

Automatic Airway Segmentation And Bronchiectasis Quantification

MSc. Garcia-Uceda A. - Prof. Dr. A.W.M. H. - Dr. De Bruijne M.

Biomedical Imaging Group Rotterdam, Erasmus MC, University Medical Center Rotterdam, The Netherlands



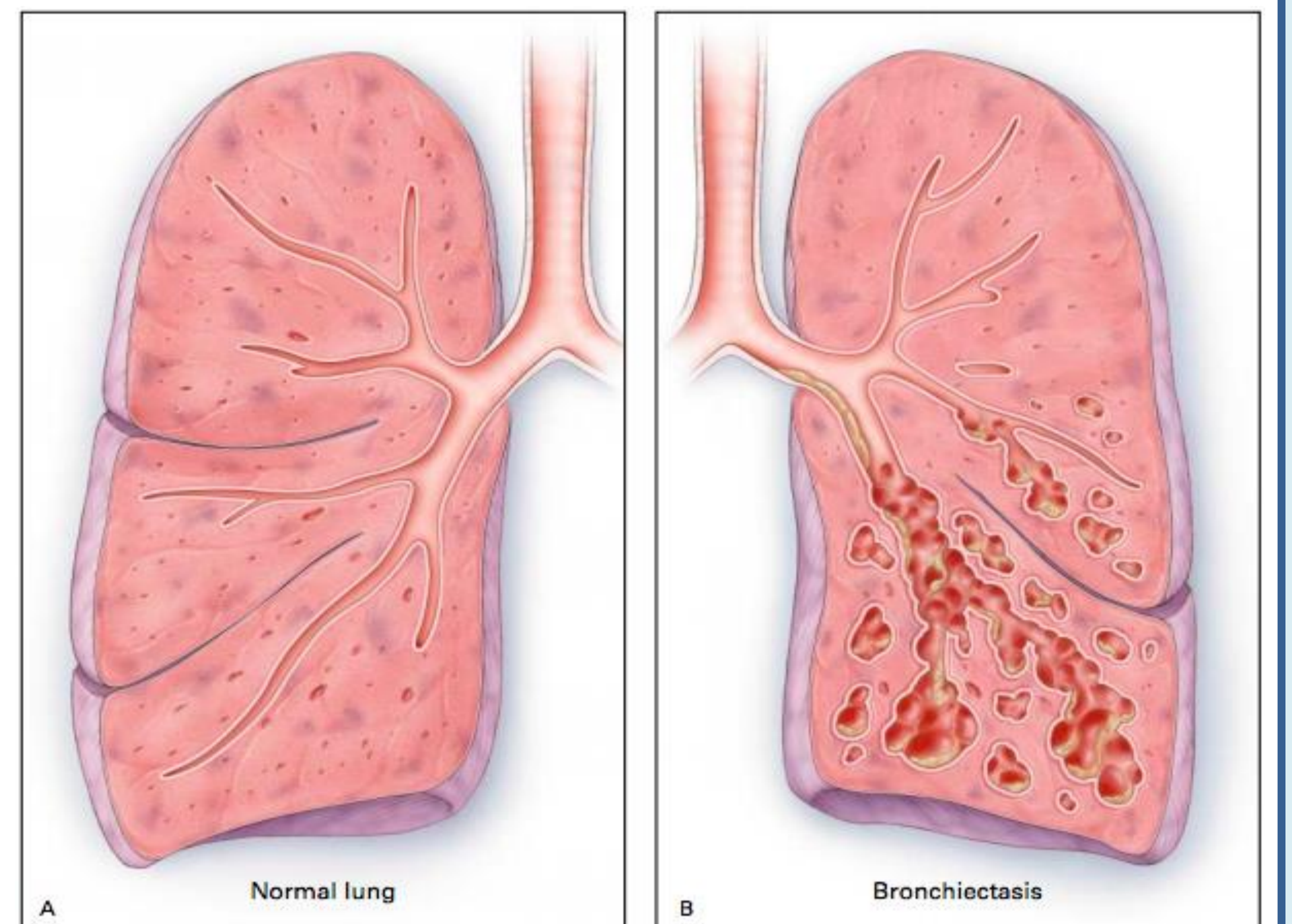
Garcia-Uceda A. a.garciauced@erasmusmc.nl · De Bruijne M. marleen.debruijne@erasmusmc.nl

Abstract:

Bronchiectasis is a disease that affects the lungs and causes an abnormal and permanent widening of the airways. It can cause several health problems such as chronic cough, shortness of breath, and can lead to severe lung infections.

