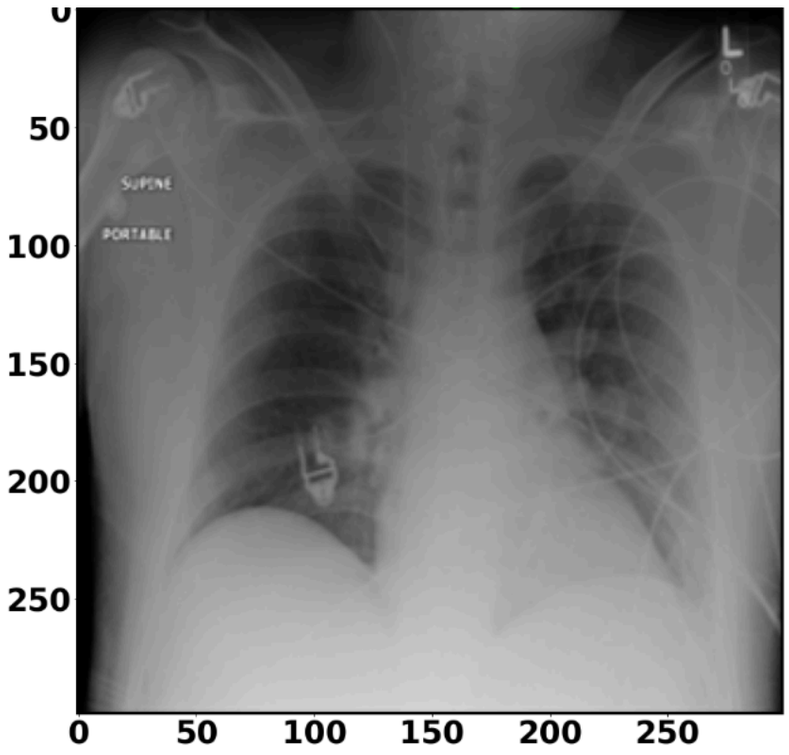
Analysis of radiographic images for pneumonia (COVID-19 and non-COVID-19) detection

Soutick Saha

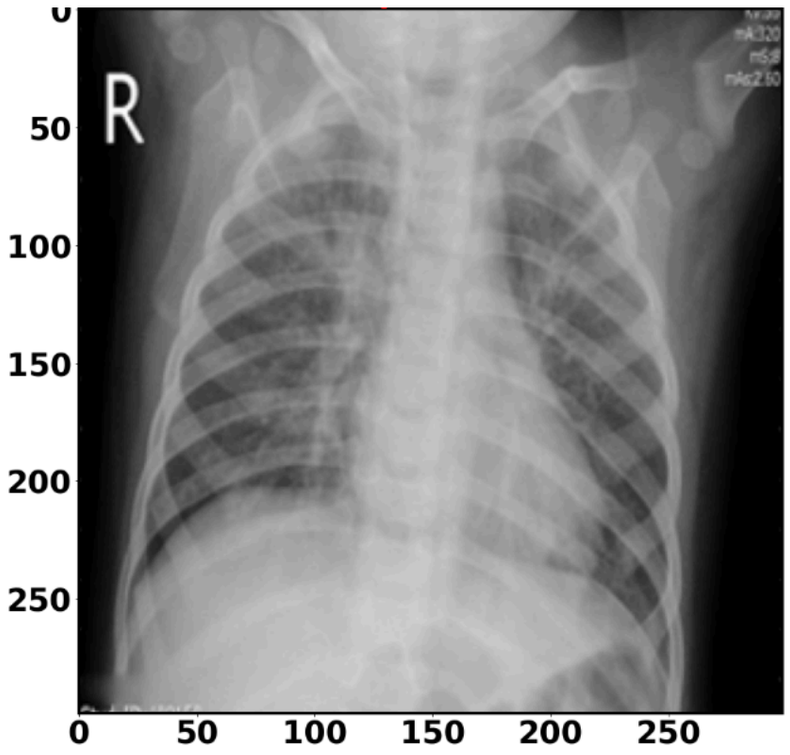
Source dataset - M.E.H. Chowdhury, T. Rahman, A. Khandakar, R. Mazhar, M.A. Kadir, Z.B. Mahbub, K.R. Islam, M.S. Khan, A. Iqbal, N. Al-Emadi, M.B.I. Reaz, M. T. Islam, “Can AI help in screening Viral and COVID-19 pneumonia?” IEEE Access, Vol. 8, 2020, pp. 132665 - 132676.
-Rahman, T., Khandakar, A., Qiblawey, Y., Tahir, A., Kiranyaz, S., Kashem, S.B.A., Islam, M.T., Maadeed, S.A., Zughaier, S.M., Khan, M.S. and Chowdhury, M.E., 2020. Exploring the Effect of Image Enhancement Techniques on COVID-19 Detection using Chest X-ray Images.
Data downloaded from - https://www.kaggle.com/tawsifurrahman/covid19-radiography-database
Code - https://github.com/souticksaha21/Predicting-COVID-19-positivity-from-radiography-images/blob/main/Predicting_COVID_positivity_from_radiography_images.ipynb

Sample radiography images of 3 types

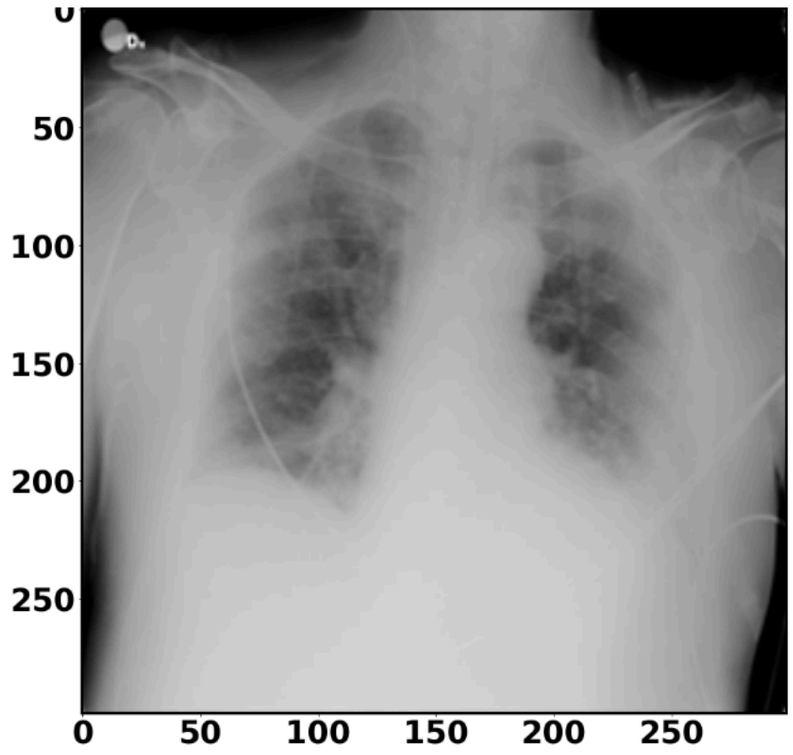
Normal



Viral pneumonia (Non-COVID)

