Learning Python for Image Segmentation

By Paul McCabe

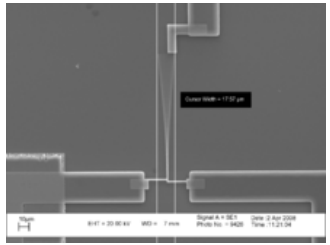
Of note: some slides have GIFs in them that only display in Slide Show mode

Presentation Structure

- Give some background of myself
- Describe the process and results of my lung segmentation approach
- Outline future plans for improved accuracy

My Background

My Background



Academic Background

- Rising Junior (undergraduate)
- Major: Electrical Engineering & Philosophy

Personal Background

- Hometown: Honolulu Hawaii
- Interned at Subaru Telescope last summer

Currently developing my knowledge of machine learning and Biomedical Engineering.

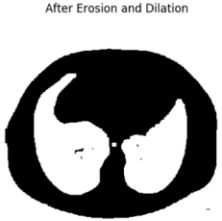
Image Segmentation

Separate Lungs

1. Original

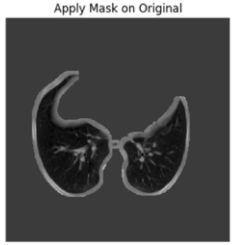
2. Threshold using KMeans

3. Erode + Dilate



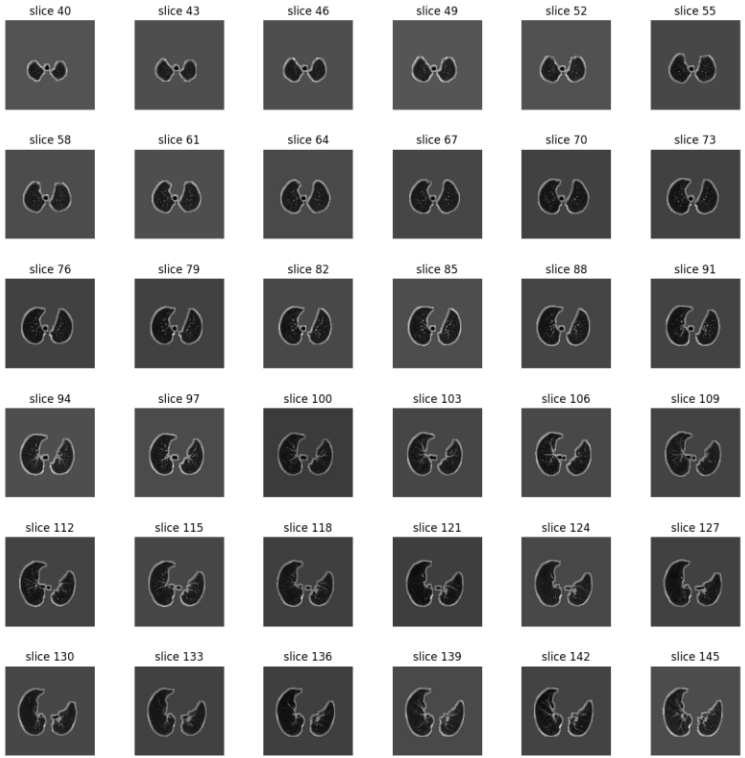
4. Label regions

5. Final Mask



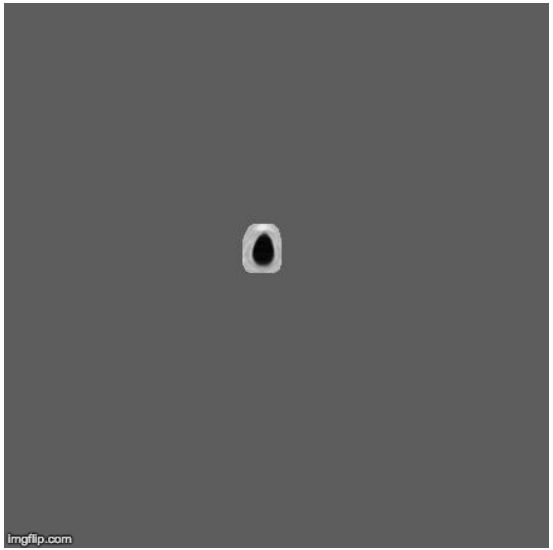
6. Applied Mask

Separate Lungs



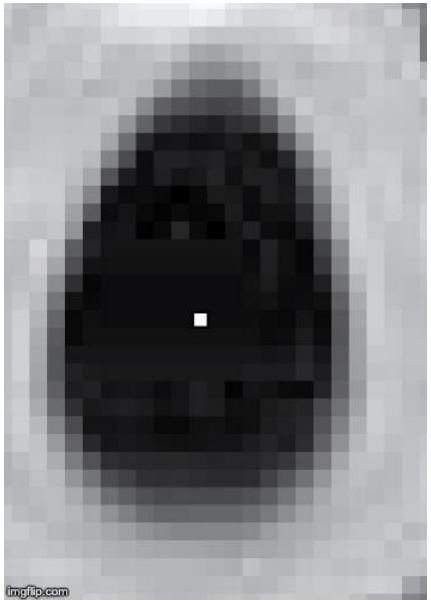
DICOM Processing and Segmentation in Python

