Medical Image Processing

Structures Segmentation In CT Scans

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Introduction

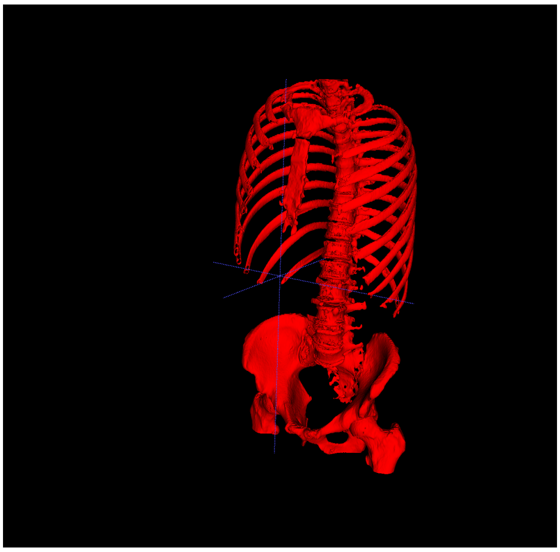
In this exercise I experimented analyzing CT scans for the first time. It was extremely interesting and I learned a lot! Unfortunately, having been sick part of the week, I had to race against the time to submit on this time. I hope you can excuse the small delay.

Part 1 - Skeleton Threshold Segmentation

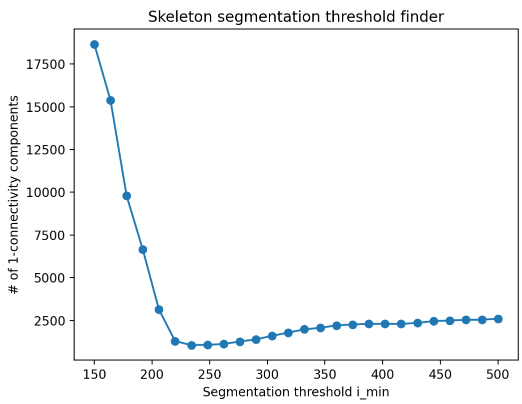
The following table shows segmentation models resulting from running
`SegmentationByTH(nifti_path, Imin, Imax)`
and `SkeletonTHFinder(nifti_path, connectivity=1)`
on CT scans 1-5

