

MULTI-ATLAS SEGMENTATION OF PARTIALLY VISIBLE STRUCTURES ON CT IMAGES OF MIDDLE AND INNER EAR

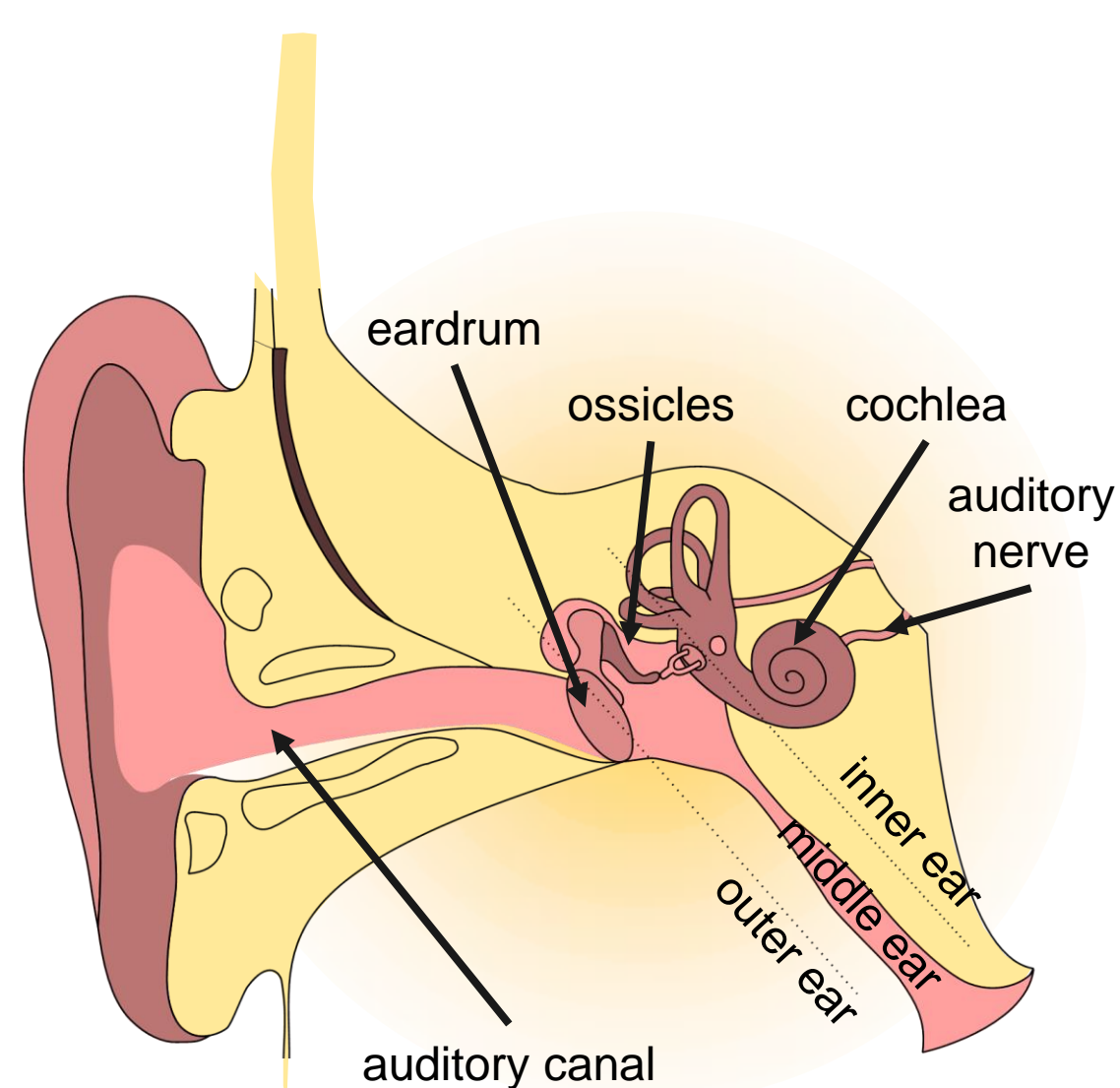
Cochlear implant surgery planning requires careful segmentation of middle and inner ear anatomical structures. This process is complex and challenging on CT images because small structures are partially visible. High resolution μ CT images are accurate enough for providing the missing information. Atlases based on manually segmented micro CT images are registered to CT, generating a probability map (work in progress). Segmentation of partially visible anatomy can be performed using shape prior.