Howard Chen, Radiology Data Quest (raddq.com)



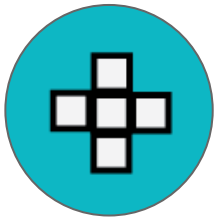
Region Grow Airway

Simple Region Growing of Airway



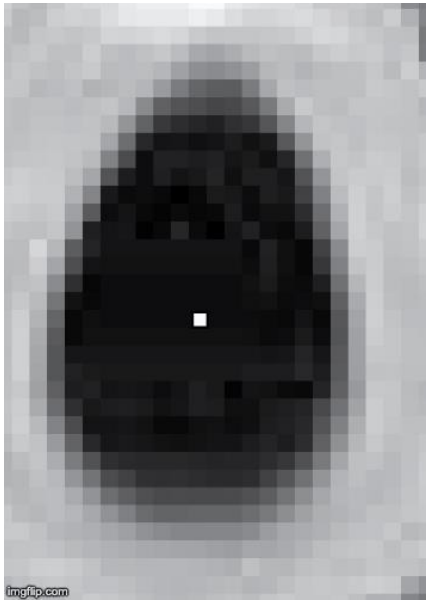
- Seed point is calculated automatically using median position of dark area.

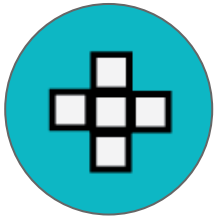
Growing Size: 6 voxels



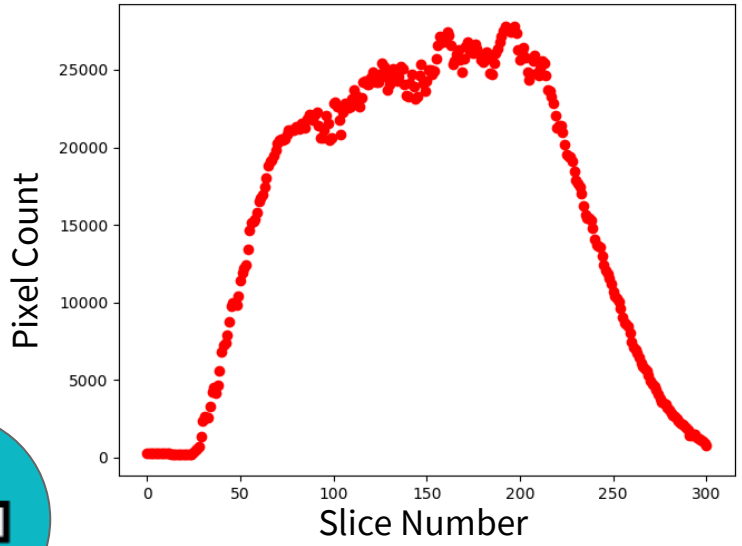
Region Grow Airway

Simple Region Growing of Airway





Leak Alert!



Region Grow Airway

Robust Region Growing Based Intrathoracic Airway Tree Segmentation

Rˆomulo Pinho, Sten Luyckx, and Jan Sijbers
University of Antwerp, Physics Department, VisionLab, Belgium

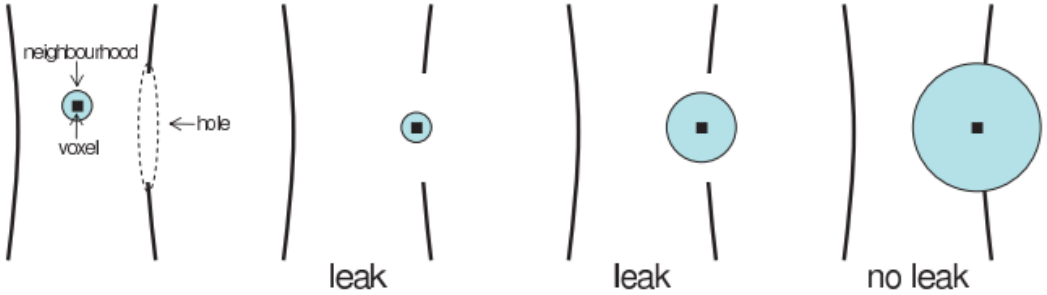
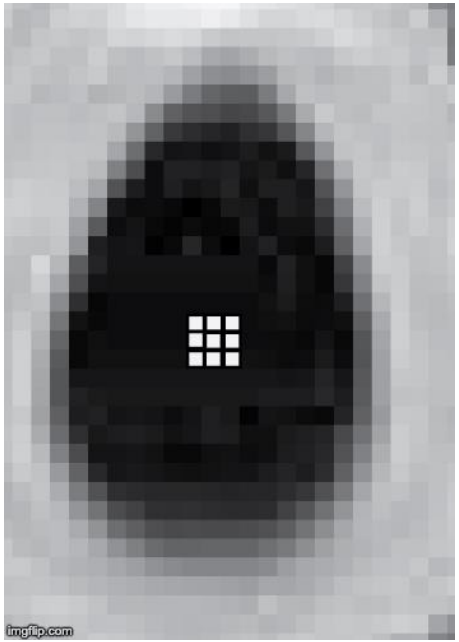


Fig. 1. Avoiding leaks. The segmentation is repeated with an increasing neighbourhood mask until no leaks are detected.