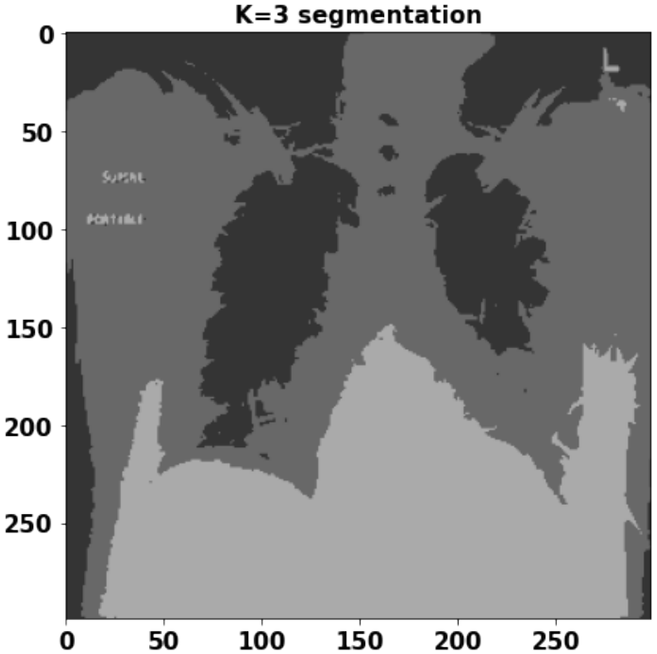


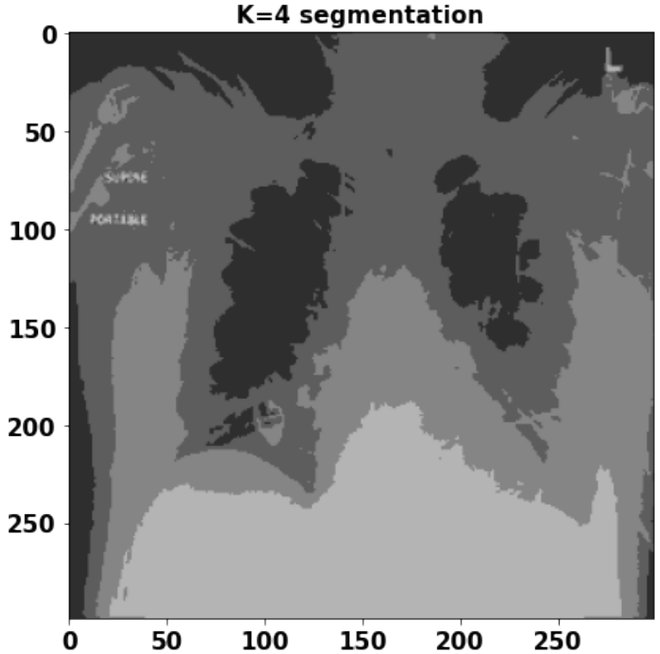
COVID-19



Effect of segmentation using K-means clustering

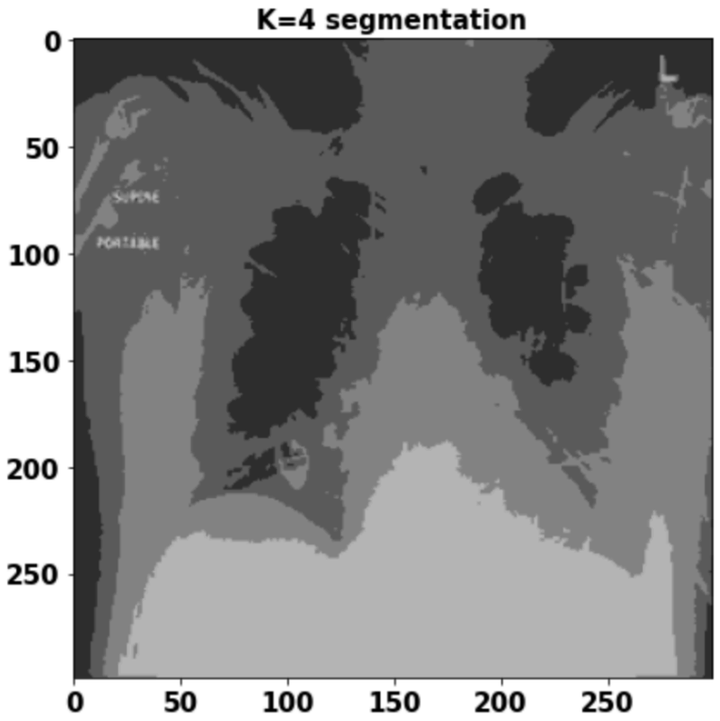
Normal lungs



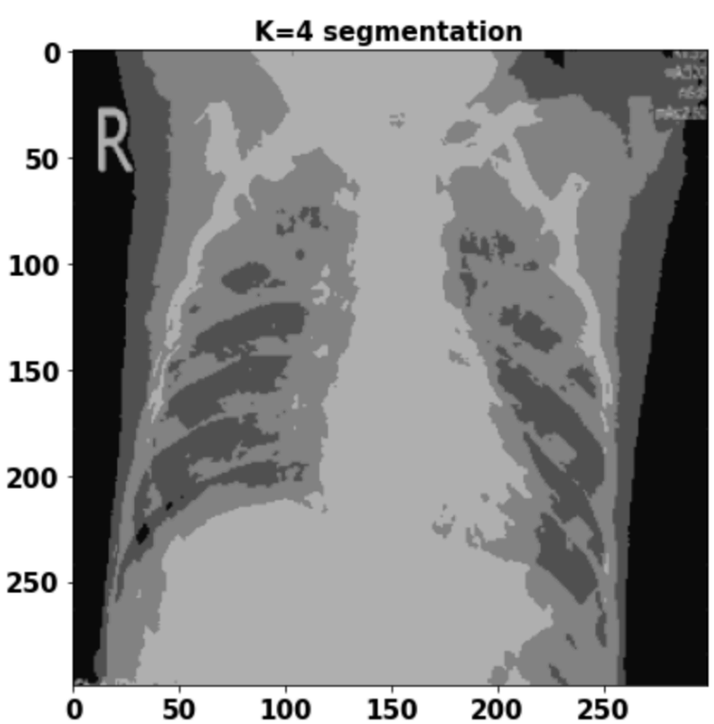


Effect of segmentation using K(=4)-means clustering

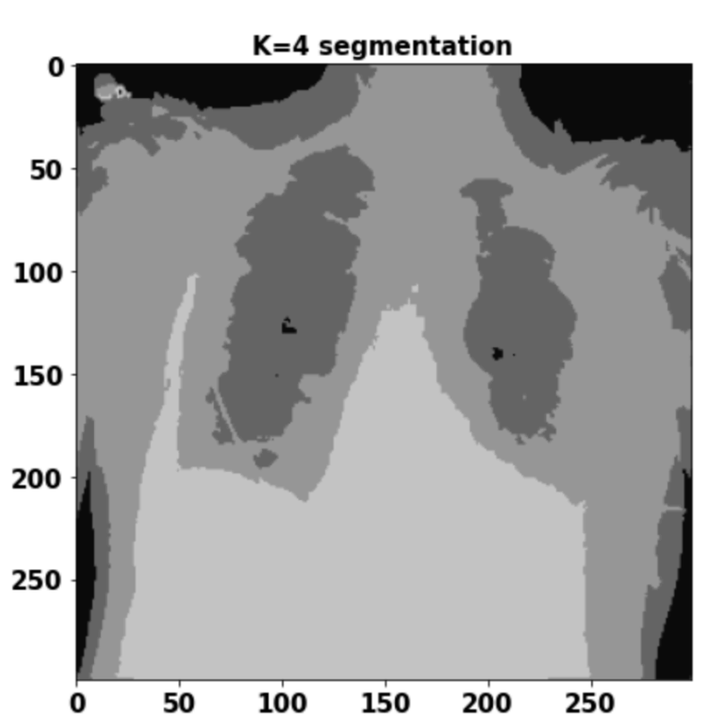
Normal



Viral pneumonia (Non-COVID)

