Assignment 1

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1 Part 1

1.1 Read in and print out all the data fields in a DICOM file (one slice) (5%)

```
Dataset.file_meta -------------------------------
(0002, 0000) File Meta Information Group Length  UL: 192
(0002, 0001) File Meta Information Version       OB: b'\x00\x01'
(0002, 0002) Media Storage SOP Class UID         UI: CT Image Storage
(0002, 0003) Media Storage SOP Instance UID      UI: 1.2.840.113654.2.55.206563254873368745167149365185553492862
(0002, 0010) Transfer Syntax UID                 UI: Explicit VR Little Endian
(0002, 0012) Implementation Class UID            UI: 1.2.40.0.13.1.1.1
(0002, 0013) Implementation Version Name         SH: 'dcm4che-1.4.31'
-------------------------------------------------
(0008, 0005) Specific Character Set              CS: 'ISO_IR 100'
(0008, 0016) SOP Class UID                       UI: CT Image Storage
(0008, 0018) SOP Instance UID                    UI: 1.2.840.113654.2.55.206563254873368745167149365185553492862
(0008, 0060) Modality                            CS: 'CT'
(0008, 103e) Series Description                  LO: 'Axial'
(0010, 0010) Patient's Name                      PN: '0d2fcf787026fece4e57be167d079383'
(0010, 0020) Patient ID                          LO: '0d2fcf787026fece4e57be167d079383'
(0010, 0030) Patient's Birth Date                DA: '19000101'
(0018, 0060) KVP                                 DS: None
(0020, 000d) Study Instance UID                  UI: 2.25.55797810939388194553373326123568654411985494567770299008361
(0020, 000e) Series Instance UID                 UI: 2.25.15200922581817473266127247637135465360164236266725699045691
(0020, 0011) Series Number                       IS: "2"
(0020, 0012) Acquisition Number                  IS: "1"
(0020, 0013) Instance Number                     IS: "12"
(0020, 0020) Patient Orientation                 CS: ''
(0020, 0032) Image Position (Patient)            DS: [-157.600006, -137.300003, -37.980000]
(0020, 0037) Image Orientation (Patient)         DS: [1.000000, 0.000000, 0.000000, 0.000000, 1.000000, 0.000000]
(0020, 0052) Frame of Reference UID              UI: 2.25.16523032769264346778716101133625802339446901194827106322410
```

Figure 1: Data fields of a DICOM file

1.2 Read in the raw data for a CT slice and convert its pixel values into Hounsfield units. Compute the max, min, mean and standard deviation of both images (raw data and Hounsfield units) (5%)

```
raw_max: 4095, raw_min: 1, raw_mean: 895.419533062717, raw_std: 503.49769509990625
hu_max: 3071.0, hu_min: -1023.0, hu_mean: -128.58046693728295, hu_std: 503.49769509990625
```

Figure 2: Data fields of a DICOM file

2 Part 2

In part 1, we read in only one individual slice (a DICOM file). Now we want to read in a 3D volume. (DICOM files in a folder)

2.1 Sort all the slices to make it into correct order. Please explain how do you sort the slices. (10%)

To sort the slices, we need to read all DICOM files of a patient. In DICOM file, there is a filed ***(0020, 0013) Instance Number***, indicated the order.

2.2 Normalize all the pixel from Hounsfield Units to float32 type number between 0.0 to 1.0 and display 25 slices in correct order. (10%)

```python
def img_normalize(img):
    img_max = img.max()
    img_min = img.min()

    normalized_img = (img - img_min) / (img_max - img_min)

    return normalized_img
```

Figure 3: Normalize method.