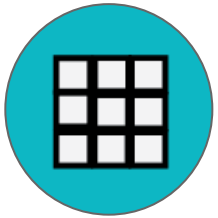
Region Grow Airway

Large Voxel Region Grower



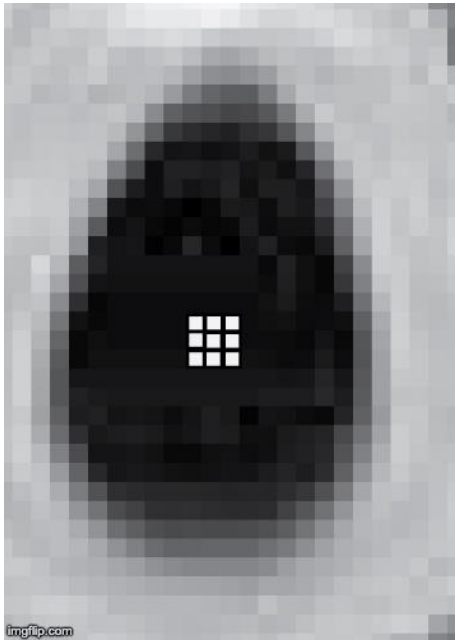
- Voxel will grow depending on how many light pixels are found in it.
- If there are 3 or more light pixels in the large voxel, it will stop growing and move to another large voxel to check.