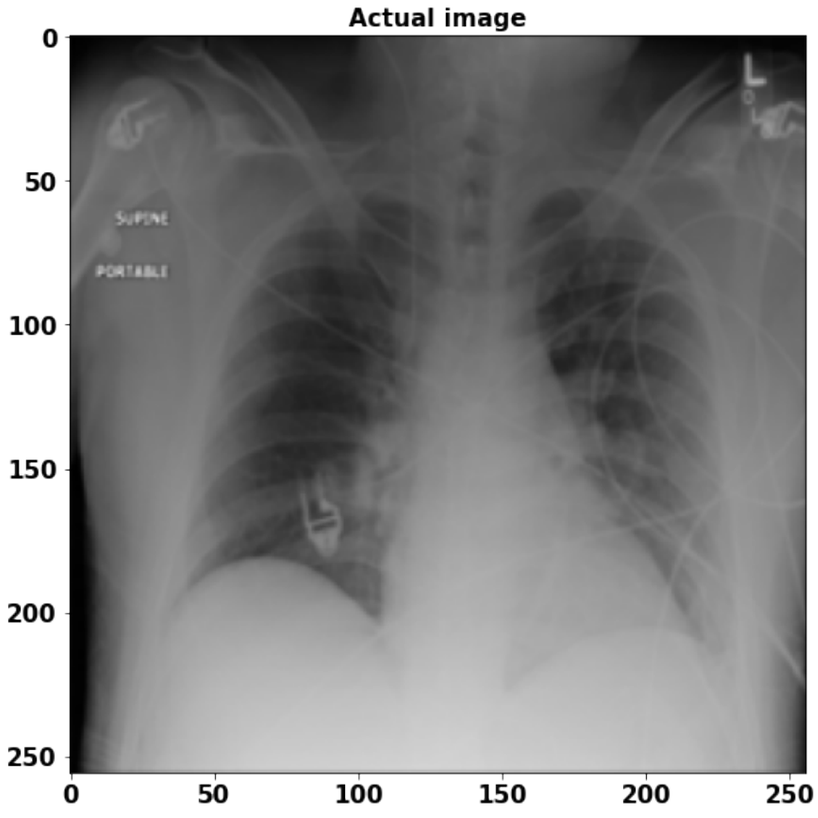


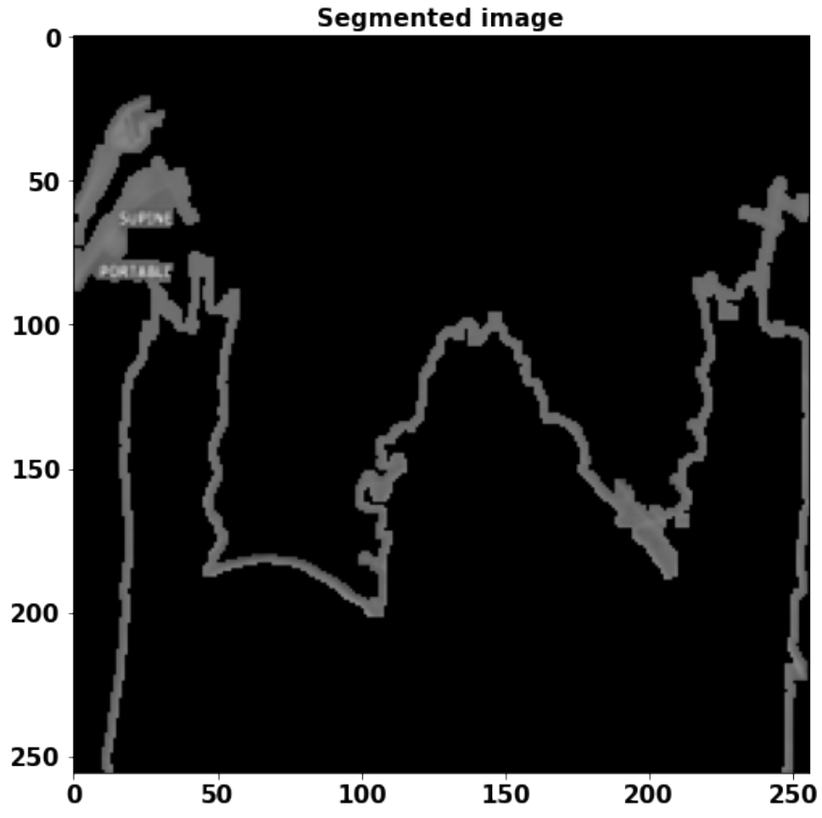
COVID-19



Effect of image segmentation using contour

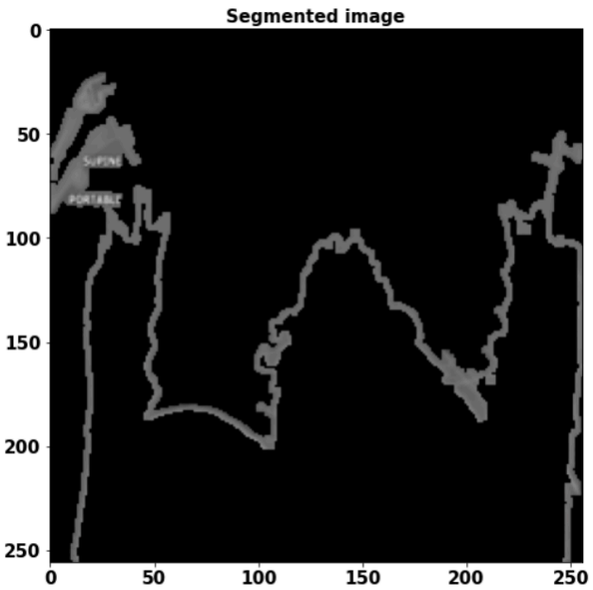
Normal lungs



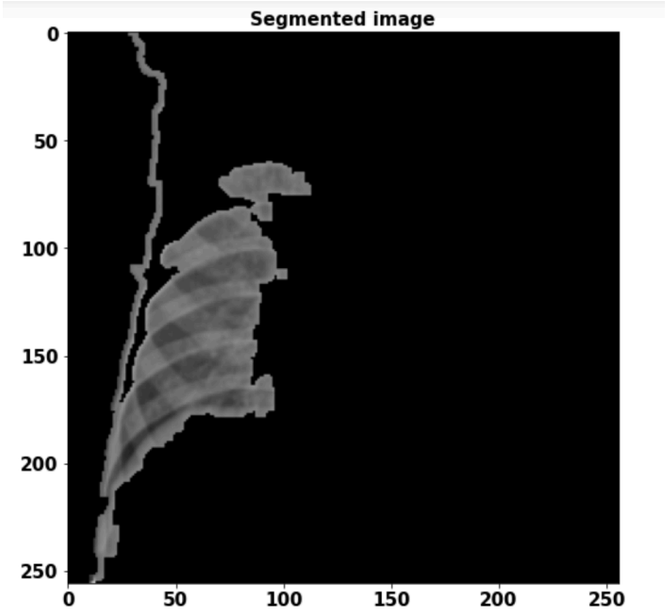


Effect of image segmentation using contour

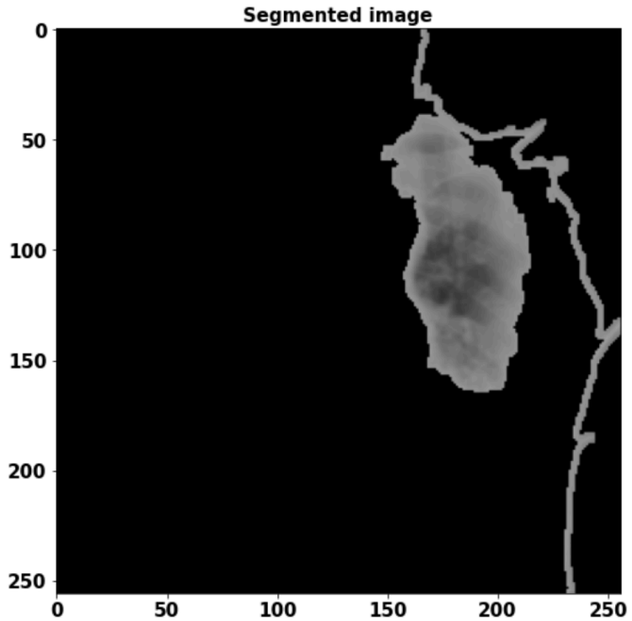
Normal



Viral pneumonia (Non-COVID)