MOTIVATIONS

A cochlear implant (CI) is a prosthetic device restoring hearing by direct electrical stimulation of the auditory nerve. In CI surgery an electrode array is inserted in one of the internal cavities of the cochlea. The operating field contains highly sensitive structures such as the facial nerve and the chorda tympani.

The intra-operative visibility is limited and surgeons access the cochlea blind to the intra-cochlear cavities. Pre-operative CT scans are used to localize high-risk structures and adjust the drilling trajectory.

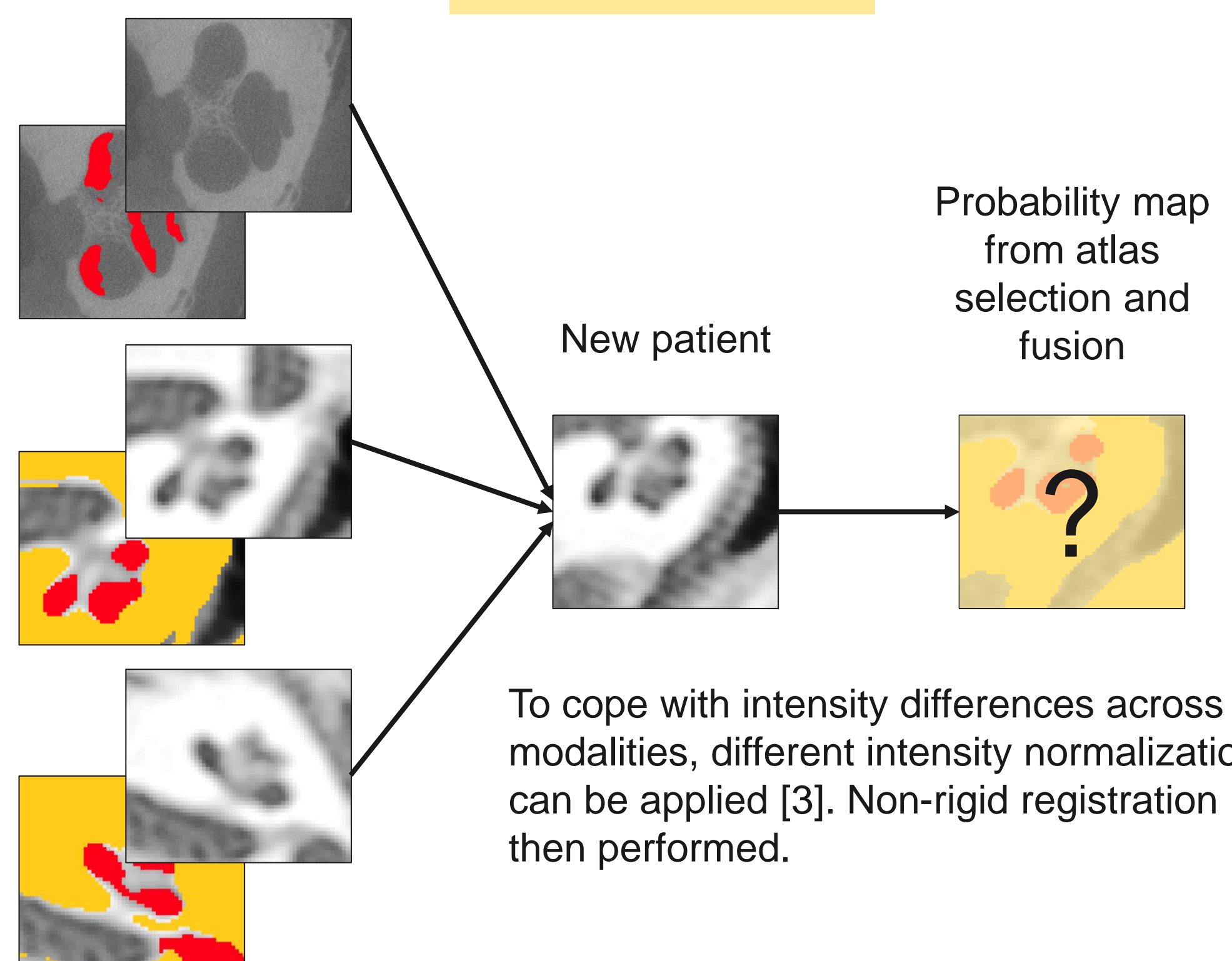
For planning CI surgery, an accurate segmentation of the risk structures in the middle and inner ear is essential.