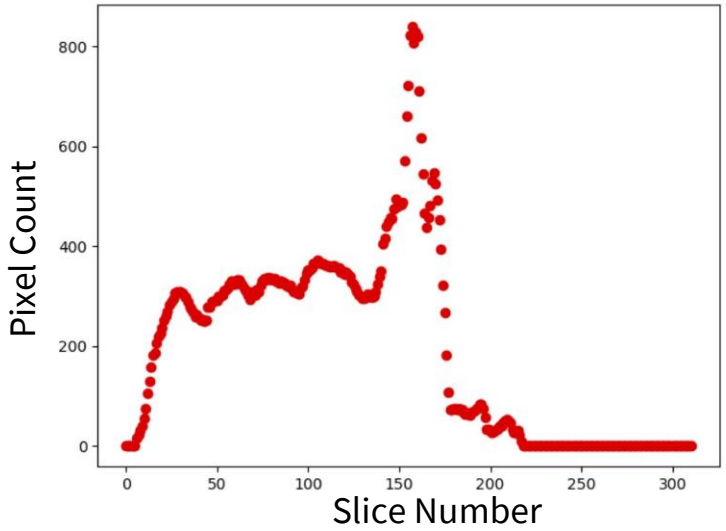
Growing Size: 26 voxels



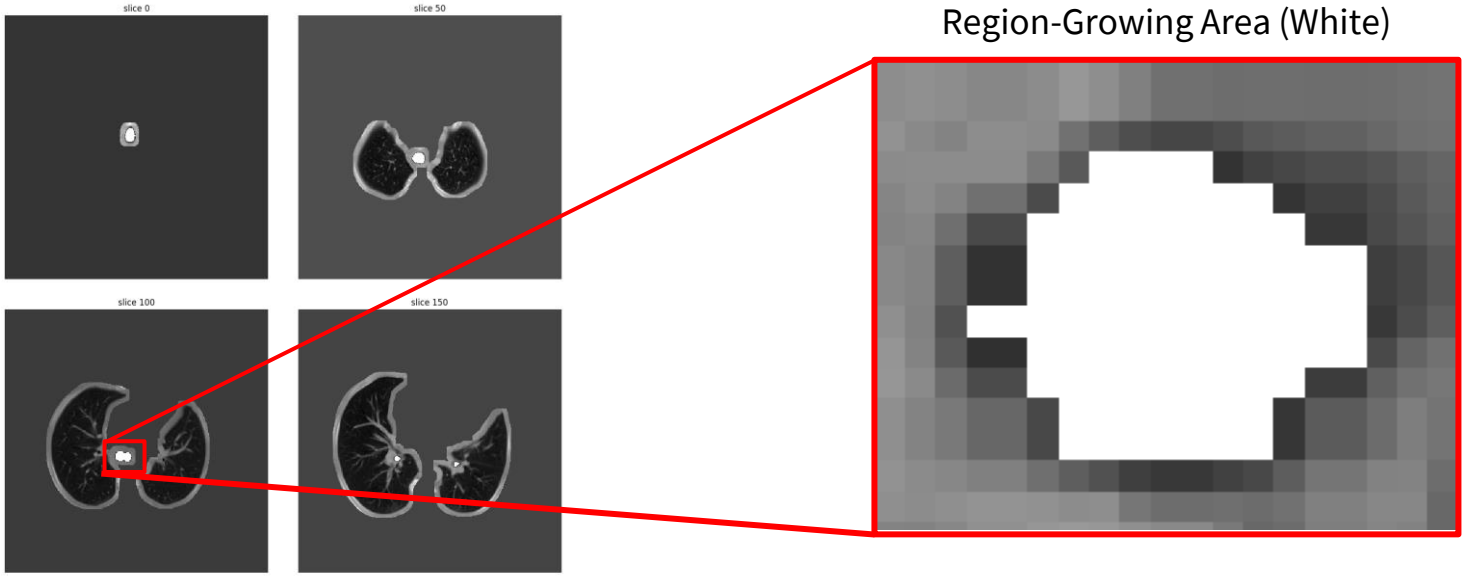
Region Grow Airway

Large Voxel Region Grower





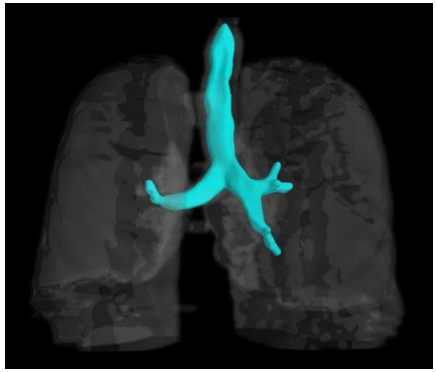
Quality Inspection



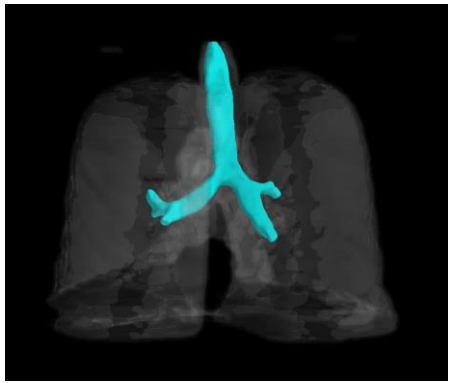
3D Modeling

Patient 1

Patient 2

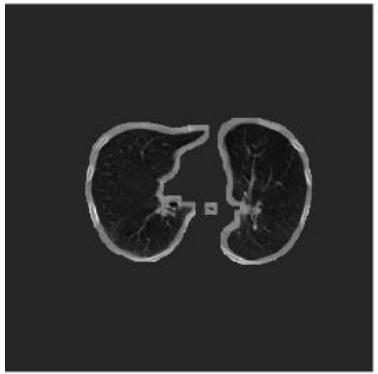


Patient 3

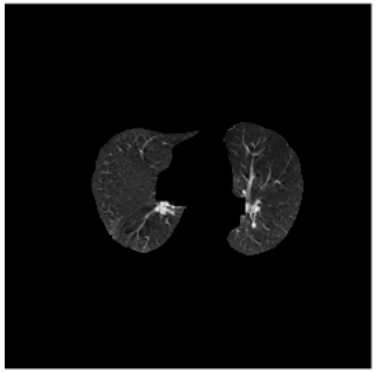


- Meshlab Mayavi with Gaussian smoothing filter
- Surrounding lung structure

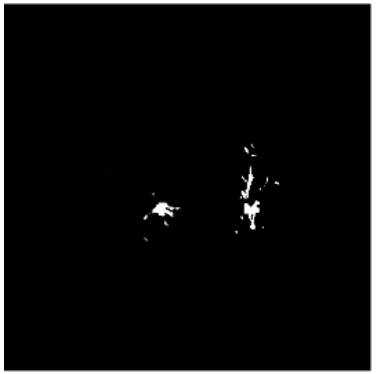
Segment Bronchioles



Lung

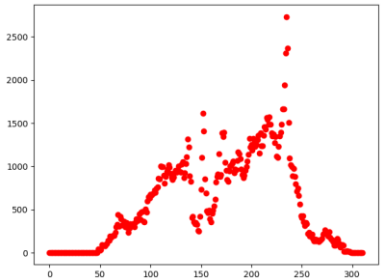


Edges Eroded



Simple Region Grow

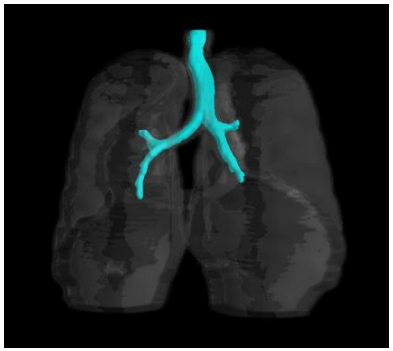
Pixel Count

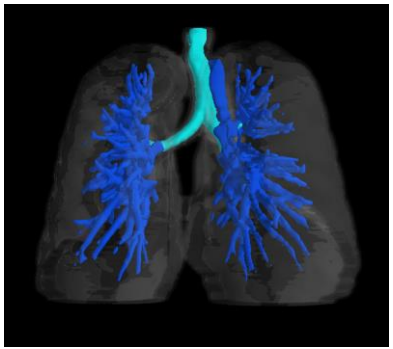


- 1 simple region growing algorithms for each lung
- Find seed point automatically using median position of light area
- If seed point lands on a dark area, retry with different lightness parameters until successful