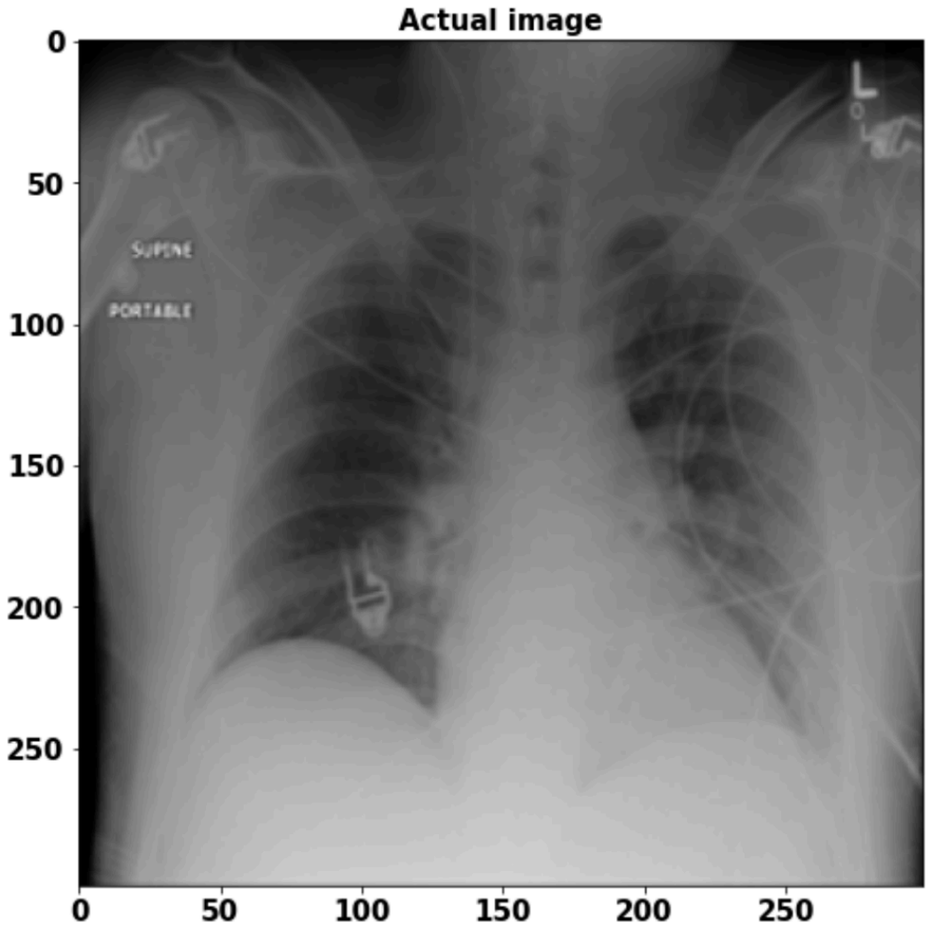


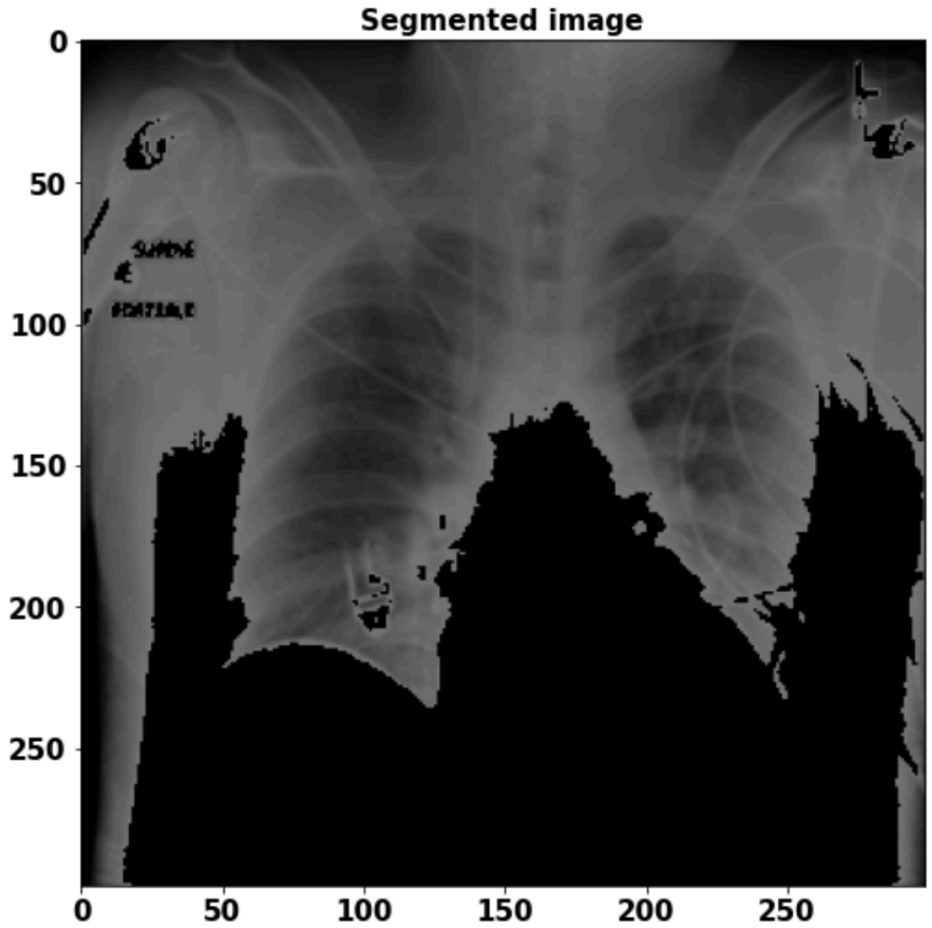
COVID-19



Effect of image segmentation using thresholding

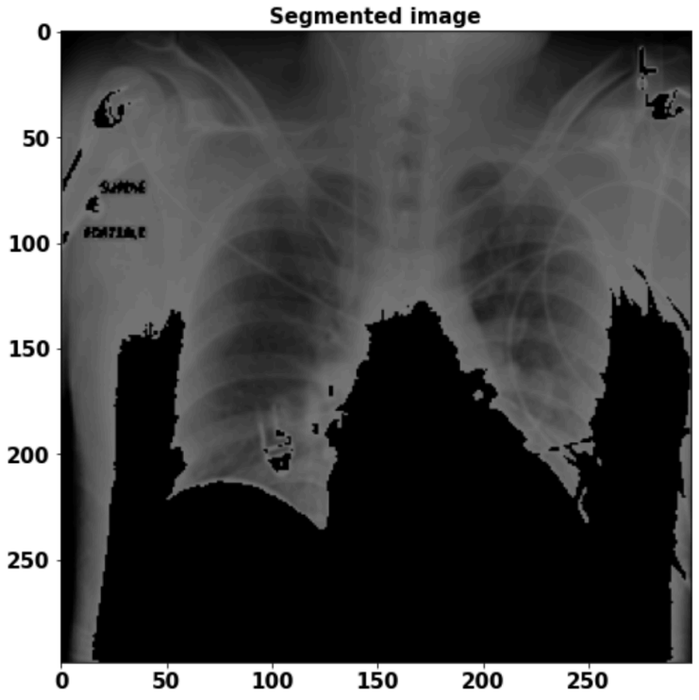
Normal Lungs



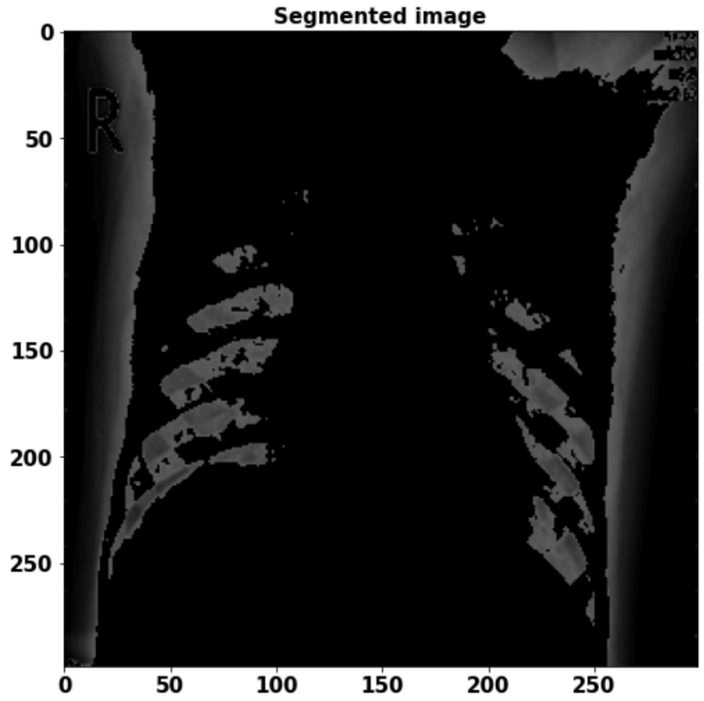


Effect of image segmentation using thresholding

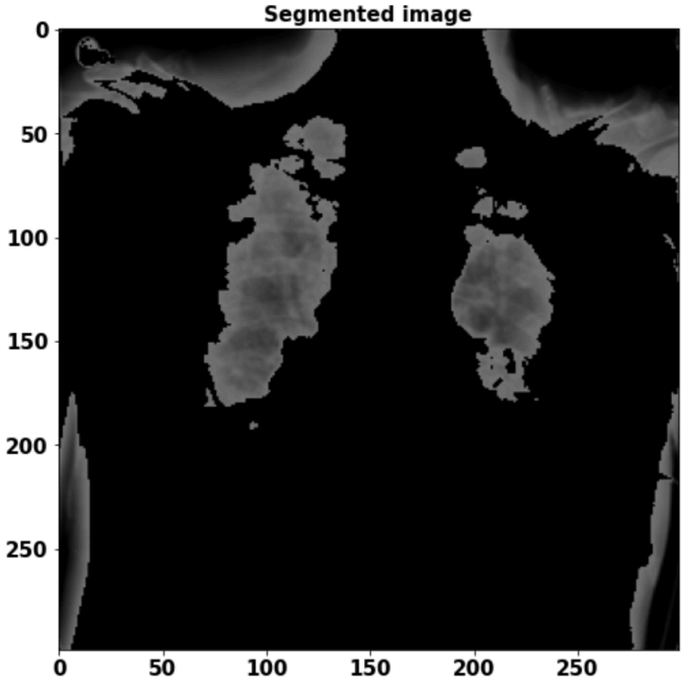
Normal



Viral pneumonia (Non-COVID)