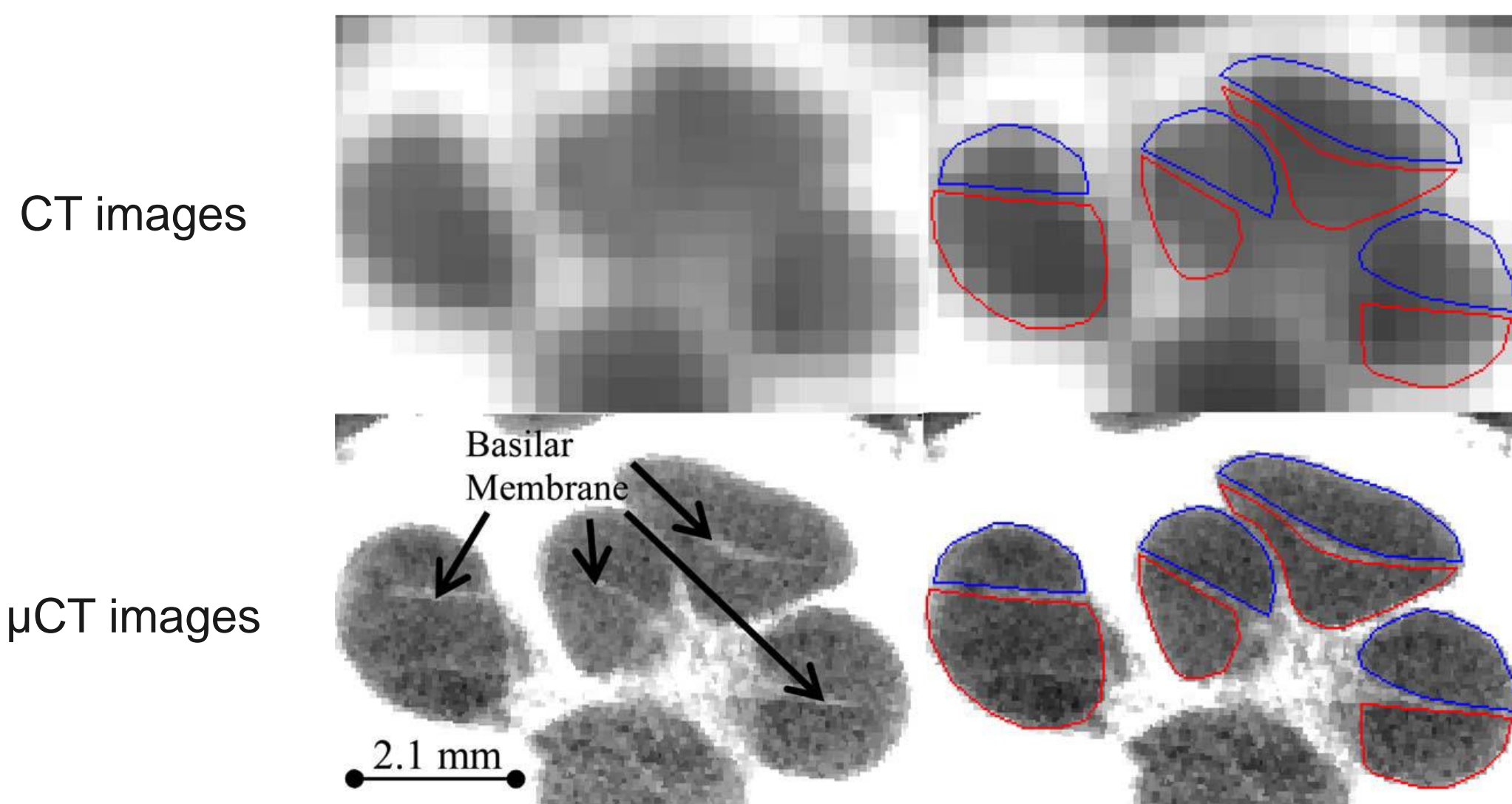
MULTI-ATLAS ACROSS MODALITIES

Atlases (with CT and μ CT data)

work in progress



NEED FOR A PRIORI KNOWLEDGE



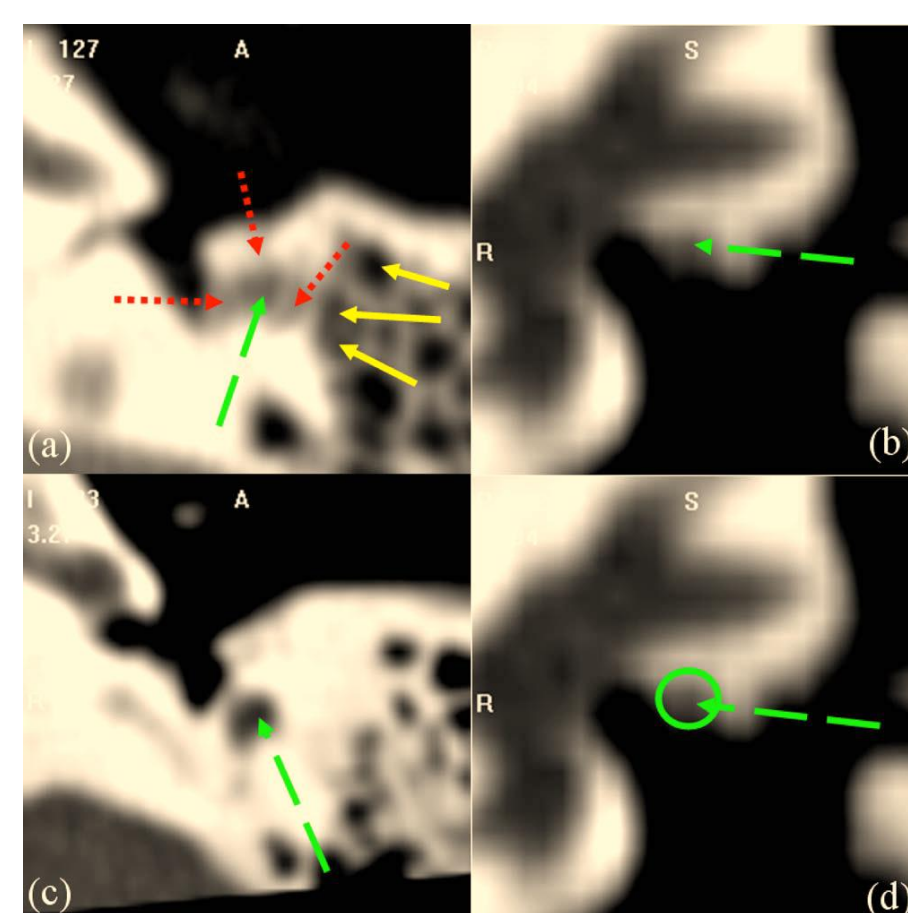
↑ The two principal intra-cochlear cavities are the scala tympani (delineated in red) and scala vestibuli (delineated in blue) [1]. Information available in CT is insufficient for automatic identification.