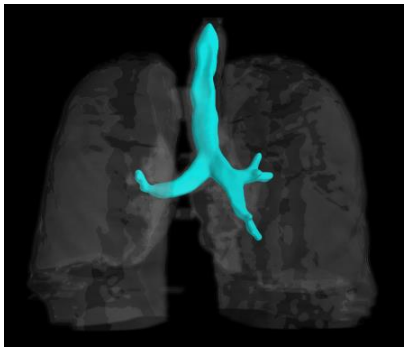
Meshlab Mayavi Modeling

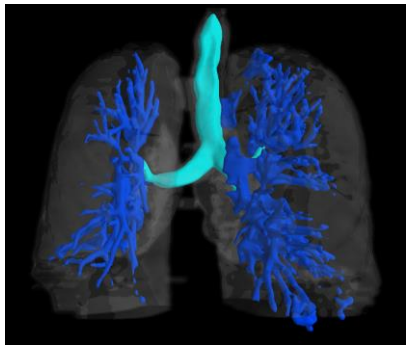
Patient 1



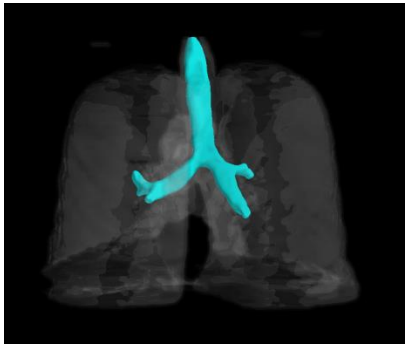


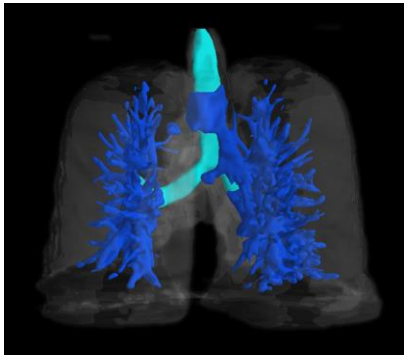
Patient 2





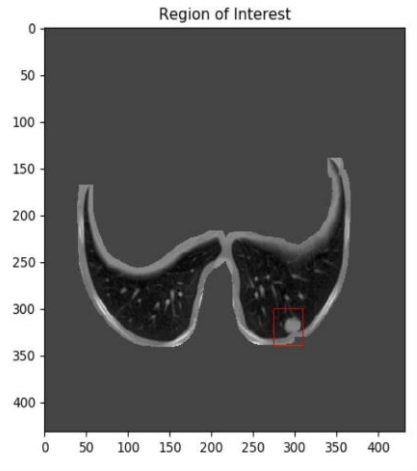
Patient 3





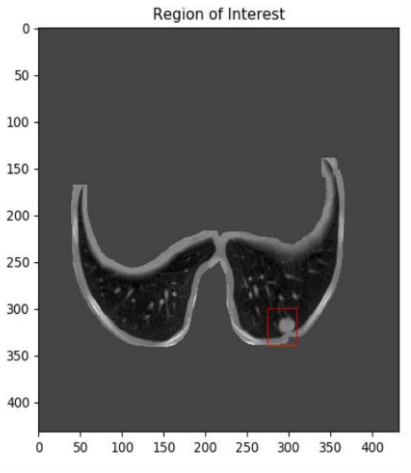
Segment Region of Interest

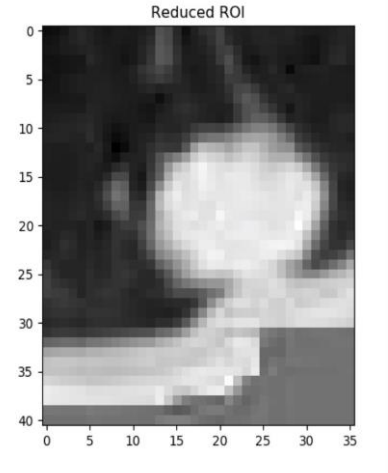
- Input slice number and 2 coordinates to form box (shown in red) of patient 1



Segment Region of Interest

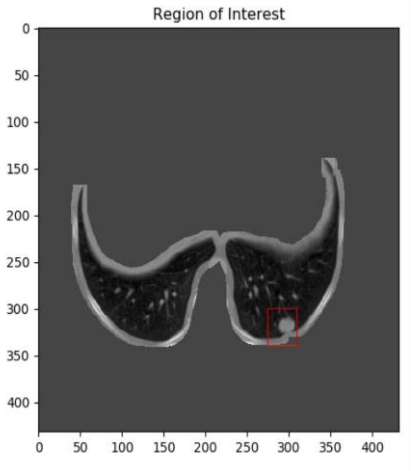
- Input slice number and 2 coordinates to form box (shown in red)