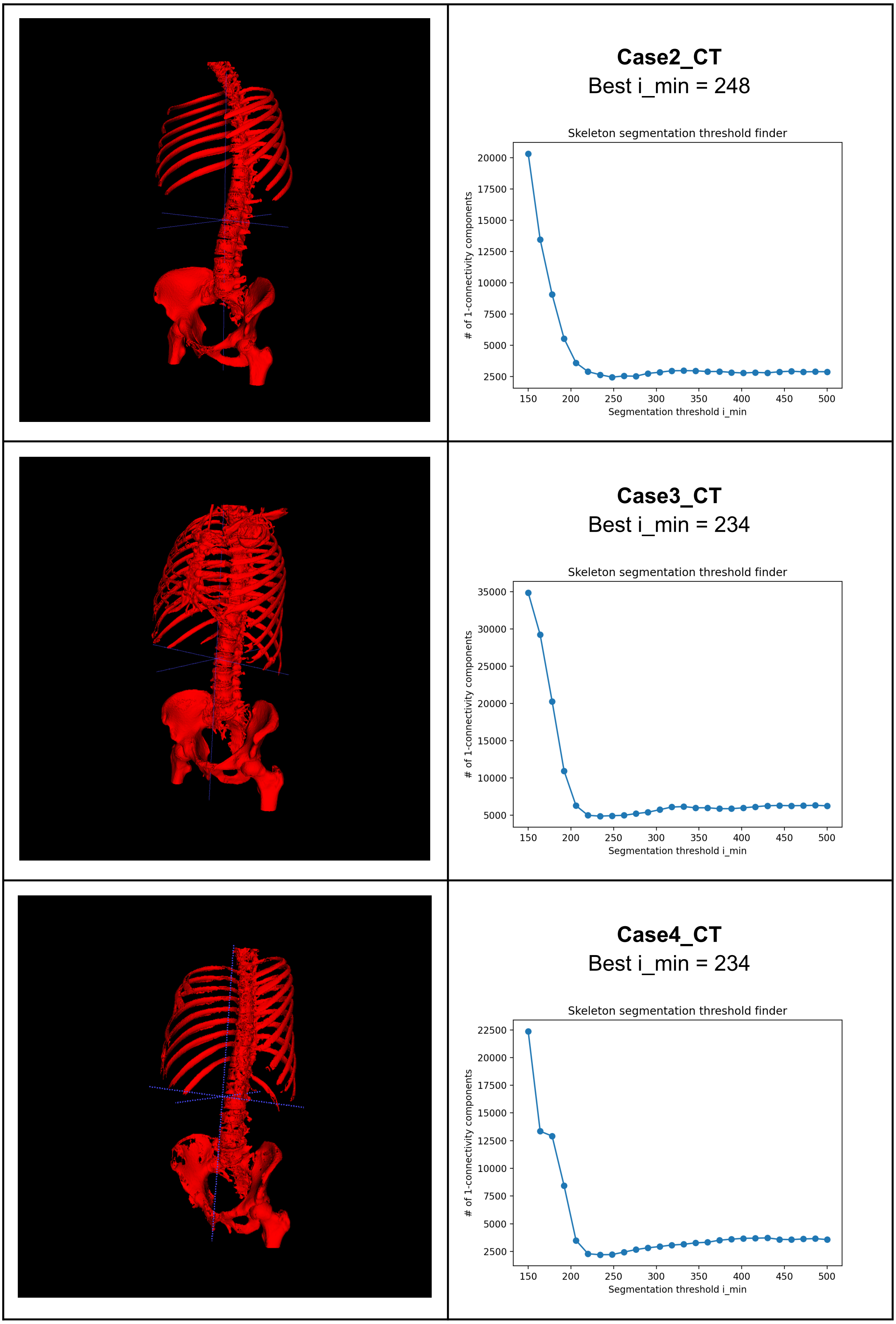
As you can see in the plots, the ideal minimum threshold value to get good segmentation varies between different CT scans, and moves between [234,276].

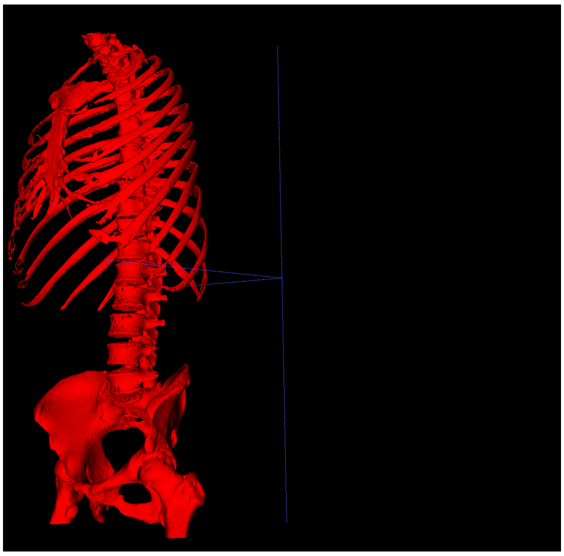
Implementing this part was pretty straightforward. The full code is available at
`bone_segmentation.py`



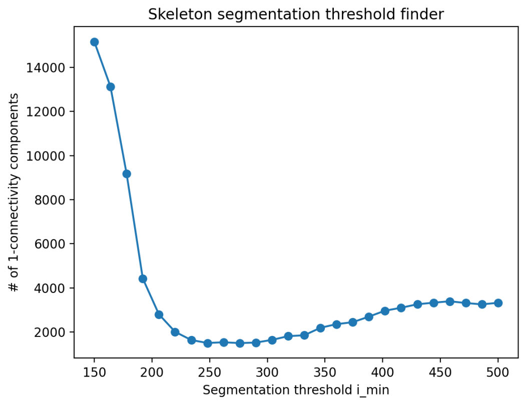
Case1_CT
Best i_min = 234




Case2_CT
Best i_min = 248
Skeleton segmentation threshold finder
# of 1-connectivity components
Segmentation threshold i_min
Case3_CT
Best i_min = 234
Skeleton segmentation threshold finder
# of 1-connectivity components
Segmentation threshold i_min
Case4_CT
Best i_min = 234
Skeleton segmentation threshold finder
# of 1-connectivity components
Segmentation threshold i_min



