



Brain MRI Segmentation **in a Few Seconds** Using Fully Convolutional Network and Transfer Learning



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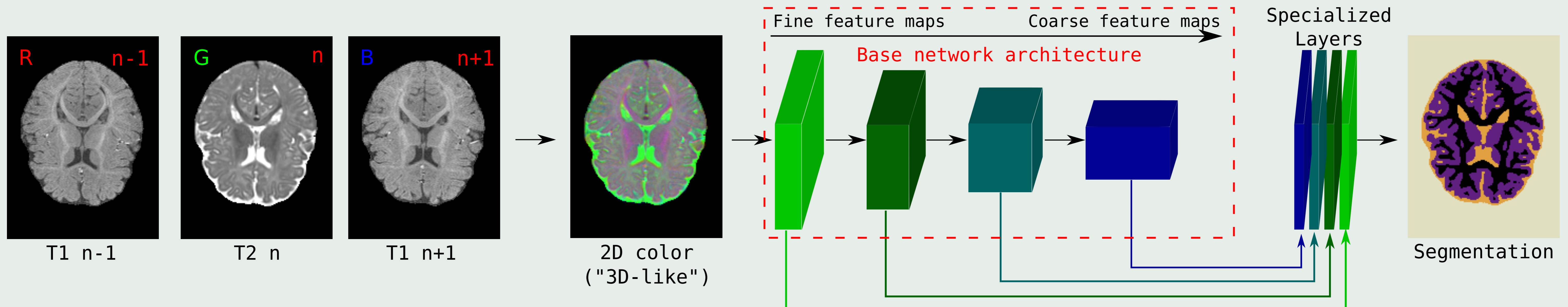
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At a glance



Problem:

- Structures in 6-mth infant brain MRI: lack of tissue contrast and difficult to segment.
- Data are inhomogeneous.

Why our approach is interesting:

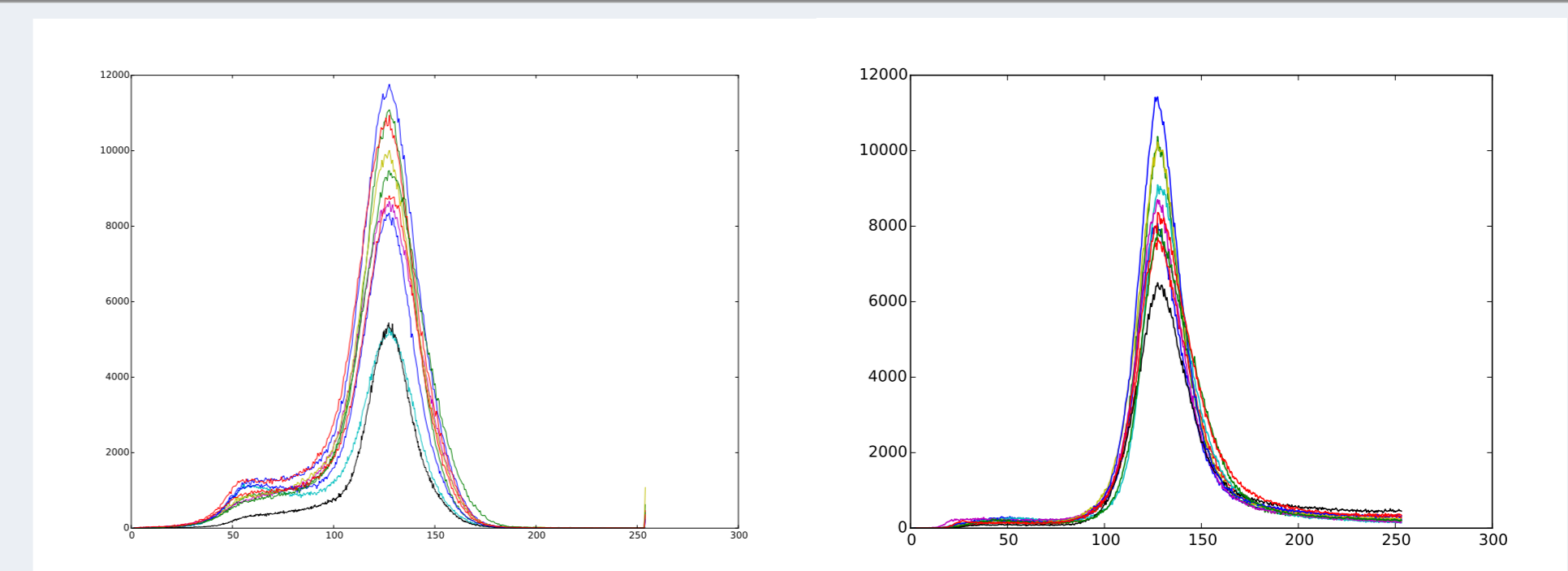
- It is simple, light, fast, and **versatile**.
- It is fully automated.

Conclusion: Our method is fast, robust, and can be applied for several purpose (such as lesion detection).

Pre-processing

Steps:

- Centering the histogram on its maximal value...
- ...and requantization on 8bit, with saturation.
- Input RGB image =
T1 slice $n - 1$ (red), T2 slice n (green), T1 slice $n + 1$ (blue).



Training dataset, test datasets and challenge

Data:

Combination of T1 and T2 images.

Training/test datasets:

- 9/1 patients, switched (classical LOSO experiment).
- Training data *expanded* with scale variation and rotations.
- Input images: a series, of 2D color images.

