

基于深度学习的医学影像配准算法研究

中期检查

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April 21, 2015

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Motivation

ISA Independent Subspace Analysis

Motivation Maximize independence of features, while allowing dependence inside subspaces with predefined structures.

Pre-requirement whitened data

Interpretation 1

Maximizing likelihood

$$\mathbf{s} = \mathbf{W}\mathbf{x}$$

$$u_i = \sqrt{\sum_{j \in S_i} s_j^2}$$

$$p(\mathbf{s}) = \prod_i \frac{1}{Z_i} \exp\left(-\frac{u_i}{b}\right)$$

$$\arg \min_{\mathbf{W}} \mathbb{E}_{\mathbf{x}} \left[\sum_i u_i \right]$$

$$\text{subject to } \mathbf{W}\mathbf{W}^T = \mathbf{I}$$

Interpretation 2

As a 2-layer neural network

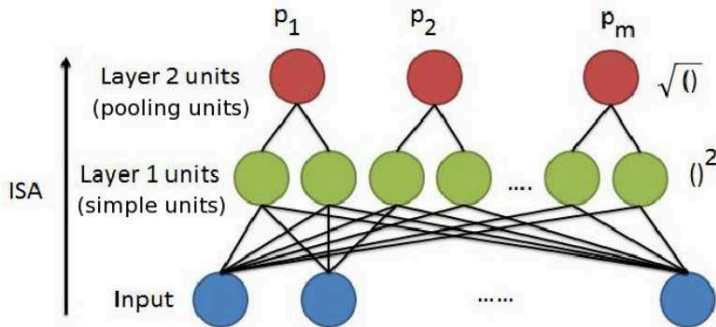


image from [1]

Interpretation 3

Sparse coding with orthonormal regularizer.

$$\begin{array}{ll} \arg \min_{\mathbf{w}} & \mathbb{E}_x \left[\sum_i u_i \right] \\ \text{subject to} & \mathbf{W}\mathbf{W}^\top = \mathbf{I} \end{array}$$

Stacked ISA

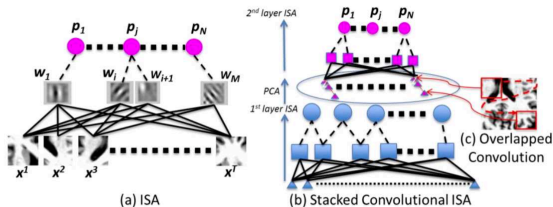


Fig. 2. Graphical depiction of ISA and the stacked convolutional ISA network

image from [2]

Optimization Method

Batched gradient decent:

$$\mathbf{w} \leftarrow \mathbf{w} - \alpha \frac{1}{N} \sum_{i=1}^N \frac{\partial T(\mathbf{x}_i; \mathbf{w})}{\partial \mathbf{w}}$$

Implementation Details

Utilities python2 + theano

Parallel Computing Data parallel on GPUs, both PCA and batched gradient computing/update are parallelized.

Network Structure

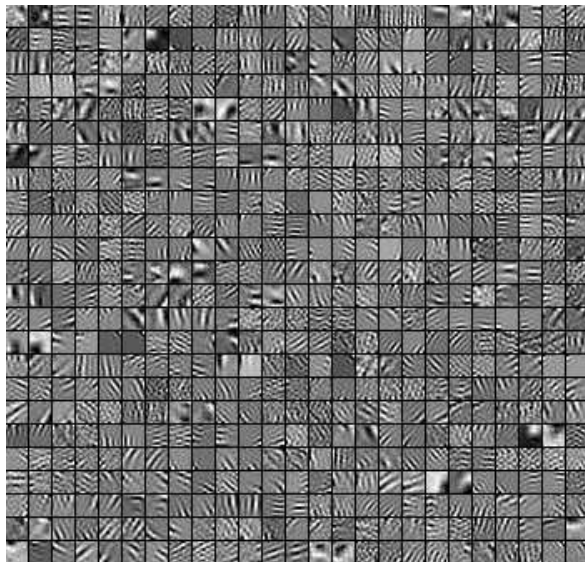
Layer	Input Patch Size	Hidden Ftr	Output Ftr
1	$13 \times 13 \times 13$	300	150
2	$21 \times 21 \times 21$	200	50

Note: layer 1 convolution stride is 8, so actual layer 2 input size is $150 \times 2 \times 2 \times 2$.

Hardware Intel(R) Core(TM) i7-4930K CPU @ 3.40GHz, 55GiB RAM, 4 Nvidia Titan GPUs

Efficiency For layer 2: 5.5GiB training data, 15secs for PCA, 0.15secs for each iteration.

Filters of Layer 1



Feature Discriminability and Robustness

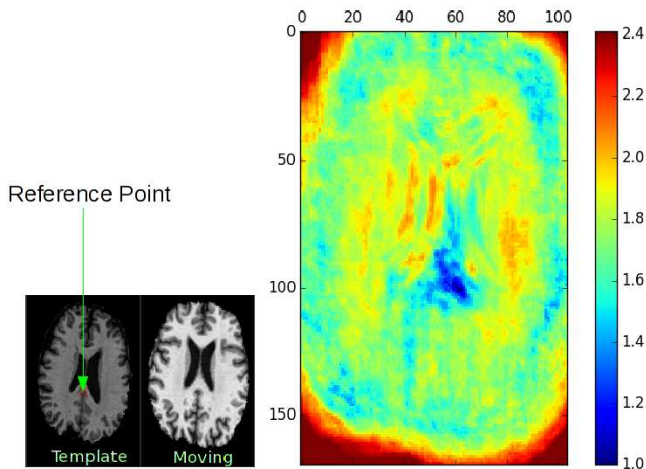


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Problems and Future Work

Major Problem No handy tool for non-rigid registration with custom features

Future Work

- 2 weeks Test feature performance by rigid registration using RANSAC
- 5 weeks Try other feature learning methods

Thanks!

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- [1] Quoc V Le et al. "Learning hierarchical invariant spatio-temporal features for action recognition with independent subspace analysis". In: *Computer Vision and Pattern Recognition (CVPR), 2011 IEEE Conference on*. IEEE. 2011, pp. 3361–3368.
- [2] Guorong Wu et al. "Unsupervised deep feature learning for deformable registration of MR brain images". In: *Medical Image Computing and Computer-Assisted Intervention–MICCAI 2013*. Springer, 2013, pp. 649–656.