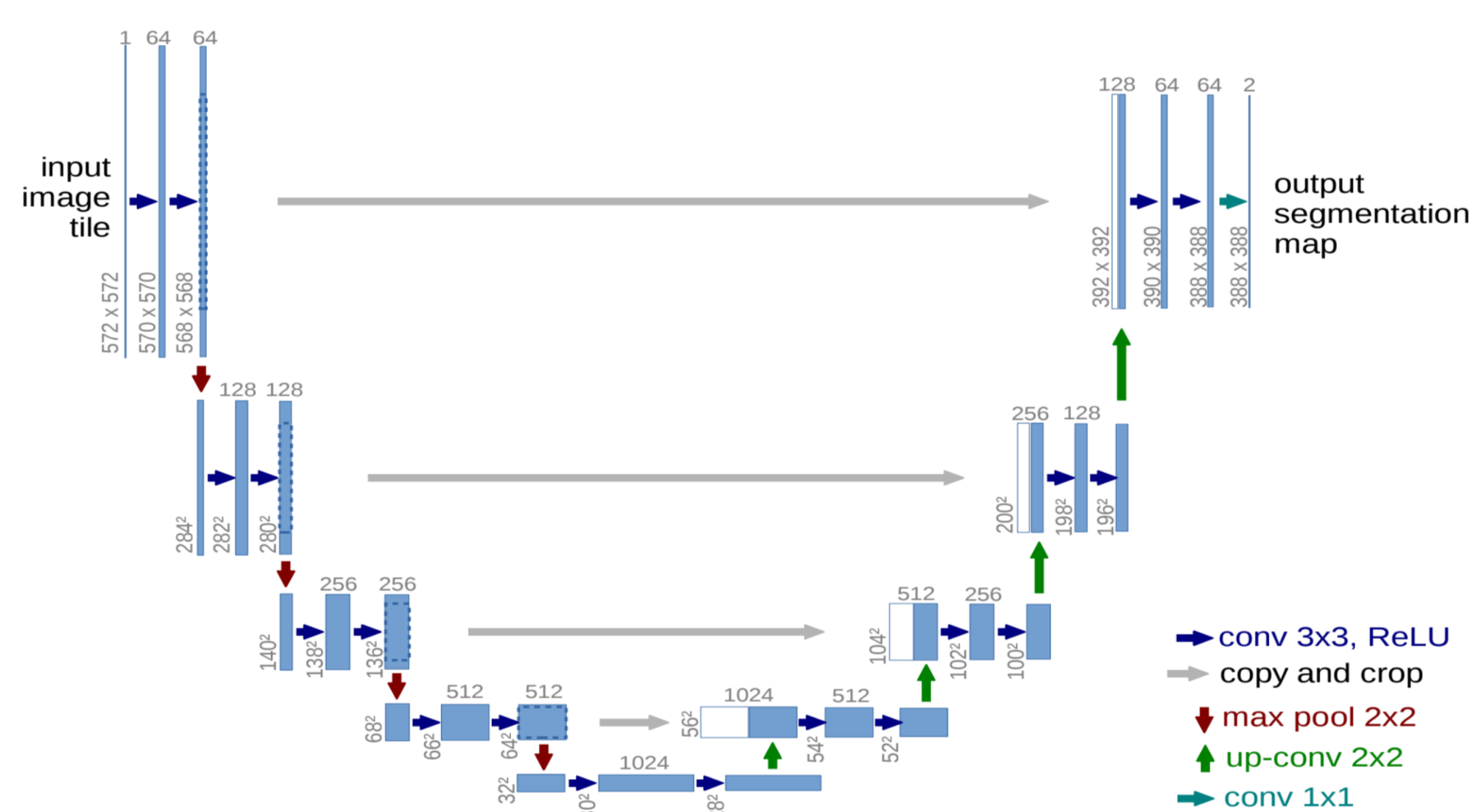
Segmentation of the airway tree in chest CT images is critical to obtain reliable biomarkers to assess bronchiectasis. These help to detect early signs of bronchiectasis and to quantify disease severity.

In this work, we develop novel image processing techniques to segment automatically the airways and the accompanying arteries in CT images. These methods are based on state-of-the-art deep convolutional neural networks for image segmentation, and in particular volumetric Unets.



Experiments set-up:

• CNN Model:

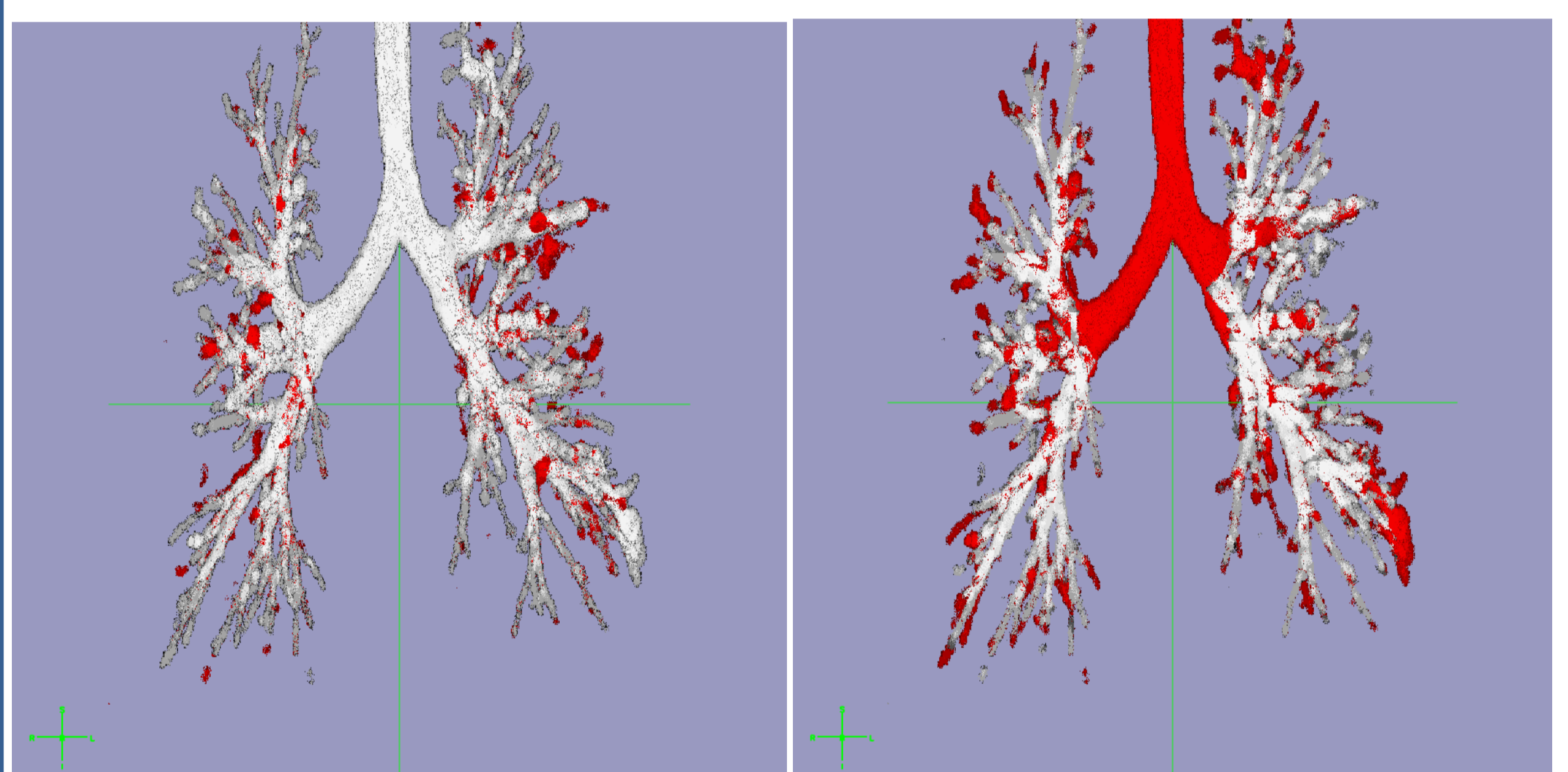


CNN Unet: 2 Convolutional layers + pooling / up-sampling layers [1].

• Data:

- Source: **LUVAR** dataset. **24** CT scans in inspiration. **12** patients, **6** with advanced bronchiectasis.
- Training / Validation / Test data: **12 / 6 / 6** scans.
- Images patches of (120, 352, 240) to fit in GPU memory, with **75%** overlap. Approx. total **1000** image patches.
- Random transformations of image patches during training.

Results:



Airway segmentations on the test set. Left: false positives (in red). Right: false negatives (in red), excluding trachea and main bronchi.

	Dice	TPR	FNR
Mean	0,734	0,659	0,341
Std.	0,056	0,077	0,077

Best segmentation results obtained on the test set. i) dice coefficient, ii) true positive rate, iii) False negative rate.

Conclusions:

- Accurate airway segmentations obtained with a simple but robust 3D Unet architecture.
- Ideas to improve results:
 - More complex Unet model
 - Tailored loss function
 - Data augmentation by elastic deformations
- Post-processing could improve results by joining disconnected airways sections.

Future work:

- Experiments on larger and more complex datasets.
- Improve network architecture.

References:

- [1] Ronneberger, O., Fischer, P., Brox, T.: U-net: Convolutional networks for biomedical image segmentation. In: Medical Image Computing and Computer-Assisted Intervention–MICCAI 2015, pp. 234–241. Springer (2015)
- [2] Pechin Lo, Jon Sparring, Haseem Ashraf, Jesper J.H. Pedersen, Marleen de Bruijne. Vessel-guided airway tree segmentation: A voxel classification approach. Medical Image Analysis 14 (527-538) 2010.
- [3] Petersen, Jens; Nielsen, Mads; Lo, Pechin Chien Pau; Nordenmark, Lars Haug; Pedersen, Jesper Johannes Holst; Wille, Mathilde Marie Winkler; Dirksen, Asger; de Bruijne, Marleen. Optimal surface segmentation using flow lines to quantify airway abnormalities in chronic obstructive pulmonary disease. Medical Image Analysis 18 (531-541) 2014.