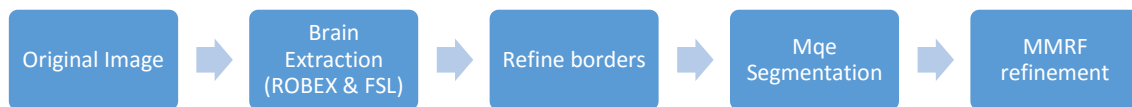# Tsallis-Entropy Segmentation through MRF for Brain Magnetic Resonance Parcellation

Mehran Azimbagirad, Fabrício H. Simozo, Antonio C. S. Senrra Filho, Luiz O. Murta Junior

Department of Computing and Mathematics, Faculty of Philosophy, Science and Languages, University of São Paulo, Ribeirão Preto, SP, Brazil

We provided hybrid modified Tsallis entropy segmentation with modified Markov Random Field (MRF), respectively, to improve the accuracy of the pipeline. Despite the preprocessing steps decrease the noise and Bias field effects of an image before thresholding, these artifacts by seven different percentages were added to a simulation in order to measure the robustness of the recent method. Then we compared the proposed pipeline with existent techniques: Expectation-Maximization, K-mean and q-entropy segmentation methods at thresholding step and classical MRF at post processing step, composing different pipelines. All pipelines were applied on five healthy subjects T1 weighted MR images from MR Brains. In each case, a manual segmentation was used for ground-truth comparison, and nine similarity metrics were calculated to evaluate and compare the pipelines.

This article will be accessible as soon as possible. In addition, the proposed method will be available as an extension for the 3DSlicer software through Slicer Extension Manager, with the source-code available at GitHub.

- This method could be completely automatic or change some parameters to get better results.
- In this approach only T1-weighted scan was used (0.958mm x 0.958mm x 3.0mm)
- Pipeline as follow

Original Image → Brain Extraction (ROBEX & FSL) → Refine borders → Mqe Segmentation → MMRF refinement

Brain Extraction: For one subject (03) the output of Brain extraction by ROBEX was not good visually. Then FSL by alpha parameter equal 0.2 was used to extract the brain. For other subjects, ROBEX was used. Averagely 130 sec was needed for nine step in ROBEX

Step 1 of 9: reading in images

Step 2 of 9: registration...

      2a) Similarity transform...

      2b) Affine transform...

      2c) Resampling volume...

Step 3 of 9: rough bias field correction

Step 4 of 9: calculating features

Step 5 of 9: voxel classification

Step 6 of 9: fitting the shape model

Step 7 of 9: free deformation

Step 8 of 9: building volume from mesh

Step 9 of 9: warping back to original space

Mqe: Modified q-entropy is a new method for brain segmentation which only need one parameter to be done. More details will be provided in paper.

MMRF: Modified MRF is a new post processing method to refine borders of a label map. Details will be in the same paper.

- Till now, the algorithm, will be able to segment MRI brain to three main tissue. Other modalities and specific usage are in progress. We are trying to modify it to detect lesions as well.

- This algorithm was tested by simulation data with different percentage of noise and bias effect. Results shows the robustness of the algorithm against artifacts.
- CPU times for the implemented pipelines in this study were roughly the same. These CPU usage times were averagely 6 to 7 minutes by using a Core i7 (4 cores, 8 threads, 3.20 GHz) and 8 Gigabyte RAM.