CLONAL SELECTION ALGORITHM FOR GAUSSIAN MIXTURE MODEL BASED SEGMENTATION OF 3D BRAIN MR IMAGES

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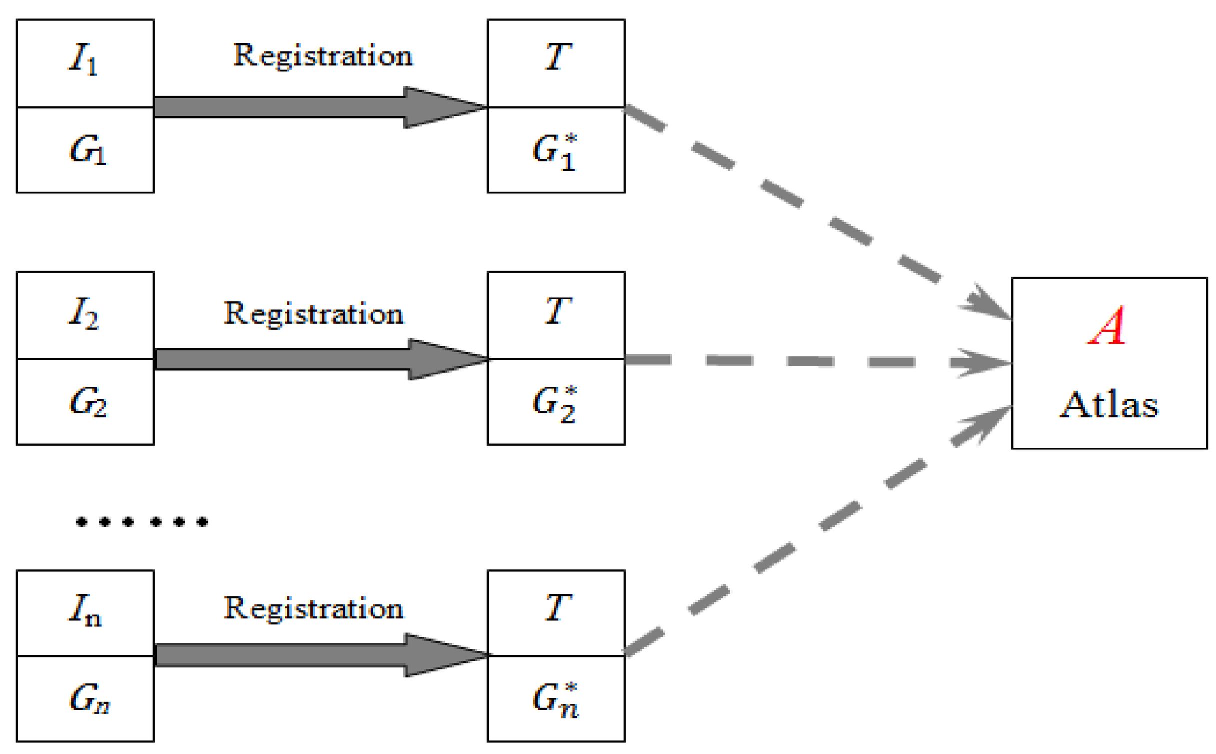
INTRODUCTION

- Segmentation of brain magnetic resonance (MR) images into gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF) can serve as a basic step for diagnosis of brain disorders and investigation of disease mechanisms.
- Since manual segmentation performed by medical professionals is time-consuming, expensive and subject to observer variability, automated brain MR image segmentation has attracted extensive research attention. Among them, Gaussian Mixture Model (GMM) based segmentation is one of the most commonly used techniques.
- In this study, we incorporate the prior anatomical information embedded in the probabilistic brain atlas into the segmentation process to facilitate the parameter initialization. Then, we propose the CSA-GMM algorithm for 3D brain MR image segmentation by using clonal selection algorithm (CSA).