Case5_CT
Best i_min = 276



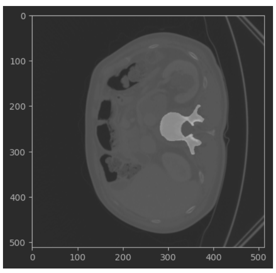
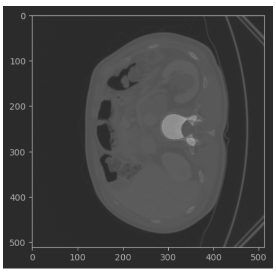
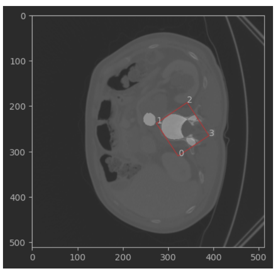
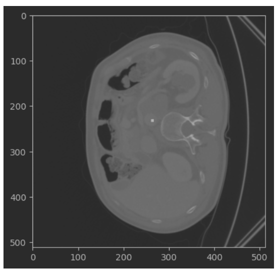
Part 2 - Aorta Segmentation in Contrast CT

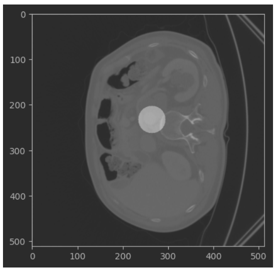
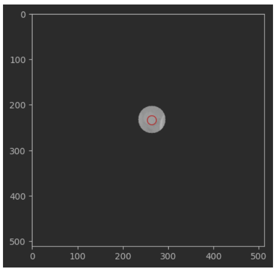
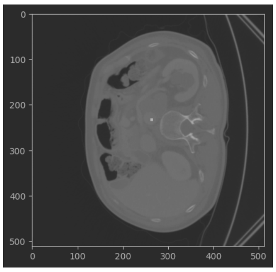
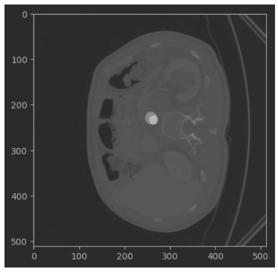
This part was a lot more interesting, as I had to come up with my own algorithm for the segmentation of the Aorta.

After exploring some scans via ITK Snap (screenshots below), I learnt that the aorta is somewhat of a vertical pipe, usually seen from the top plane as a circle, sitting next to the leftmost point of the widest layer of L1.

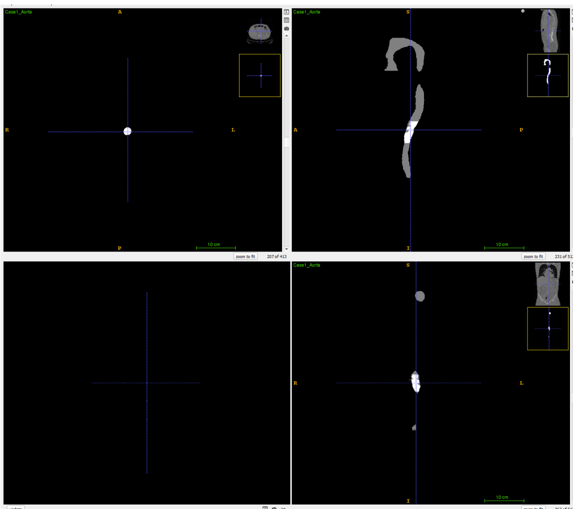
I assumed that if I was able to track down a single layer of the Aorta, I will be able to follow it up and down the stack.