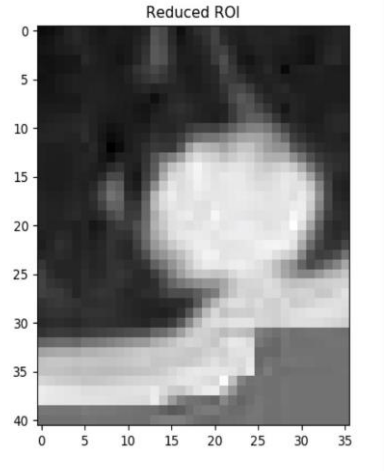


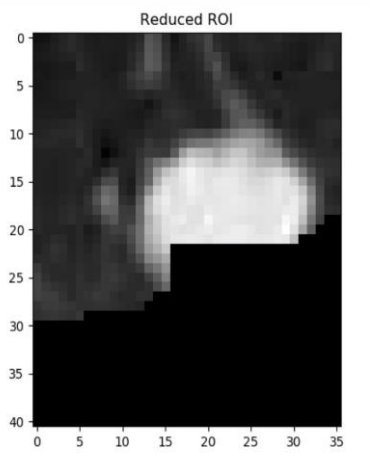


Segment Region of Interest

- Input slice number and 2 coordinates to form box (shown in red)

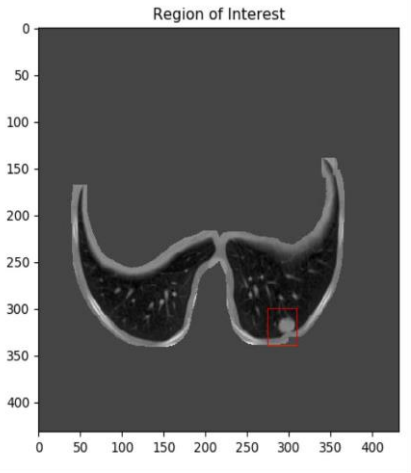


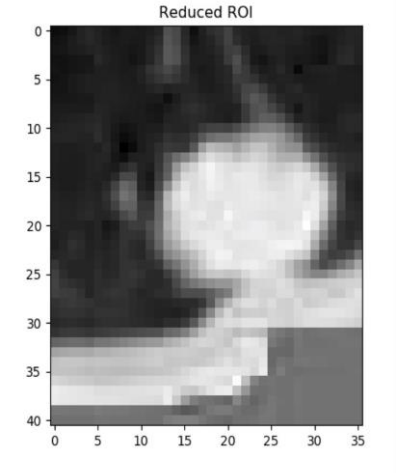


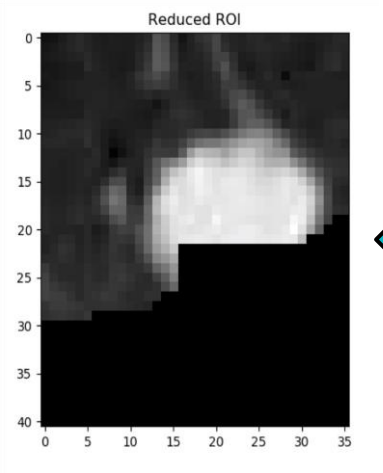


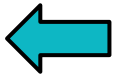
Segment Region of Interest

- Input slice number and 2 coordinates to form box (shown in red)
- When segmenting the lungs, an object that touches the walls of the lung may affect the dilation of the lung mask