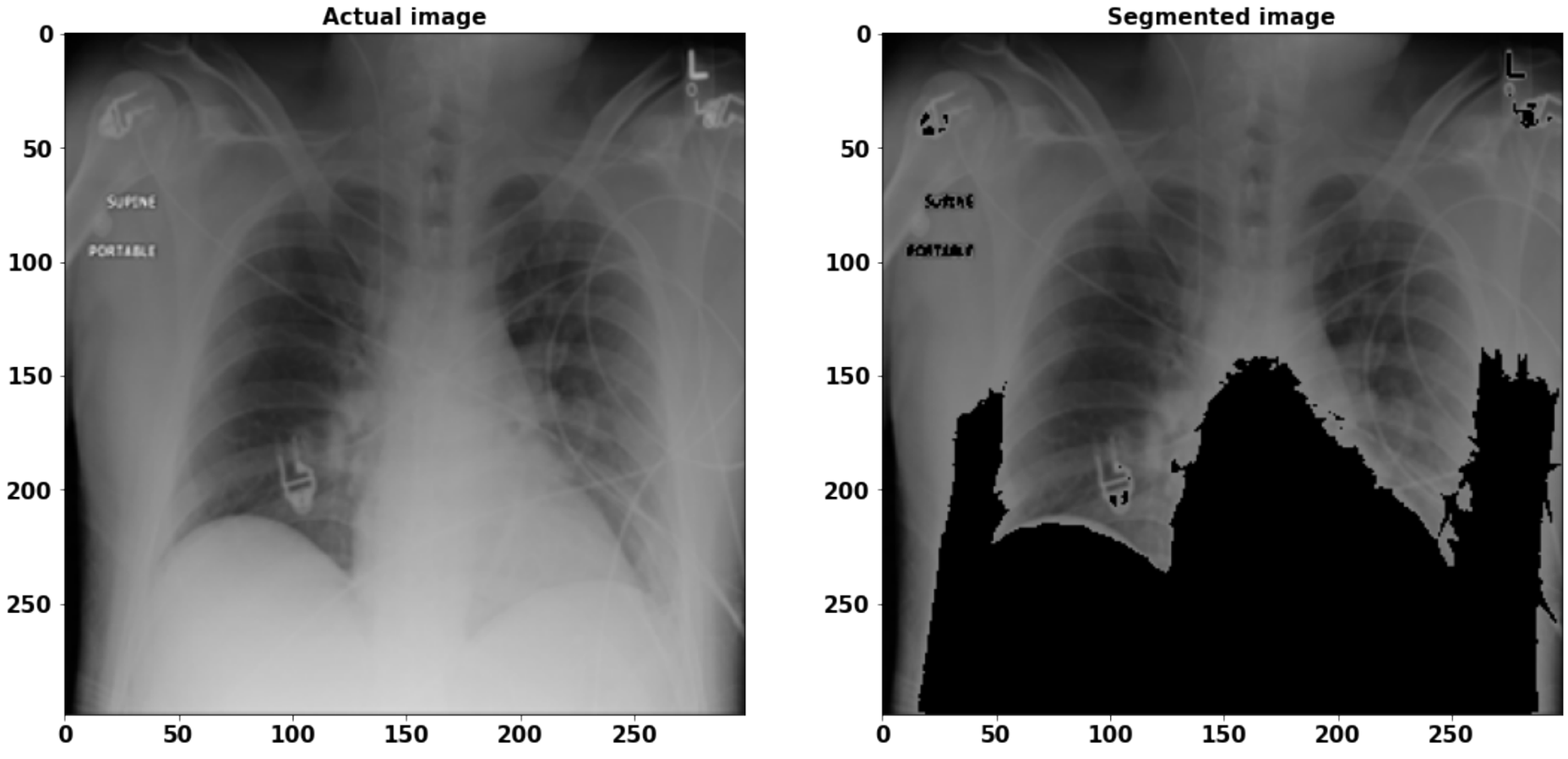


COVID-19



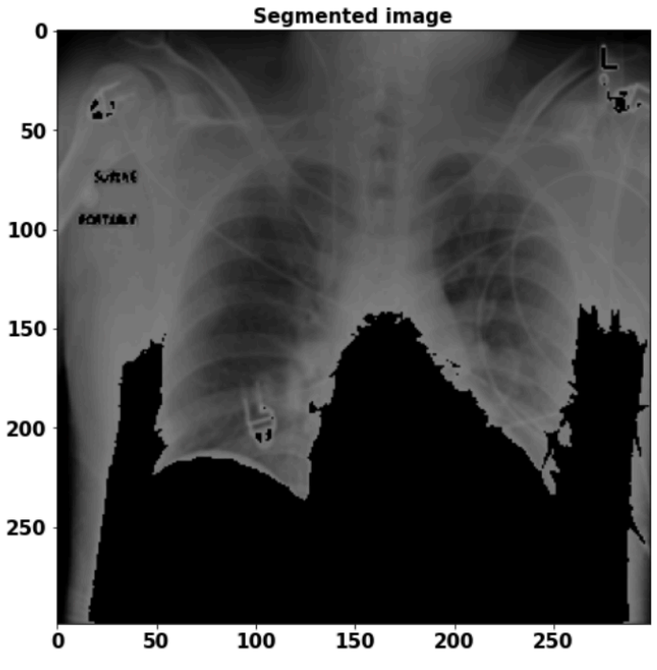
Effect of masking

Normal lungs

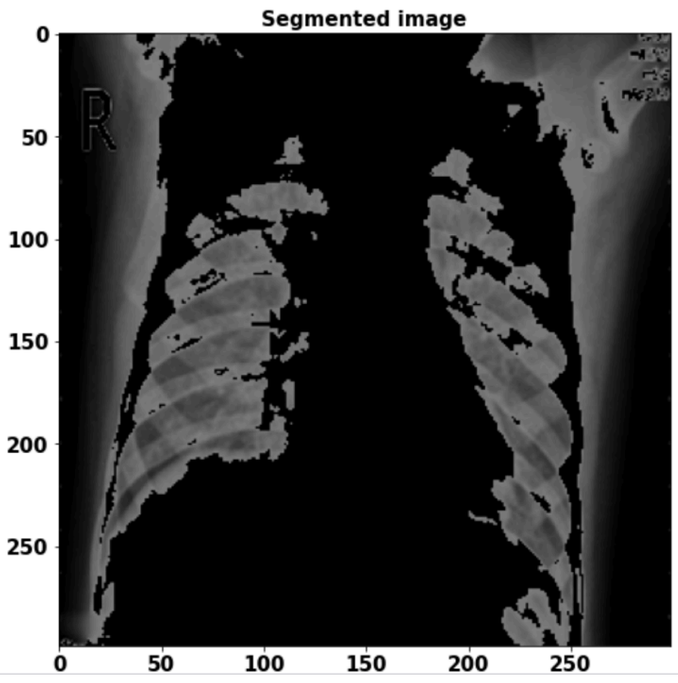


Effect of masking

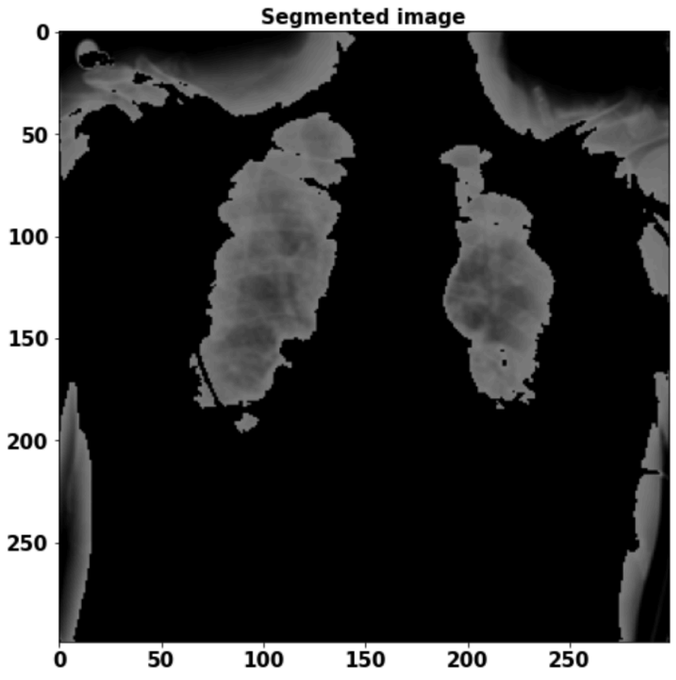
Normal



Viral pneumonia (Non-COVID)



