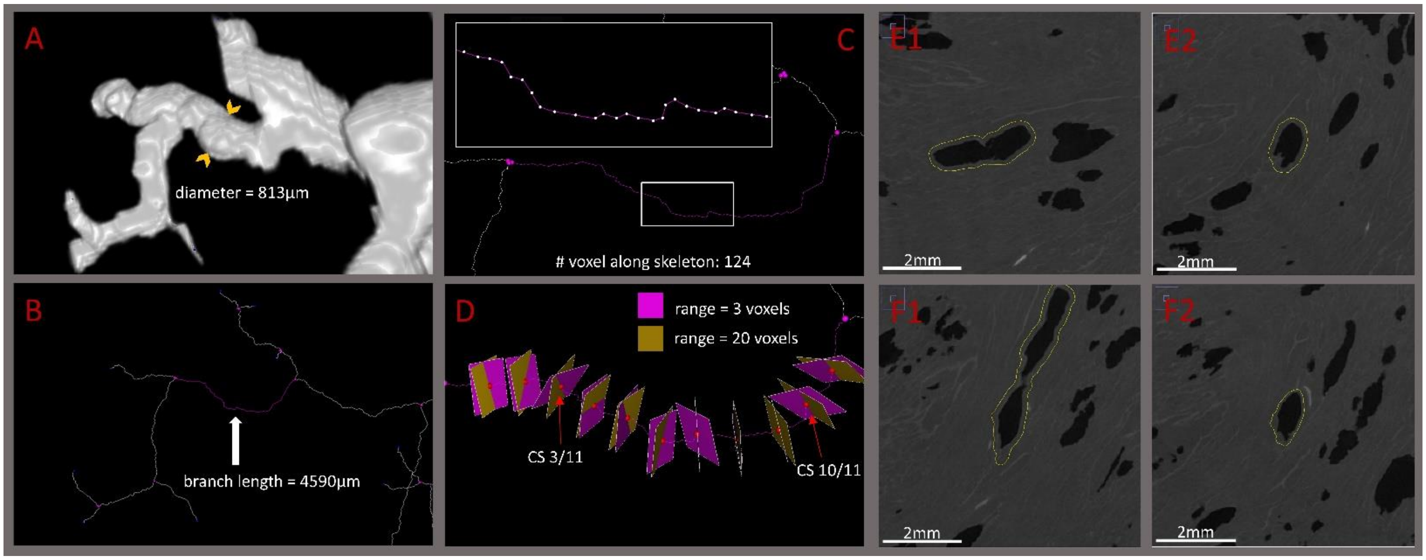

Figure x: the process from airway meshes generated from the CT scan to final cross-sectional images of airways

Dragos I will leave the process from mesh to skeleton for you because I have not worked with it extensively

The final skeleton produced is limited in resolution by voxel (pixel length * pixel width * pixel depth) size of the original image, as seen in xC. This means each skeleton is a list of discrete points that are connected by lines only for visual appearance.

Branch length as shown in xB can then be calculated as

$$L = \sum_{i=2}^{N} |(\vec{P}_i - \vec{P}_{i-1})| = \sum_{i=2}^{N} \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2 + (z_i - z_{i-1})^2}$$

Where $\vec{P}$ denotes the position of each voxel in 3D coordinates, scaled based on CT scan resolution.

Where N indicated the total voxel count for the airway.

This formula generates the sum of distances between adjacent points to produce a total length of the airway branch to the accuracy of the skeletonization process and image resolution.