For the challenge:

- Model trained on all the 10 patients with *expansion*.
- For each patient \in test dataset: pre-processing, inference, and reconstruction are fully automated.
- Runtime on a 3D volume is **1.8 second** on average.

Learning and model

Network:

- From the 16 layers **VGG network**, **pre-trained** on millions of natural images of ImageNet for image classification.
- Each stage = convolutional layers, Rectified Linear Unit (ReLU) layers, and max pooling layers
- 4 first stages only are needed!

Parameters:

- Total number of iterations: 150k.
- Learning rate: $lr = 10^{-8}$ for the first 50k iterations, $lr = 10^{-10}$ otherwise
- momentum* = 0.99 for the first 50k iterations, 0.999 otherwise
- weight_decay* = 0.0005

Main reference: <http://publications.lrde.epita.fr/xu.17.icip>

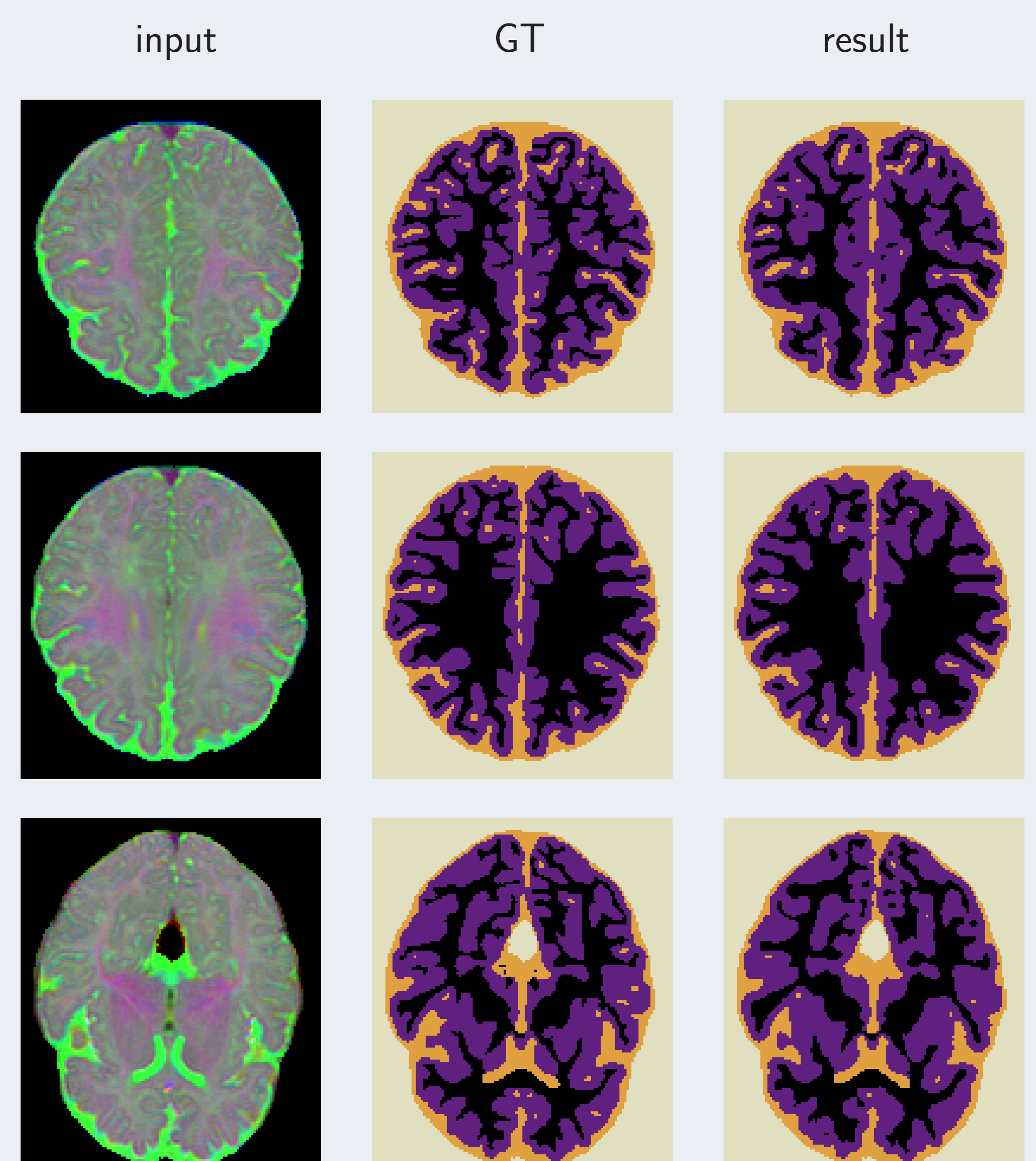
Y. Xu, T. Géraud, I. Bloch, "From Neonatal to Adult Brain MR Image Segmentation in a Few Seconds Using 3D-Like Fully Convolutional Network and Transfer Learning," to appear in Proc. of IEEE International Conference on Image Processing (ICIP), 2017.

Results

Quantitative results:

	WM	GM	CSF
Dice	0.861	0.887	0.928
MHD	6.607	5.852	9.875
	rank 2nd/21	rank 1st/21	
ASD	0.523	0.458	0.201

Qualitative results:



Orange: CSF; purple: grey matter; black: white matter.