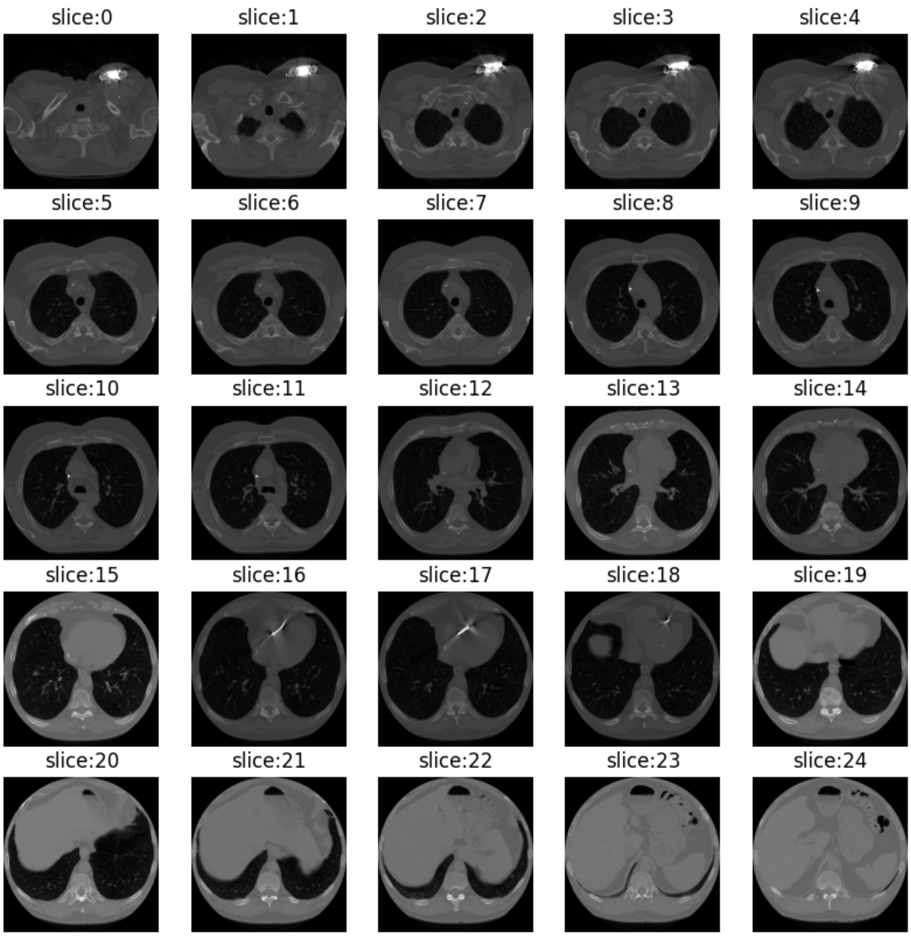

Figure 4: 25 Slices of Normalized CT Scan.

3 Part 3

Now we can try to segment out our lung. We know that lower Hounsfield units correspond to low density materials (like air) and higher Hounsfield units correspond to highly attenuative materials, like bone.

Please try to use at least two different thresholding algorithm to segment the chest.

- Balanced Histogram Thresholding (BHT)

- Local mean
- Local median
- Otsu's method

3.1 Local median

3.1.1 Plot the histogram of your pixels and the threshold. (15%)

In this part, I first draw the frequency histogram without air part. And get the local median via utilizing *numpy.median()* on the slice.

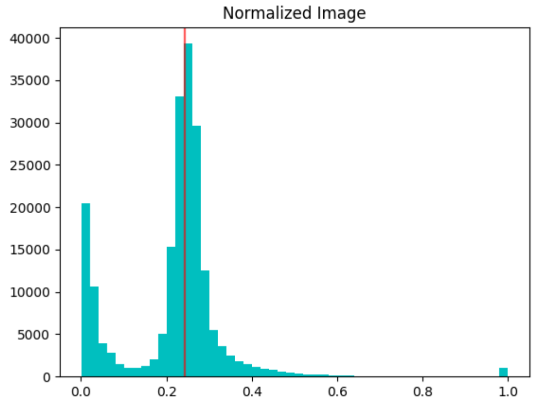

Figure 5: Use local median as a threshold.

3.1.2 Display one CT slice and the corresponded segmentation result. (15%)

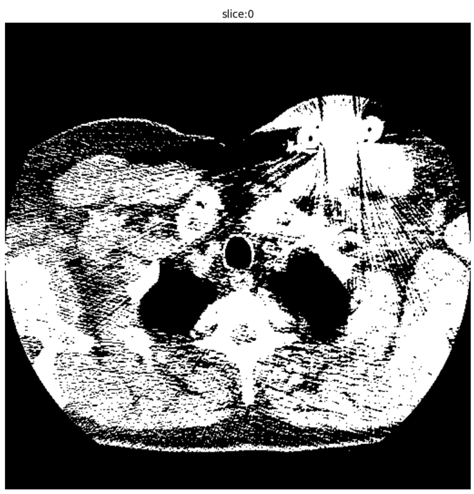

Figure 6: A slice example of after thresholding by local median.

3.2 Local mean

3.2.1 Plot the histogram of your pixels and the threshold. (15%)

Similarly, we can get the local mean via directly calling *ndarray.mean()* on the slice.

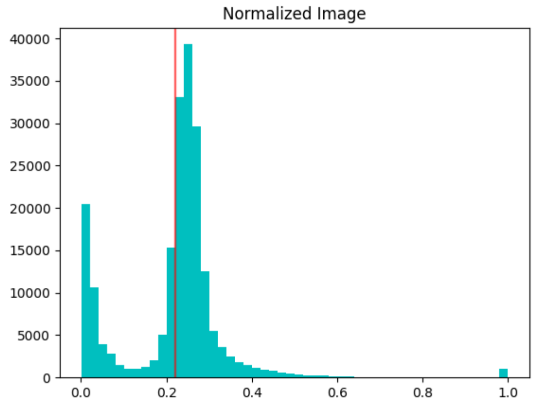

Figure 7: Use local mean as a threshold.

3.2.2 Display one CT slice and the corresponded segmentation result. (15%)

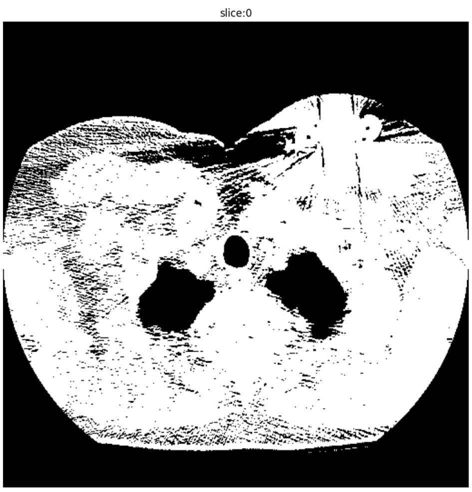

Figure 8: A slice example of after thresholding by local mean.

4 Summary (10%)

In this assignment, I learned how to process *DICOM* file and do the segmentation via different thresholding skills.