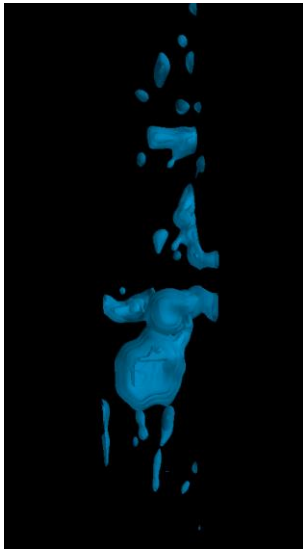






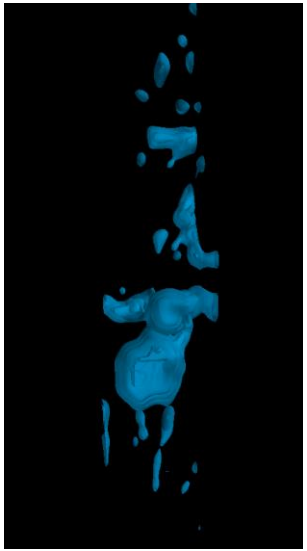
Current Problem

Segment Region of Interest

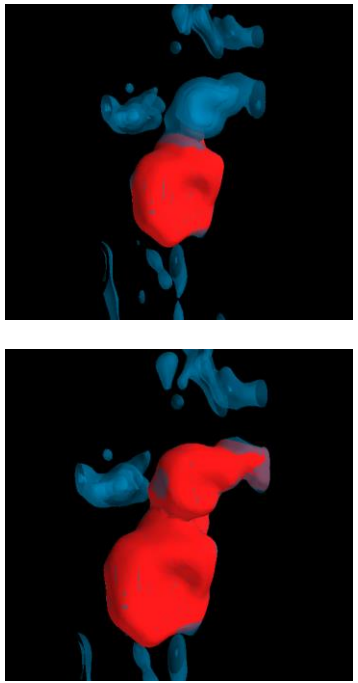


Threshold of ROI

Segment Region of Interest



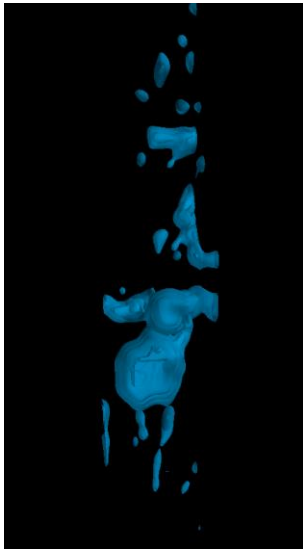
Threshold of ROI



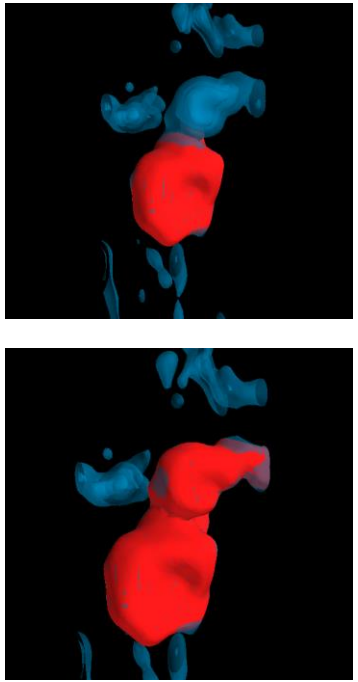
Region Grow

Calibrating large region growing algorithm

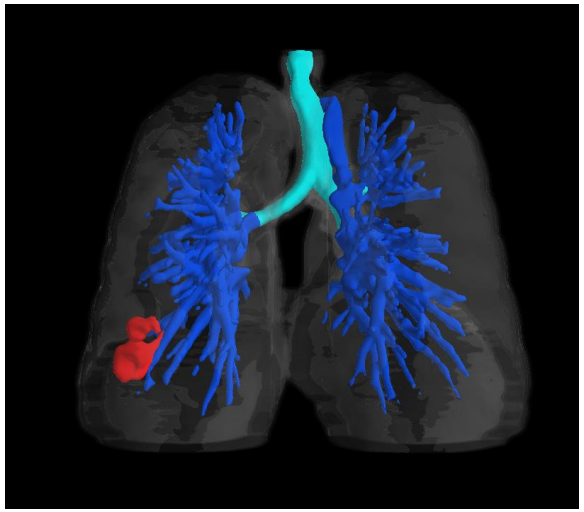
Segment Region of Interest



Threshold of ROI



Region Grow



Modeled with Lungs

Future Strategy

Future Steps

- Improve quality of region growing algorithm. (Use Hounsfield units)
- Properly separate objects that are close to the walls of the lung. Rolling ball algorithm or others
- Begin machine vision approach for automatically defining regions of interest

Image Sources and Citations

1. Clark K, Vendt B, Smith K, et al. The Cancer Imaging Archive (TCIA): Maintaining and Operating a Public Information Repository. *Journal of Digital Imaging*. 2013; 26(6): 1045-1057. doi: 10.1007/s10278-013-9622-7.
2. Chen Howard, Radiology Data Quest, https://www.raddq.com/dicom-processing-segmentation-visualization-in-python/
3. Ramadan, Zayed M. “Optimum Image Filters for Various Types of Noise.” *Telkomnika*, vol. 16, no. 5, Oct. 2018, pp. 2458–2464. *EBSCOhost*, doi:10.12928/TELKOMNIKA.v16i5.10508.
4. Rˆomulo Pinho, Sten Luyckx, and Jan Sijbers, Robust Region Growing Based Intrathoracic Airway Tree Segmentation, University of Antwerp, Physics Department, VisionLab, Belgium
5. https://en.wikipedia.org/wiki/Microelectromechanical_systems
6. https://case.edu/emails/engineering/SDLE_Grand_Opening.html
7. https://www.bandsintown.com/e/17356503-time-cat-at-wruw-fm-91.1

Thank you for your time

Extra slides

My Background

Coding Background

- Recently revisited Java for a personal project: *Pixelated Impressionism*

Airway Segmentation

Pixel count for each slice

- Graph indicates number of pixels counted for each slice
- Observe leaks before 3D plotting