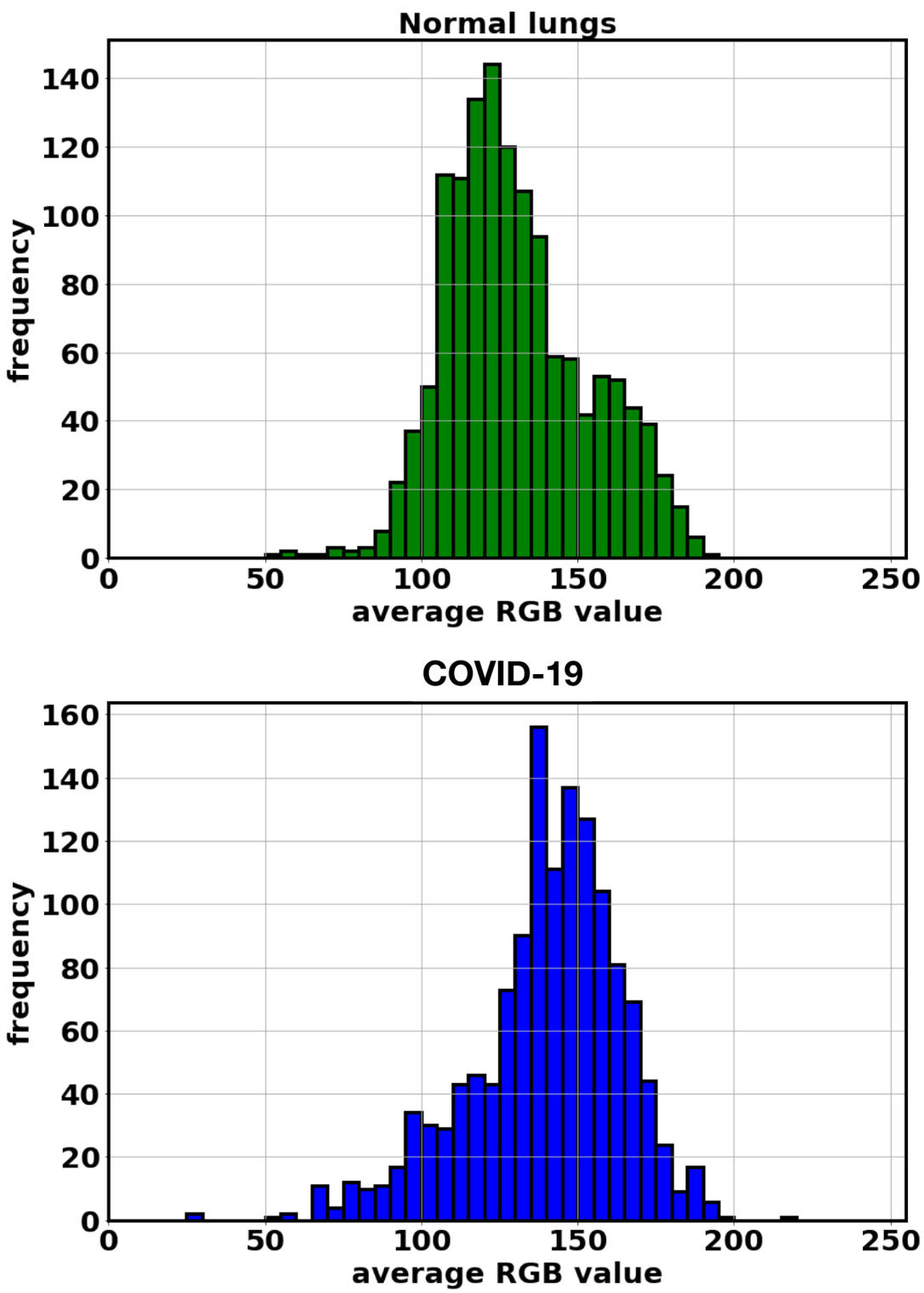
COVID-19

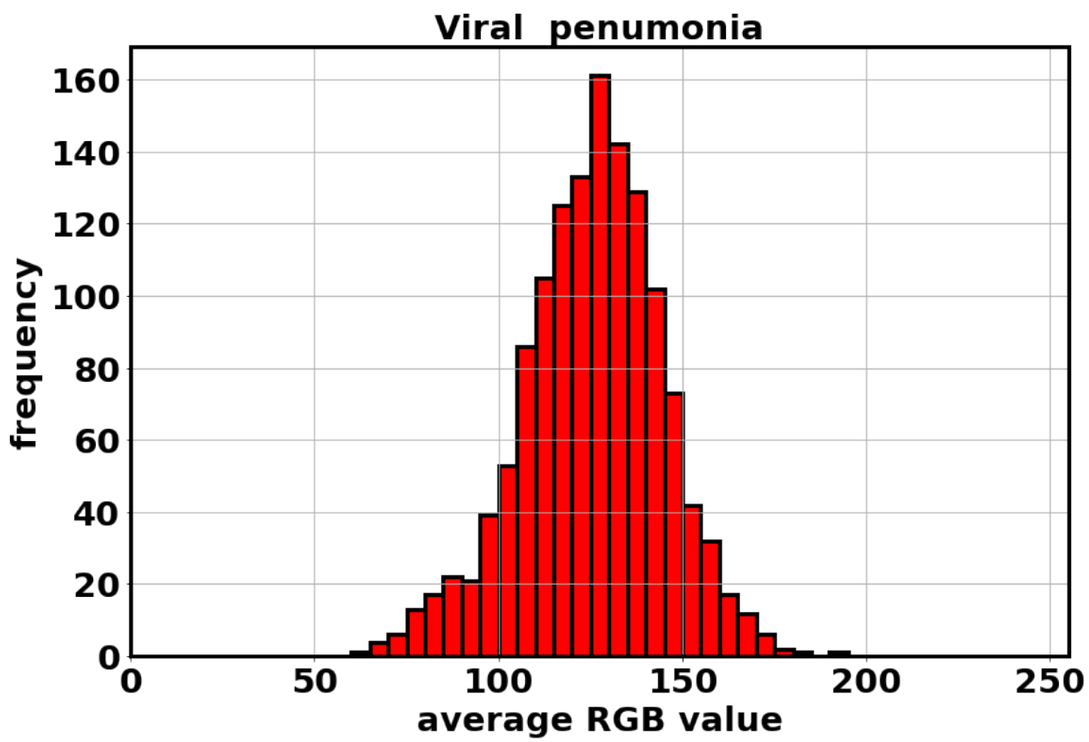


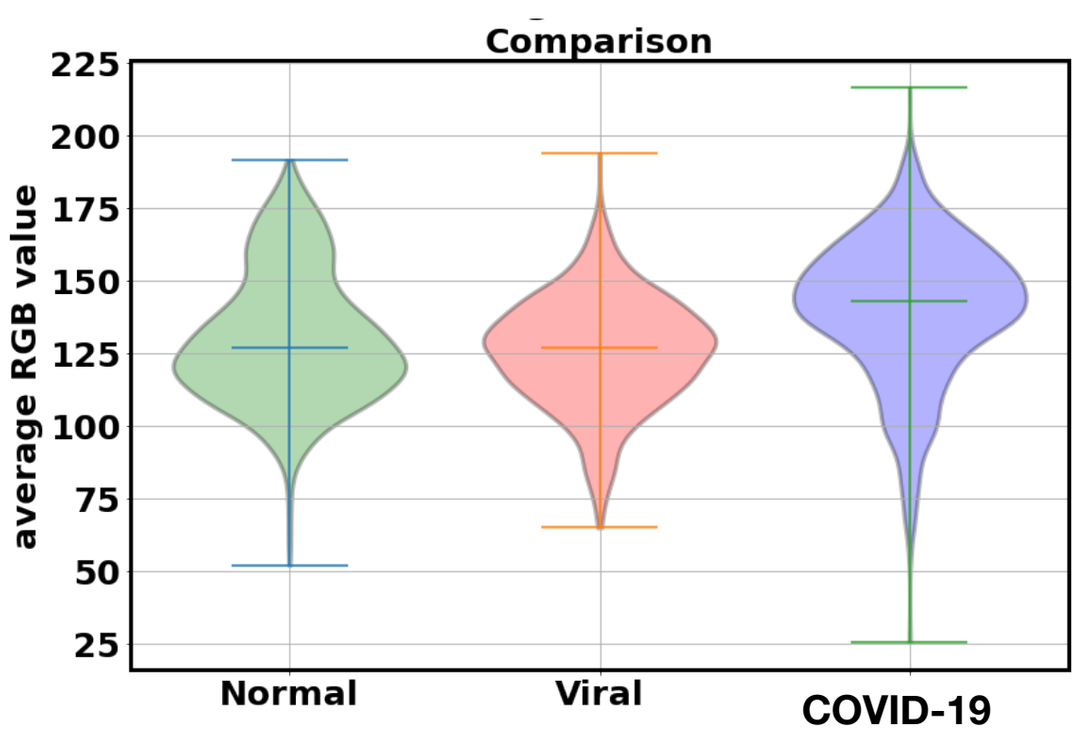
But these are one image from individual cases. What are the qualitative distinctive features if we analyze ~1300 images for both cases?

