Brain Segementation

April 12, 2013

Abbreviation:	brain
Number of instances:	5
Number of variables:	$785540 - 7109137$
Number of labels:	5
Number of factors:	$3094923 - 28325233$
Order:	2
Function type:	Potts

Description The brain segmentation dataset includes 5 instances of simulated 3d MRI-brain data [1]. This should be segmented into five classes corresponding to modes in the intensity histogram. We choose a T1 pulse sequence with 3% noise relative to the brightest tissue and 20% intensity non-uniformity. The simulated slice thickness was set to 1,3,5,7, and 9mm, producing a $181 \times 217\times$ 181, 60, 36 , 26, 20 voxel volume, respectively, Fig. 1 shows the original simulated noisy volume (left) and the segmentation (right).

Figure 1: Original simulated noisy volume (left) and the segmentation (right).

Objective / Learning The objective function includes unary data terms and second order Potts terms that approximate a boundary regularisation [2]. The local data terms a given by the L1-distance of the voxel intensity to the prototypical class intensities (4, 45, 105, 150, and 204), i.e.

$$\varphi_i(x_i) = \|I(i) - C_{x_i}\|_1 \qquad \forall i \in V \qquad (1)$$

Furthermore, we use a pairwise Potts term to penalize the boundary length using the 6-neighbourhood in the 3D-grid. The penalty strength β was set to 10 for the boundary term

$$\varphi_{ij}(x_i, x_j) = \begin{cases} 0 & \text{if } x_i = x_j \\ \beta & \text{else} \end{cases} \qquad \forall ij \in E. \qquad (2)$$

Here $E \subset V \times V$ defines the neighborhood relation on the 3D-grid on the variables.

Overall this leads to the following objective function

$$J(x) = \sum_{v \in V} \varphi_i(x_i) + \sum_{ij \in E} \varphi_{ij}(x_i, x_j). \qquad (3)$$

The parameters of the brain segmentation dataset are fully hand tuned and no learning is applied.

References

[1] Brainweb: Simulated brain database. http://brainweb.bic.mni.mcgill.ca/brainweb/.

[2] Yuri Boykov and Vladimir Kolmogorov. An experimental comparison of min-cut/max-flow algorithms for energy minimization in vision. *IEEE PAMI*, 26(9):1124–1137, 2004.