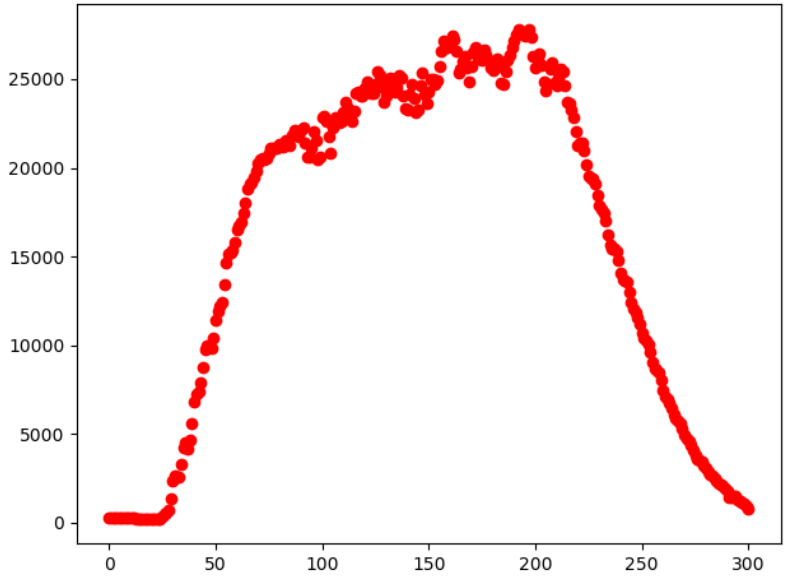
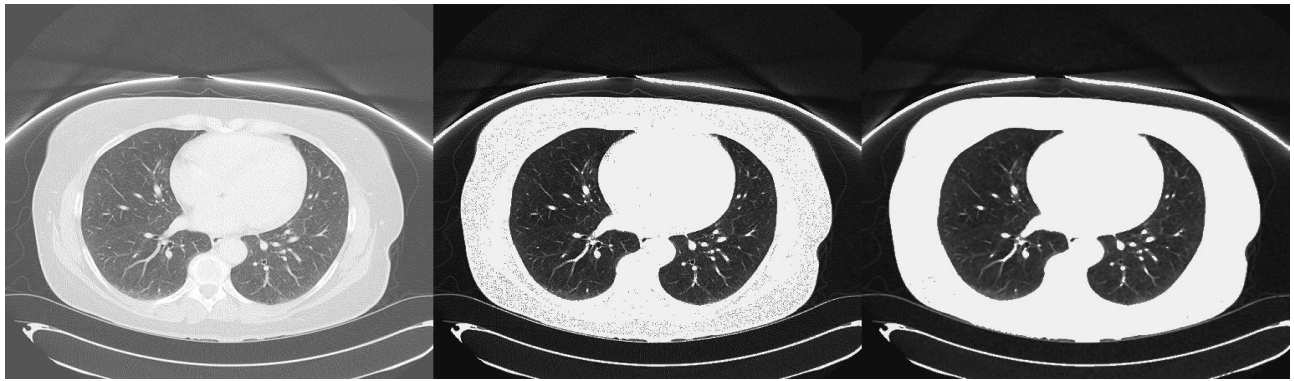


Image Processing: Filtering Images

Optimum Image Filters for Various Types of Noise." *Telkomnika*, vol. 16, no. 5, Oct. 2018

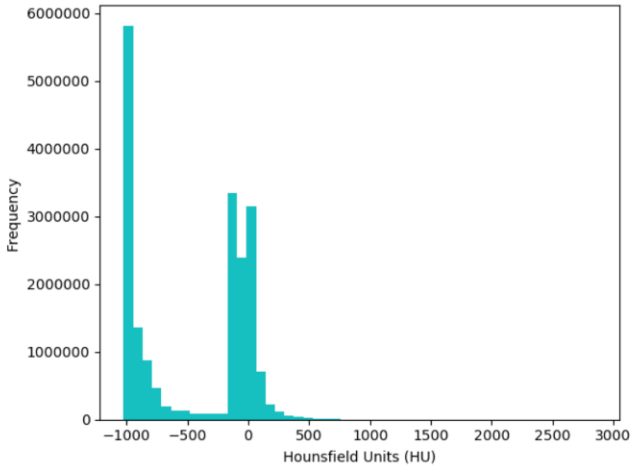


Original ⇨ Pointwise Transformation ⇨ Median Filter

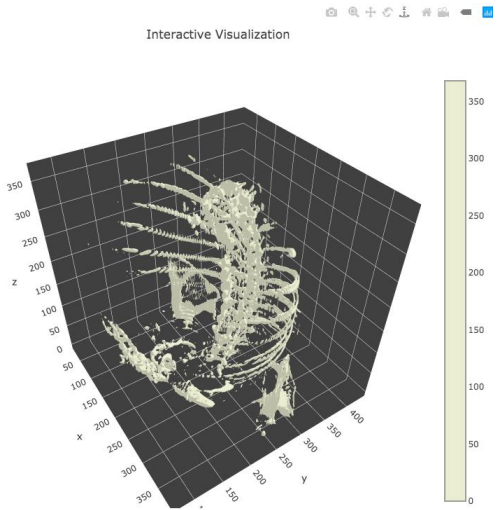
- Gaussian Noise
- Speckle Noise
- Salt and Pepper Noise
- Poisson Noise

Image Processing: Process DICOM Files

The Cancer Imaging Archive (TCIA)



Histogram



3D-Plot