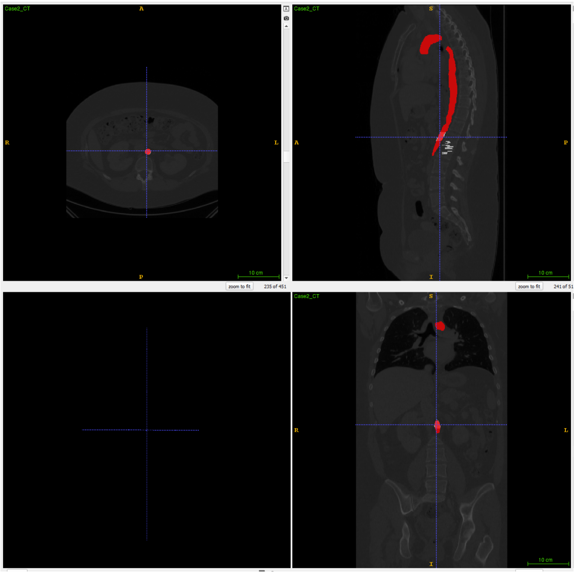
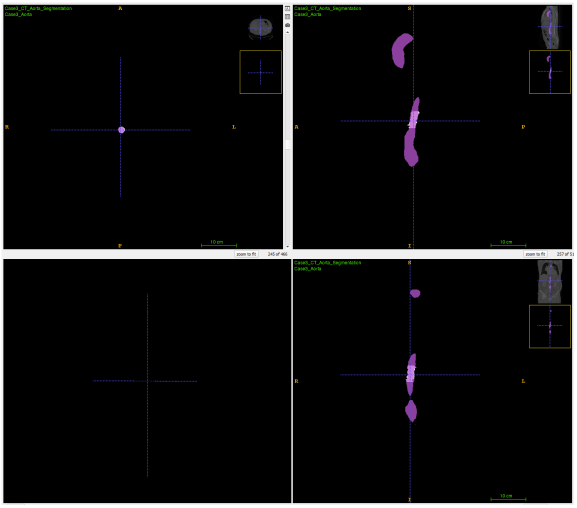
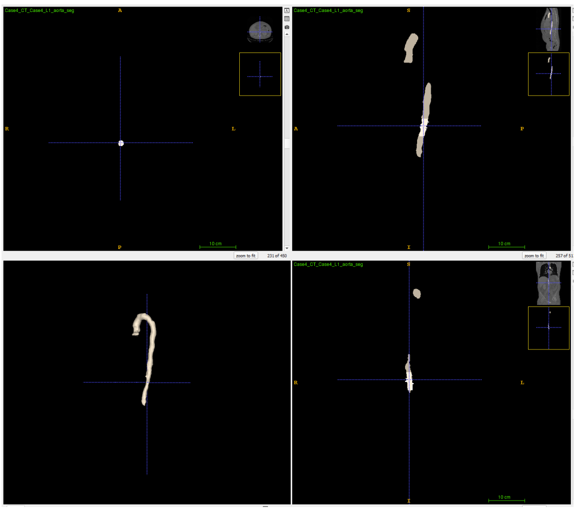
So my algorithm works as follows:

(1)	(2)	(3)	(4)
			
Find the L1 layer with widest area to get a starting point that is **invariant to different scans**	Smooth and threshold to remove pointy edges before bounding	Create maximal bounding box, corner #1 is **always very close to the aorta**	Take a fixed step towards a “**key position**” which is almost surely in the aorta

(5)	(6)	(7)	(*)
			
Create a circular mask around that point, **the aorta is surely inside and not much else**	In that circular mask, use hough_circle to **find a circle that is closest to the “key position”**	Use the **center of that circle as the “key position”** for the next layer, keep doing steps (5)-(7) over all of the ROI	Here is a comparison between my segmentation of the aorta and the ground truth

After three long nights with not much sleep, and three full days of pretty much nothing but working on this exercise… I was able to make this work! The results are in the table below:

	**Case1_CT** VOD result: 0.2296484540448962 DICE result: 0.8702808746829992

	**Case2_CT** VOD result: 0.8170785851709339 DICE result: 0.3092706117853121
	**Case3_CT** VOD result: 0.22256020278833966 DICE result: 0.8747860810039931
	**Case4_CT** VOD result: 0.29476584022038566 DICE result: 0.827140549273021

As you can see, the DICE score is pretty good in ¾ cases. The VOD score has room for improvement, but for now the best improvement is submitting and finally, getting some sleep.

Thank you for reviewing my submission, and please contact me if you have any questions!
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