Segmentation of White Matter Hyperintensities in a Few Seconds Using Fully Convolutional Network and Transfer Learning

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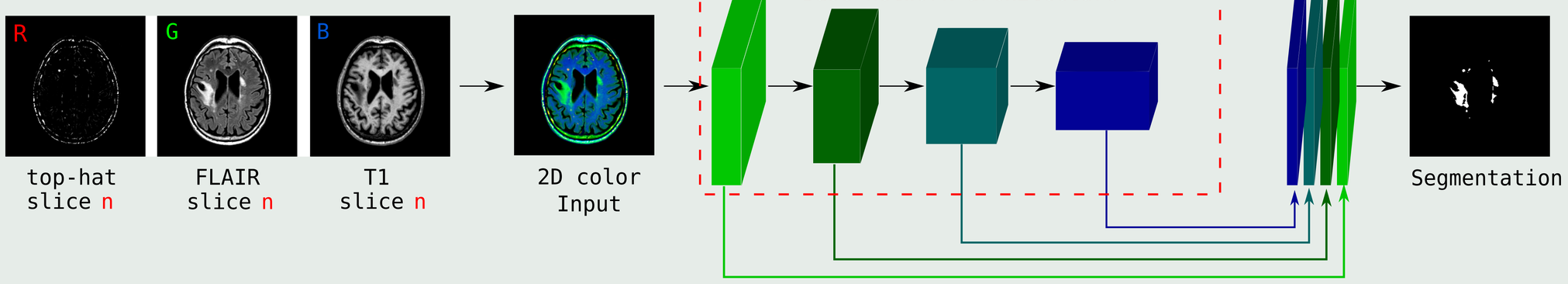
MICCAI WMH Challenge, Poster ID W248

At a glance

for each slice n do:



Problem:

- White matter hyperintensities (WMH) are difficult lesions to segment.
- Data are inhomogeneous.

Why our approach is interesting:

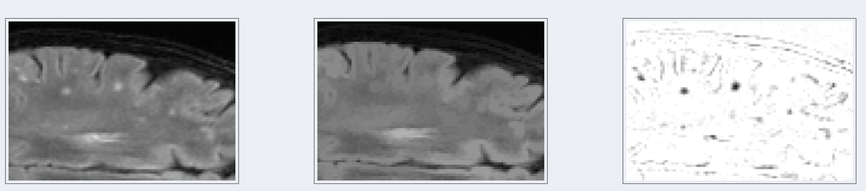
- Small WMH are "highlighted" thanks to MM.
- It is simple, light, fast, and **versatile**

Conclusion: Transfer learning works for WMH segmentation, but also for other applications (such as Brain MRI segmentation).

Pre-processing using mathematical morphology (MM)

Steps:

- Requantization of voxel values on 8bit.
- For every 2D slice, do: top-hat = FLAIR - area_opening(FLAIR).
- Input **2D color image** = combination of top-hat (red), FLAIR (green), and T1 (blue) 2D slices



FLAIR | area_opening(FLAIR) | top-hat

Training datatest, test datasets, and challenge

Data:

Bias field corrected FLAIR images + Bias field corrected T1 images aligned with FLAIR.

Training/test dataset:

- 30/30 patients (10 from each hospital).
- Augmentation of training data with scale variations and rotations.
- Input images: a serie (3D volume) of 2D color images.

For the challenge:

- Training on all the 60 *expanded* patients.
- For every patient: pre-processings steps, centering, inference and reconstruction = fully automated.
- Runtime on a 3D volume is around **10 seconds**.

Learning and model

Network:

- From the 16 layers **VGG network, pre-trained** on millions of natural images in ImageNet for image classification.
- Each stage = convolutional layers, Rectified Linear Unit (ReLU) layers for non linear activation function: $f(z_i) = \max(0, z_i)$, and max pooling layers
- 4 first stages only

Parameters:

- Total number of iterations: 150k.
- Learning rate: $lr = 10^{-8}$ for the first 50k iterations, $lr = 10^{-9}$ 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:

type	Dice	AVD	Lesion Detection	F1 score
proposed method	0.75	22.63	0.61	0.63
without top-hat	0.72	28.24	0.39	0.48

Quantitative results:

Qualitative results: input | GT | result