Topology consistent airway segmentation

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The preprocess of the input CT data consists in a random cropping of the whole volume into "Regions-Of-Interest" (ROIs) of 128x112x224 voxels, whose origin lies within the lung region. A contrast normalization is performed to map the values from the range [-1000, 600] to [0,1]. Lung mask, airway radius map and a distance map to the surface of the airway are created automatically to use them during training loss computation.

The radius map was created from the skeletonization of the airway segmentation, using the shorter distance from the center line and the airway surface as radius, and assign as the value of each pixel the nearest centerline point distance value.

The Long-Term Slice Propagation (LTSP) method[1] is used together a U-Net to preserve the topology completeness.

The loss function is a combination of clDice[2] and a multi-weighted loss that considers not only the imbalance between background and airway but also the airway diameter and the distance map. This loss only considers those voxels contained in the lung.

The network was trained during 500 epochs, where each epoch contains a total of 900 random extracted ROIs from all training CT scans.

References

1. Wu, Y. *et al.* LTSP: long-term slice propagation for accurate airway segmentation. *International Journal of Computer Assisted Radiology and Surgery* **17**, 857–865 (2022).
2. Shit, S. *et al.* clDice-a novel topology-preserving loss function for tubular structure segmentation. in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* 16560–16569 (2021).