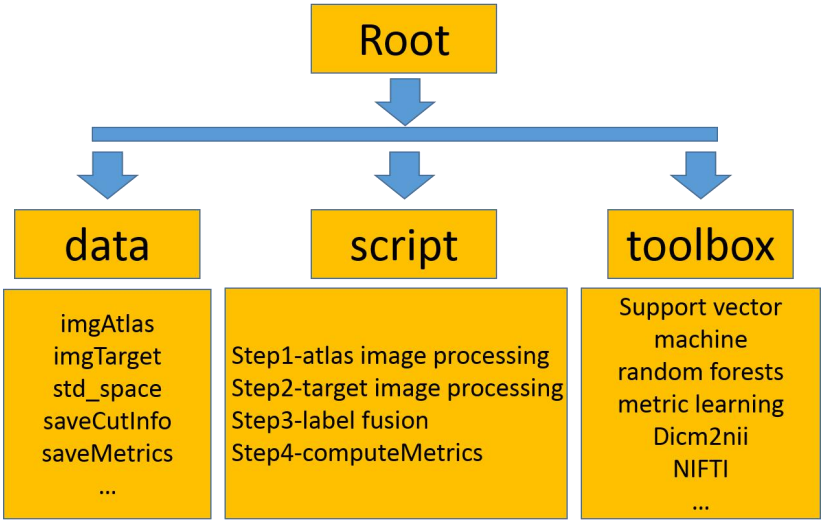
Local label learning (LLL)
for multi-atlas based image segmentation

This package contains standalone Executable files (linux) and research source codes of the Local label learning (LLL) for multi-atlas based image segmentation methods, described in following papers:

- Y. Hao, J. Liu, Y. Duan, X. Zhang, C. Yu, T. Jiang, and Y. Fan, "Local label learning (L3) for multi-atlas based segmentation," in SPIE Medical Imaging, 2012, p. 83142E.
- Y. Hao, T. Jiang, and Y. Fan, "Shape-constrained multi-atlas based segmentation with multichannel registration," in Proceeding of SPIE Medical Imaging: Image Processing, vol. 8314, p. 83143N, 2012.
- Y. Hao, T. Jiang, and Y. Fan, "Iterative multi-atlas based segmentation with multi-channel image registration and Jackknife Context Model," in 2012 9th IEEE International Symposium on Biomedical Imaging (ISBI), 2012, pp. 900- 903.
- Y. Hao, T. Wang, X. Zhang, Y. Duan, C. Yu, T. Jiang, and Y. Fan, "Local label learning (LLL) for subcortical structure segmentation: application to hippocampus segmentation," Human Brain Mapping, vol. 35, pp. 2674-2697, 2014.
- H. Zhu, H. Cheng, and Y. Fan, "Random local binary pattern based label learning for multi-atlas segmentation," in Processing of SPIE Medical Imaging: Image Processing, vol. 9413, p. 94131B, 2015.
- H. Zhu, H. Cheng, X. Yang, and Y. Fan, "Metric learning for label fusion in multi-atlas based image segmentation," in 2016 IEEE 13th International Symposium on Biomedical Imaging (ISBI), 2016, pp. 1338-1341.
- H. Zhu, H. Cheng, X. Yang, and Y. Fan, "Metric learning for multi-atlas based segmentation of hippocampus," Neuroinformatics, vol. 15, pp. 41-50, 2017.
- Q. Zheng and Y. Fan, "Integrating semi-supervised label propagation and random forests for multi-atlas based hippocampus segmentation," IEEE International Symposium on Biomedical Imaging (ISBI), April 2018.

The source codes were organized by Qiang Zheng based on research codes used in the above papers. For questions, please contact qiang.zheng@uphs.upenn.edu or yong.fan@ieee.org.



Organization of the codes

Functions of the codes are following:

Step1-atlas image processing

Given a group of atlas images:

1. N4 bias correction

2. rigid registration to MNI152 standard space

3. building the bounding box, and cut the atlas images

Step2-target image processing

Given a target image to be segmented:

1. N4 bias correction

2. rigid registration to MNI152 standard space

3. cut the target image using the bounding box

4. atlas selection using the mutual information

5. non-rigid registration to the target image

Step3-label fusion

Given the prepared target image and altas images

1. feature extraction

2. label fusion

The label fusion methods include:

% % % % SegMethodNum=0; mv
T. Rohlfing, R. Brandt, R. Menzel, and C. R. Maurer Jr, "Evaluation of atlas selection strategies for atlas-based image segmentation with application to confocal microscopy images of bee brains," Neuroimage, vol. 21, pp. 1428-1442, 2004.

% % % % SegMethodNum=1; nlp
% P. Coupe, J. V. Manjon, V.Fonov, J. Pruessner, M. Robles, and D. L. Collins, "patch-based segmentation using expert priors: Application to hippocampus and ventricle segmentation," Neuroimage, vol. 54, pp. 940-954, 2011.

% % % % SegMethodNum=2; clasvm
% Y. Hao, T. Wang, X. Zhang, Y. Duan, C. Yu, T. Jiang, and Y. Fan, "Local label learning (LLL) for subcortical structure segmentation: application to hippocampus segmentation," Human Brain Mapping, vol. 35, pp. 2674-2697, 2014.

% % % % SegMethodNum=3; rlbp

% H. C. Zhu, H. W. Cheng, and Y. Fan, "Random local binary pattern based label learning for multi-atlas segmentation," in Processing of SPIE Medical Imaging: Image Processing, vol. 9413, p. 94131B, 2015.

% % % % SegMethodNum=4; metricLearn
% H. C. Zhu, H. W. Cheng, X. S. Yang, and Y. Fan, "Metric learning for multi-atlas based segmentation of hippocampus," Neuroinformatics, vol. 15, pp. 41-50, 2017.

% % % % SegMethodNum=5; clarf
% % % % SegMethodNum=6; mv_ss
% % % % SegMethodNum=7; clarf_ss
% Q. Zheng, Y. Fan, "Integrating semi-supervised label propagation and random forests for multi-atlas based hippocampus segmentation", ISBI2018.

Step4-compute segmentation evaluation Metrics

Dice, Jaccard, Precision, Recall, MeanDistance, Hausdorff, Hausdorff95, ASSD, RMSD

Third party software packages are needed:

1. Dicm2nii

   https://www.mathworks.com/matlabcentral/fileexchange/42997-dicom-to-nifti-converter--nifti-tool-and-viewer

2. Nifti_20140122

   https://www.mathworks.com/matlabcentral/fileexchange/8797-tools-for-nifti-and-analyze-image

3. ANTS

   https://github.com/ANTsX/ANTs

4. ITK

   https://itk.org/

5. Liblinear-2.11

   https://www.csie.ntu.edu.tw/~cjlin/liblinear/

6. Metric Learning

   Faqiang Wang, Wangmeng Zuo, Lei Zhang, Deyu Meng, and David Zhang. A Kernel Classification Framework for Metric Learning. IEEE Transactions on Neural Networks and Learning Systems.

7. Random forests

   https://code.google.com/archive/p/randomforest-matlab/