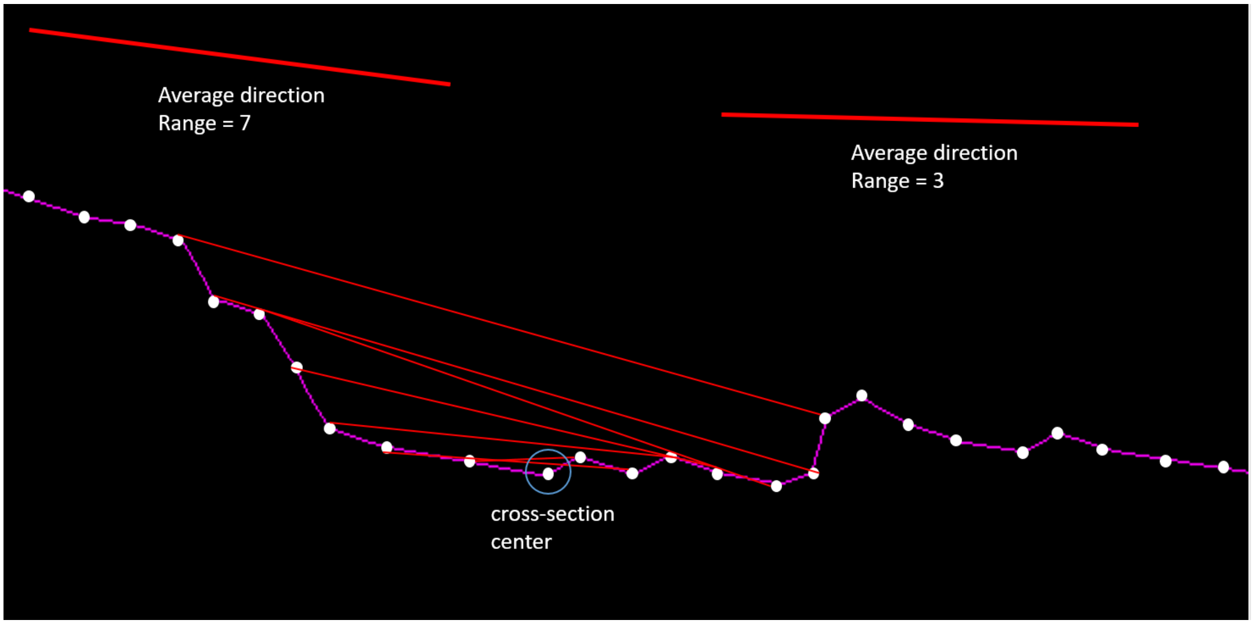

Figure y: the orientation of cross sections based on consideration range.

To determine the orientation of cross sections an approximation of the local tangent line at the center point is done, using the vector created by neighboring voxels on the skeleton. The average of these vectors as seen in y is used as the orthogonal line to the cross section seen in xD.

The parameter range determines the number of voxels to the left and right of the center to include in the calculation. The calculation seeks to emulate average direction of the airway for this selected range of pixels to give an accurate estimate of the tangent at the cross section point while remaining insusceptible to minor local inaccuracies, but still accounting for airway curves.

$\vec{V}$ is a vector orthogonal to the cross section because it is calculated as a sum of trendlines and will be parallel to the airway. The magnitude of $\vec{V}$ is irrelevant and thus division by no. of points can be neglected.

$$\vec{V} = \sum_{i=1}^{R} (\vec{P}_{n-i} - \vec{P}_{n+i}) = \sum_{i=1}^{R} \langle x_{n-i} - x_{n+i} | y_{n-i} - y_{n+i} | z_{n-i} - z_{n+i} \rangle$$

Where R is the # of voxels in consideration range. In cases of airways with insufficient voxel numbers for cross sections near the beginning and ends, the range will be reduced to the maximum value possible given the voxel count.

Where $\vec{P}_n$ and n denote the central voxel for the cross section, and its index, respectively.

Using the direction of $\vec{V}$ we have the angle to rotate the original CT image which we center at $\vec{P}_n$ after the transformation producing final cross-sectional images.

To determine a pertinent value of the consideration range, manual inspection of the cross-sectional images along with 3D visualizations of the tangent lines were done by _____. It was found that a consideration range of 20 in both directions, R=20 gave the greatest results. Using a range exceeding 20 was found to reduce the sensitivity to curves in the airway that were flatted out by the long consideration range. In comparison a range less than 20 was found to be suspectable to small variance and noise present at the limits of the image's resolution, as seen in xD.

Two sample cross sections have been included: xE and xF, showing firstly the cross section obtained with a range of 3 and secondly with a range of 20 to the right. You can see the airway lumen in cross sections produced with a consideration range of 20 are rounder which indicates a more correct depiction of the airway's cross section.

This analysis was conducted with the ranges 3,5,7,11,15,20,25,30 and 40 on a variety of airways to narrow down a ideal value of R as 20.