METHODOLOGY

Probabilistic Brain Atlas Construction



GMM-Based Brain MR Image Segmentation

With the optimal parameters θ^*, the class label of each voxel can be easily estimated by using Bayes classifier:

$$\theta^* = \arg\max_{\theta} \ln\big(p(X|\theta)\big)$$

$$p(X|\theta) = \prod_{i=1}^{N}\Big(\sum_{k=1}^{M} w_k g(x_i|\mu_k,\Sigma_k)\Big)$$

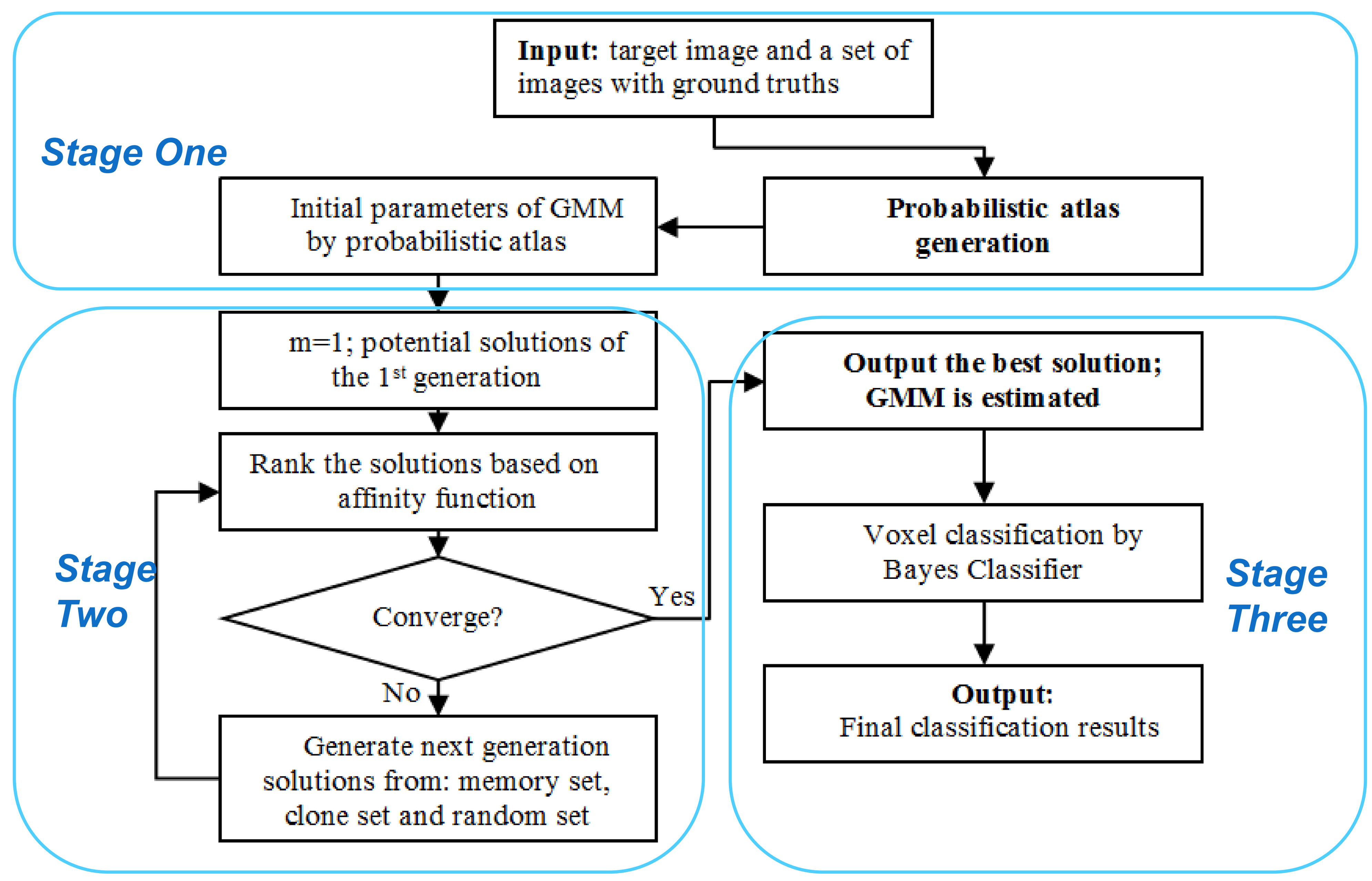
CSA for GMM Estimation

1. Initialize a population of antibodies randomly;
2. Calculate the affinity of each antibody in the population with the specific antigen;
3. Select n best individuals from the population and reproduce (clone) them proportionally to their affinity;
4. Mutate these cloned antibodies with a rate in inverse proportion to their affinity;
5. Use the mutated antibodies to update the memory set and remaining set;
6. Replace some low affinity antibodies with random antibodies;
7. Repeat Steps 2 to 6 until a stop criterion is met.