Features when considering average RGB levels for each image before any alteration

Image before segmentation

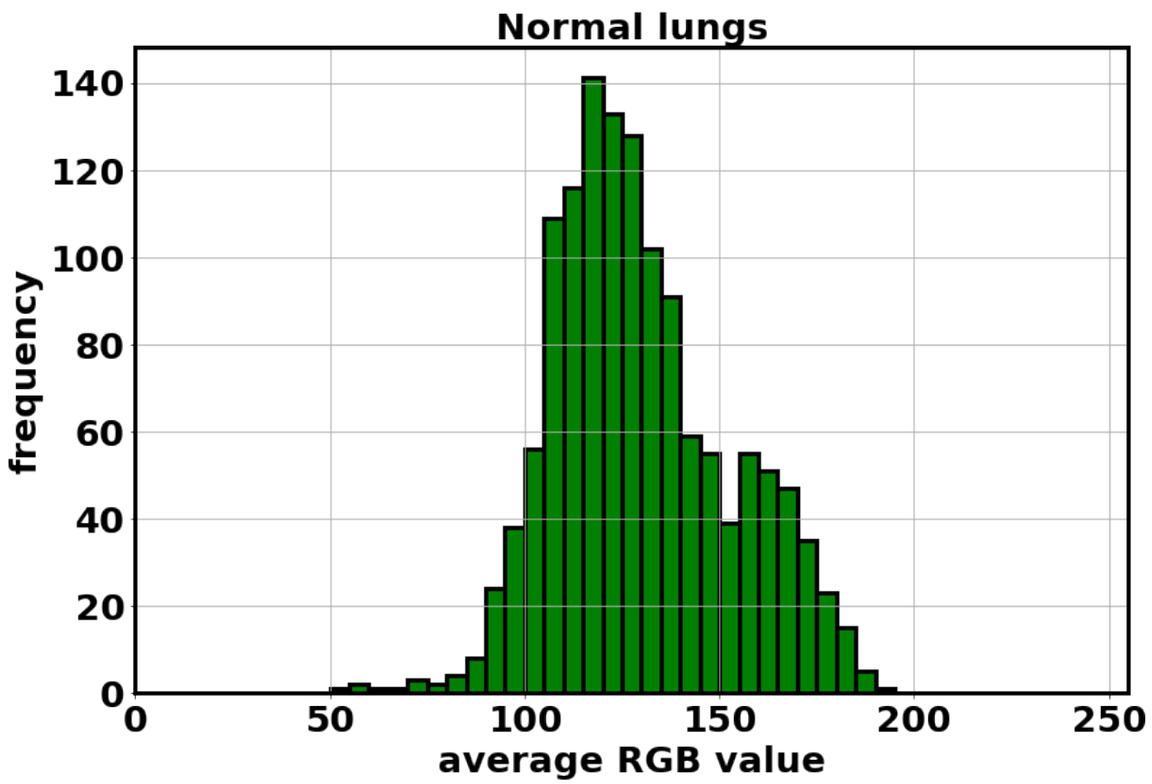


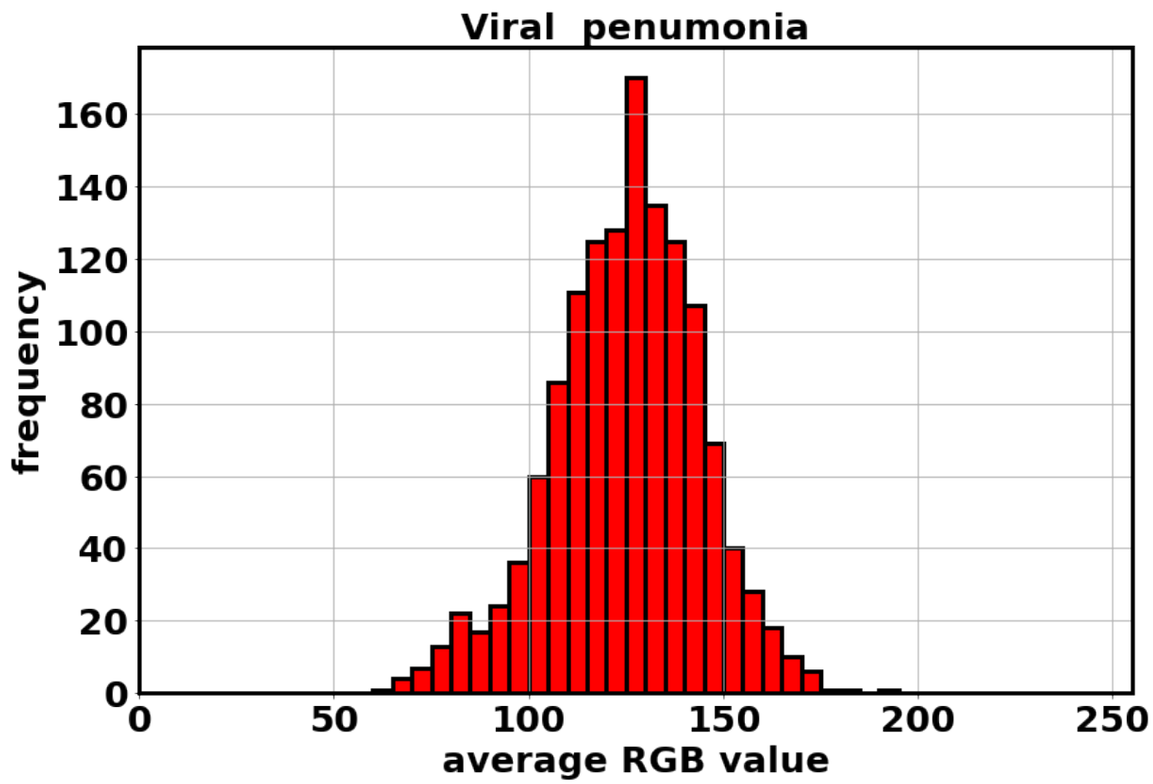


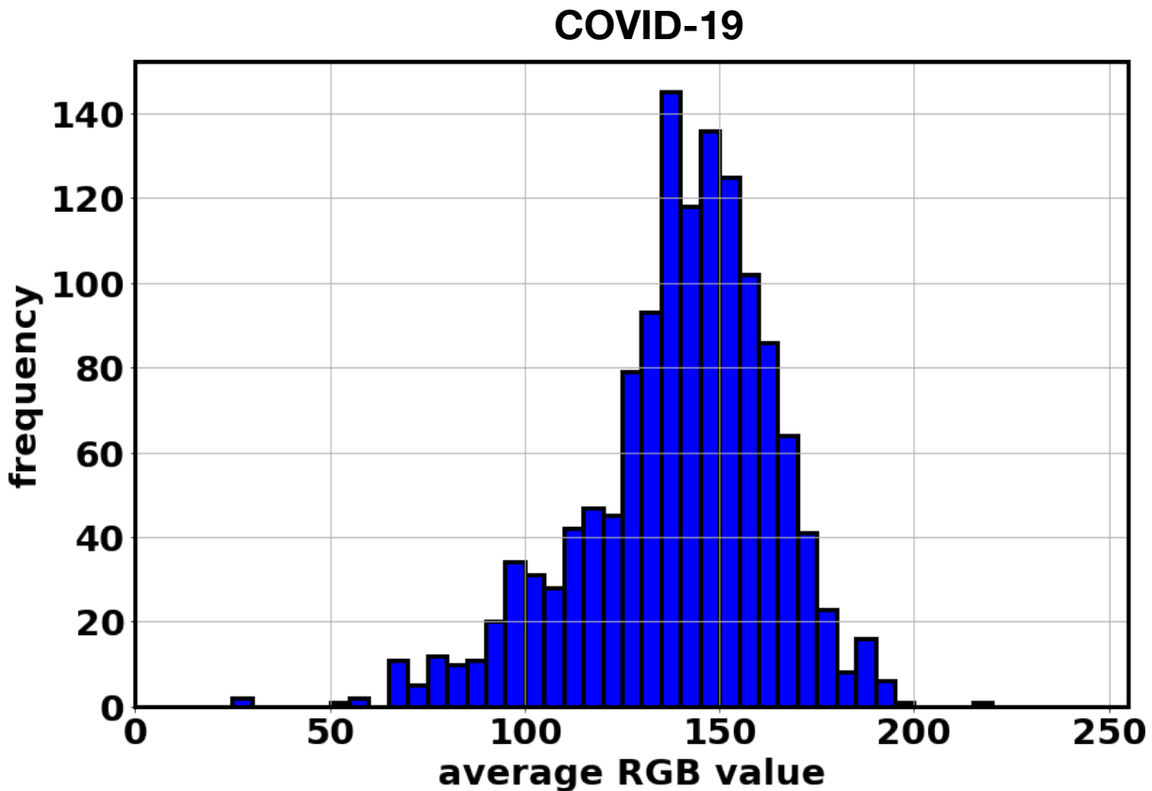