Facial nerve (dashed green arrow) is partially visible on CT [2]. →

Anatomical structures are very small with complex shapes (shell-like spiral of cochlear anatomy) and different topology types (nerves, canals, membranes).

Structures of interest have low contrast and vary in appearance.

Therefore, a priori knowledge is needed which is why we apply multi-atlas segmentation based on both CT and μ CT.

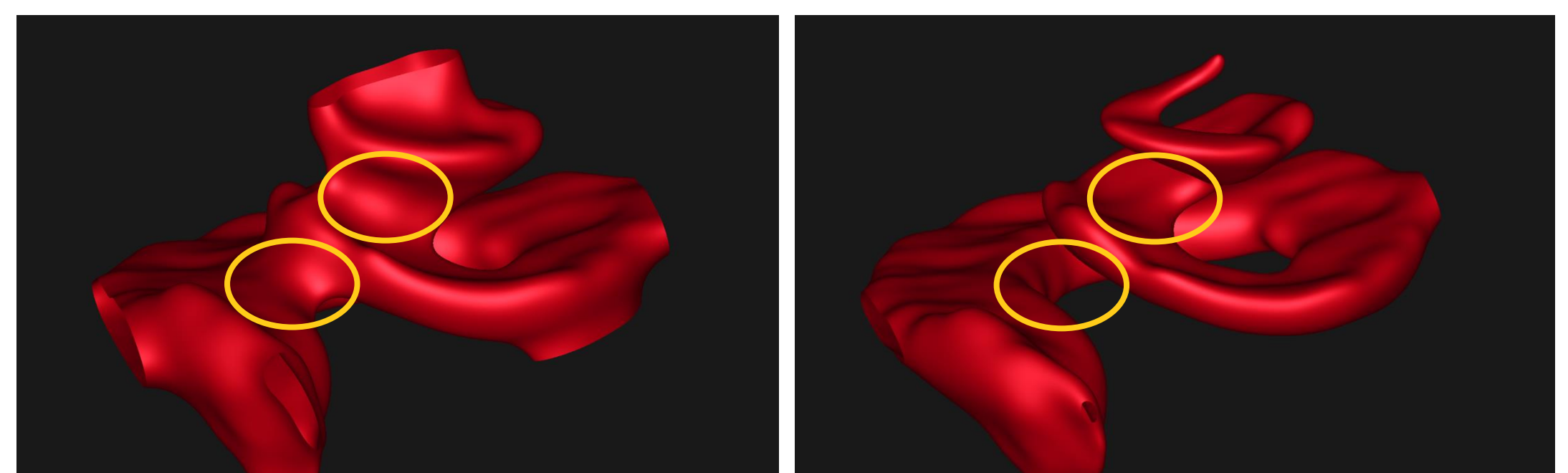


EXPECTED RESULTS

Multi-atlas segmentation may produce topology preservation violations. We plan to integrate prior knowledge [4].

Loss of topology preservation

Segmentation with constrained shape



REFERENCES

- [1] Noble et al., *Automatic segmentation of intra-cochlear anatomy in conventional CT*. IEEE Trans. Biomed. Eng. 2011.
- [2] Noble et al., *Automatic segmentation of the facial nerve and chorda tympani in CT images using spatially dependent feature values*. Med. Phys. 2008.
- [3] Iglesias et al., *A generative model for multi-atlas segmentation across modalities*. Biomed. Imaging (ISBI). 2012.
- [4] Eslami et al., *Segmentation by retrieval with guided random walks: application to left ventricle segmentation in MRI*. Med. Image Anal. 2013.