CONCLUSION

- This paper proposes a new brain MR image segmentation scheme, which combines the spatial information with the CSA and the GMM based segmentation techniques.
- Our results show that the proposed algorithm can achieve better segmentation accuracy in average than the GA-EM algorithm and the popular segmentation algorithms used in the SPM and FSL packages.
- Future work in combining bias field correction and detailed parameter analysis is in progress.

CSA-GMM OVERVIEW



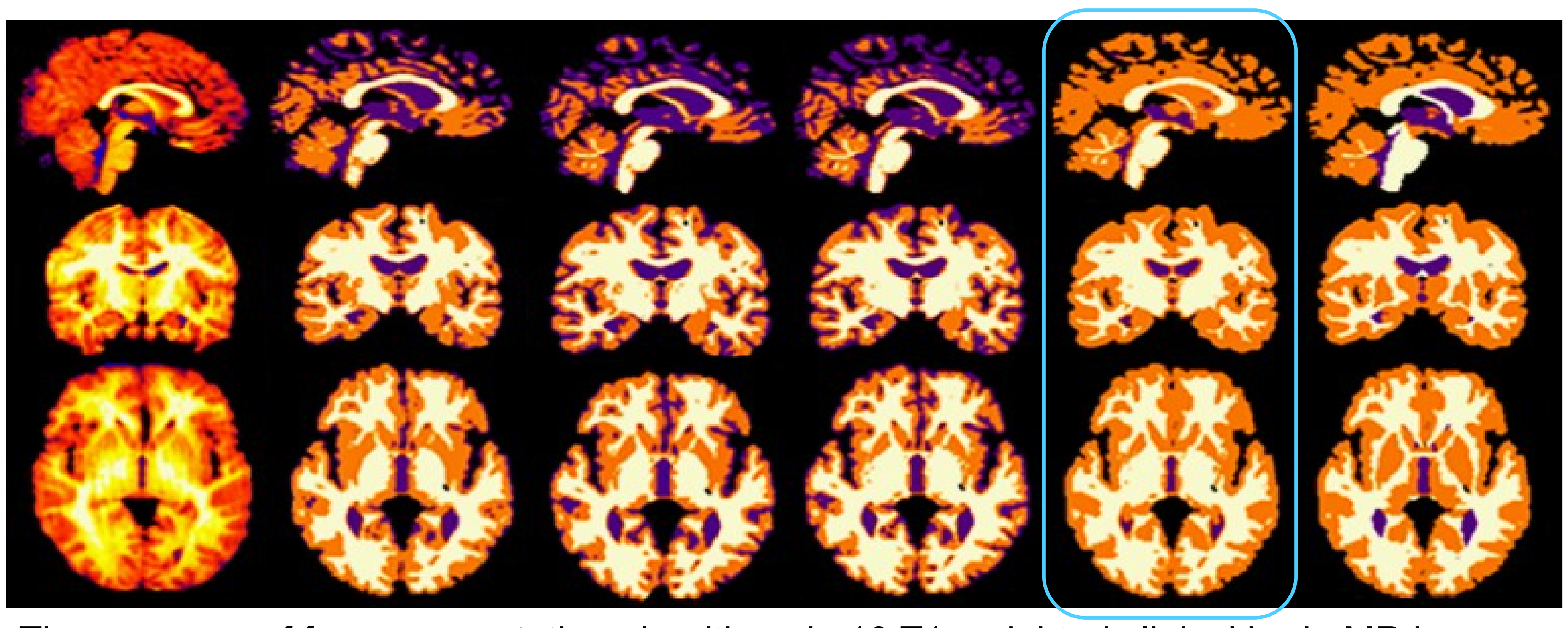
EXPERIMENTS

Experiments on BrainWeb Dataset

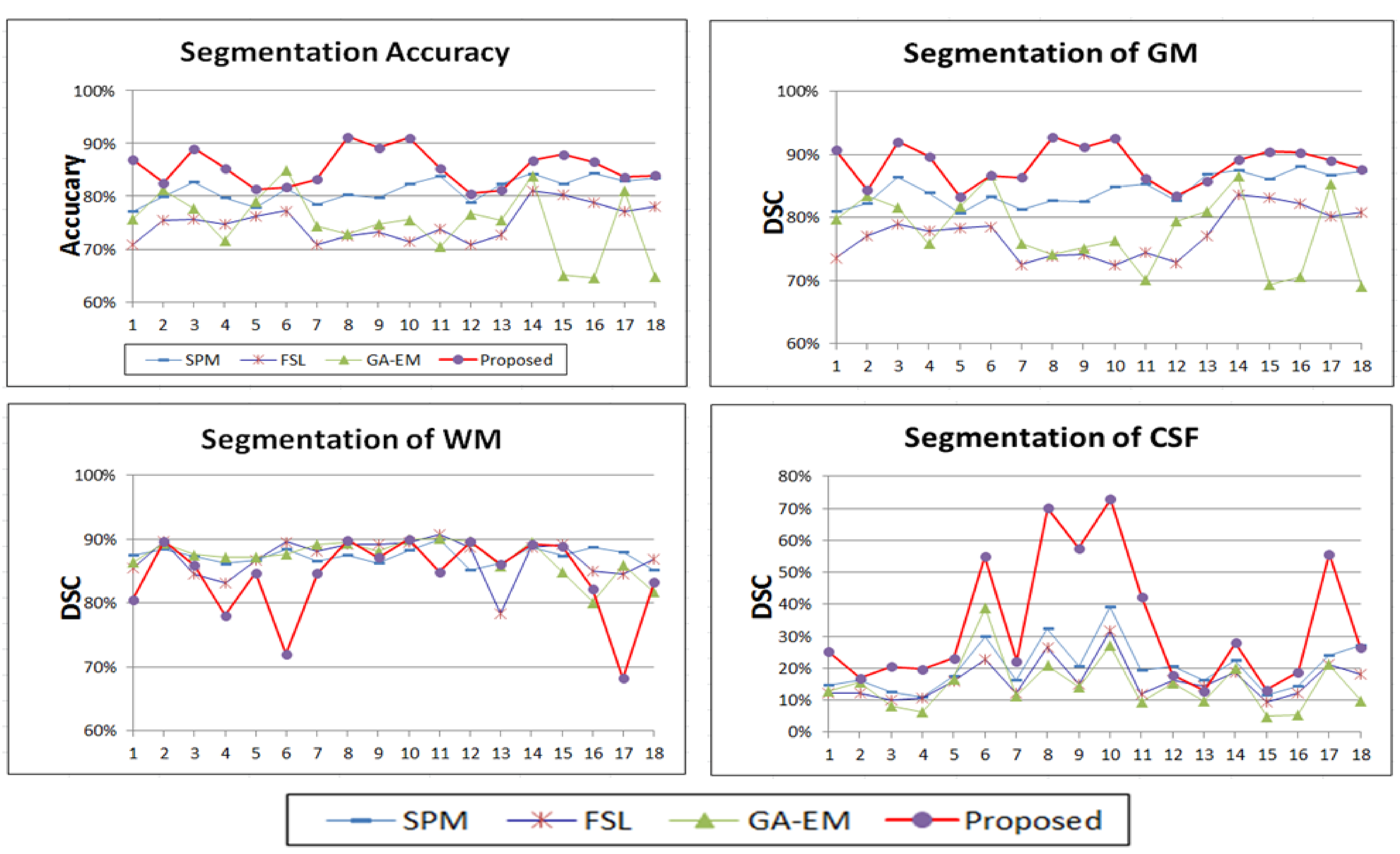
	1% noise	3% noise	5% noise
Accuracy	94.78%	93.20%	92.42%
GM	94.56%	93.00%	92.01%
CSF	96.93%	96.10%	94.61%
WM	94.30%	92.25%	92.18%

Experiments on IBSR V2.0

Segmentation results on one T1-Weighted Clinical Brain MR Image



The accuracy of four segmentation algorithms in 18 T1-weighted clinical brain MR images



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