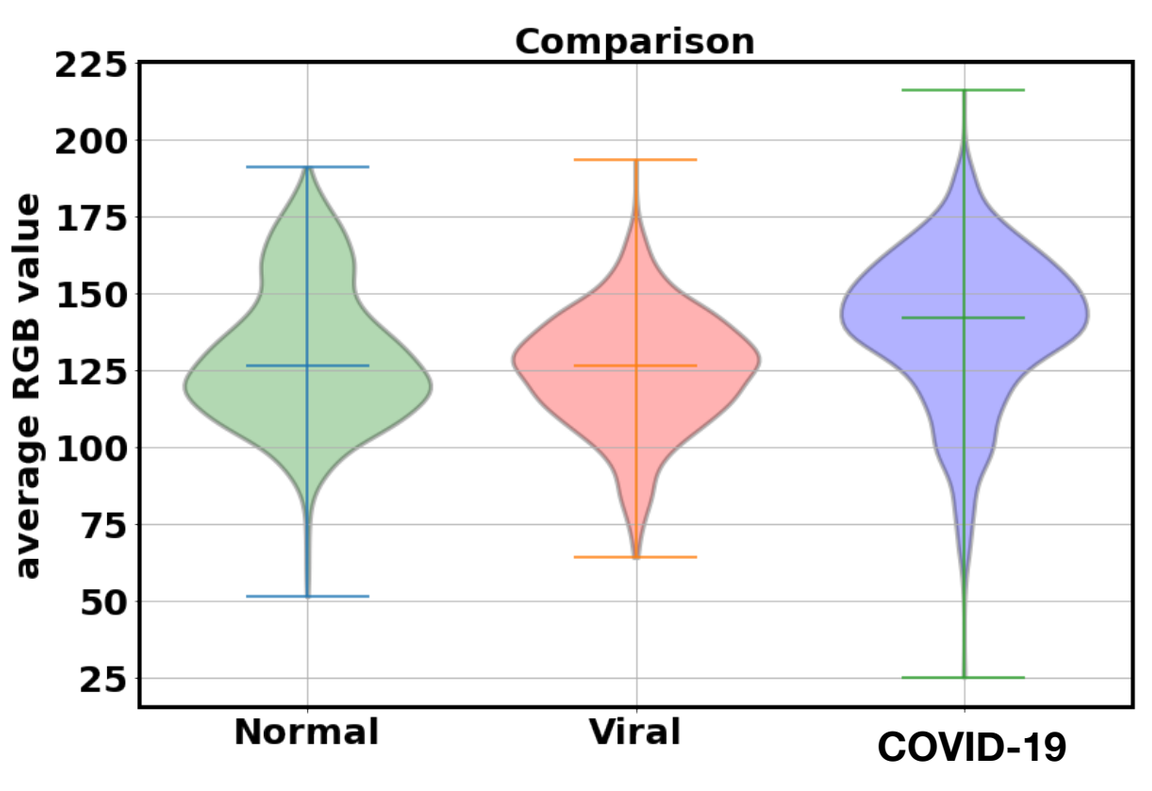
Features considering average RGB levels for each image with k=4 means clustering

k=4 mean clustering segmentation



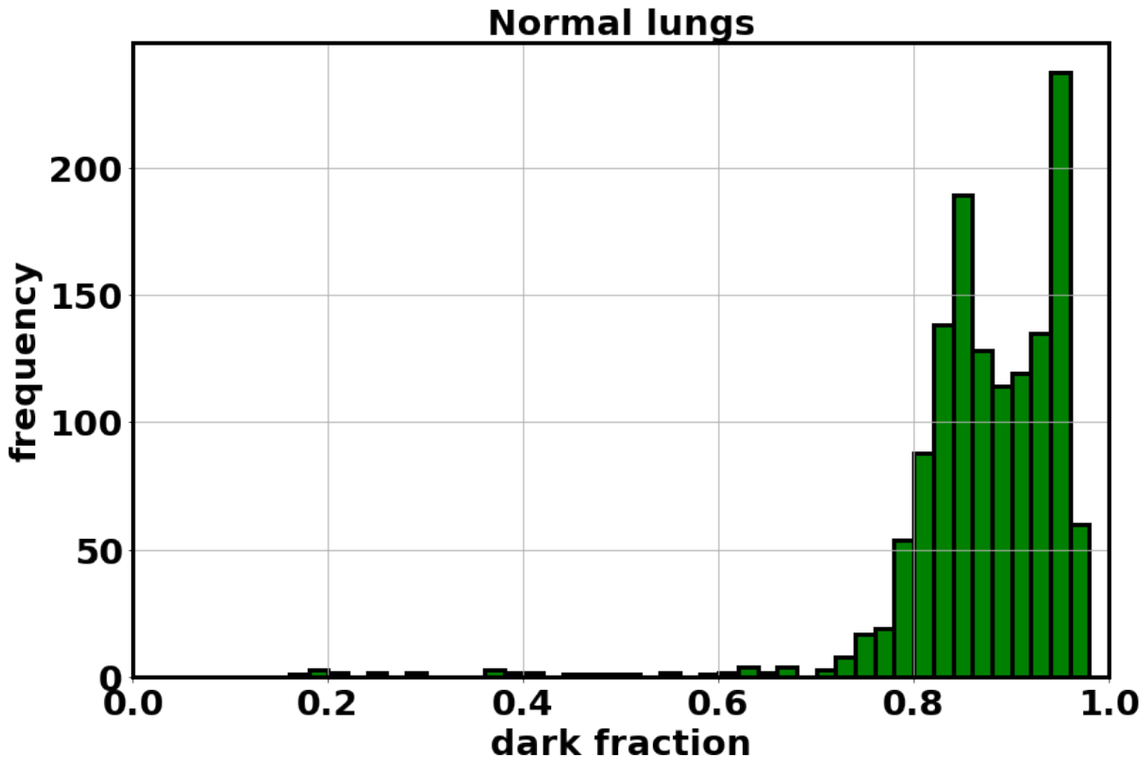


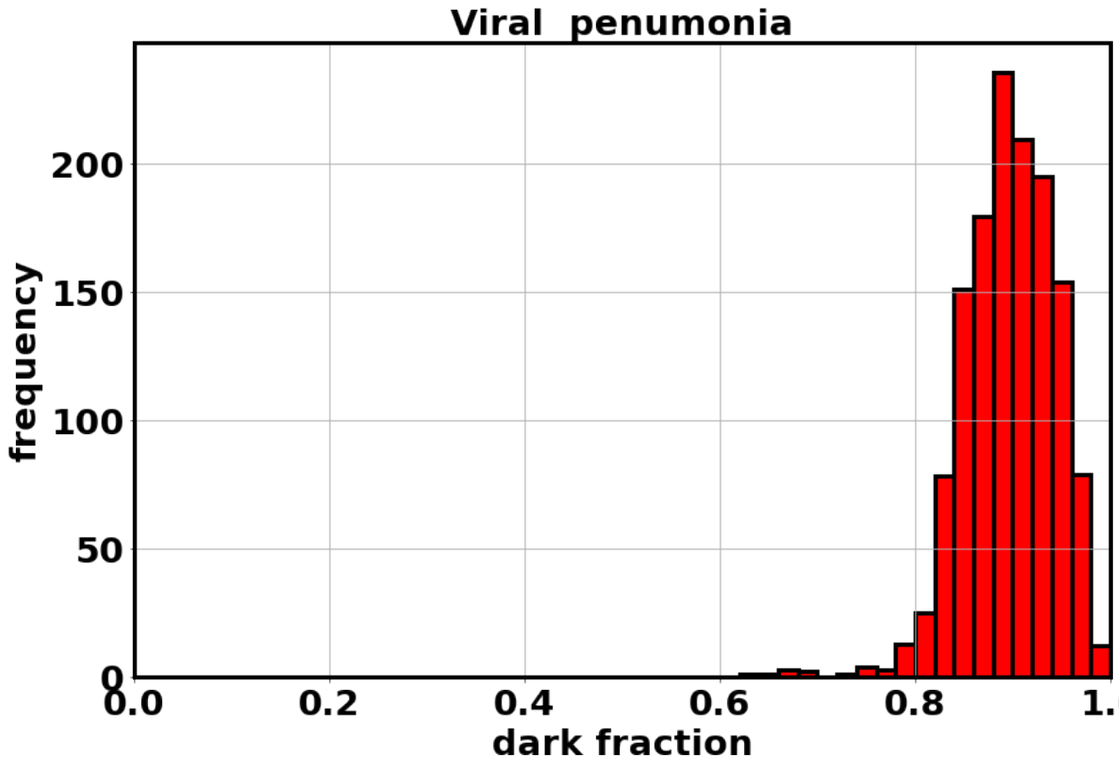


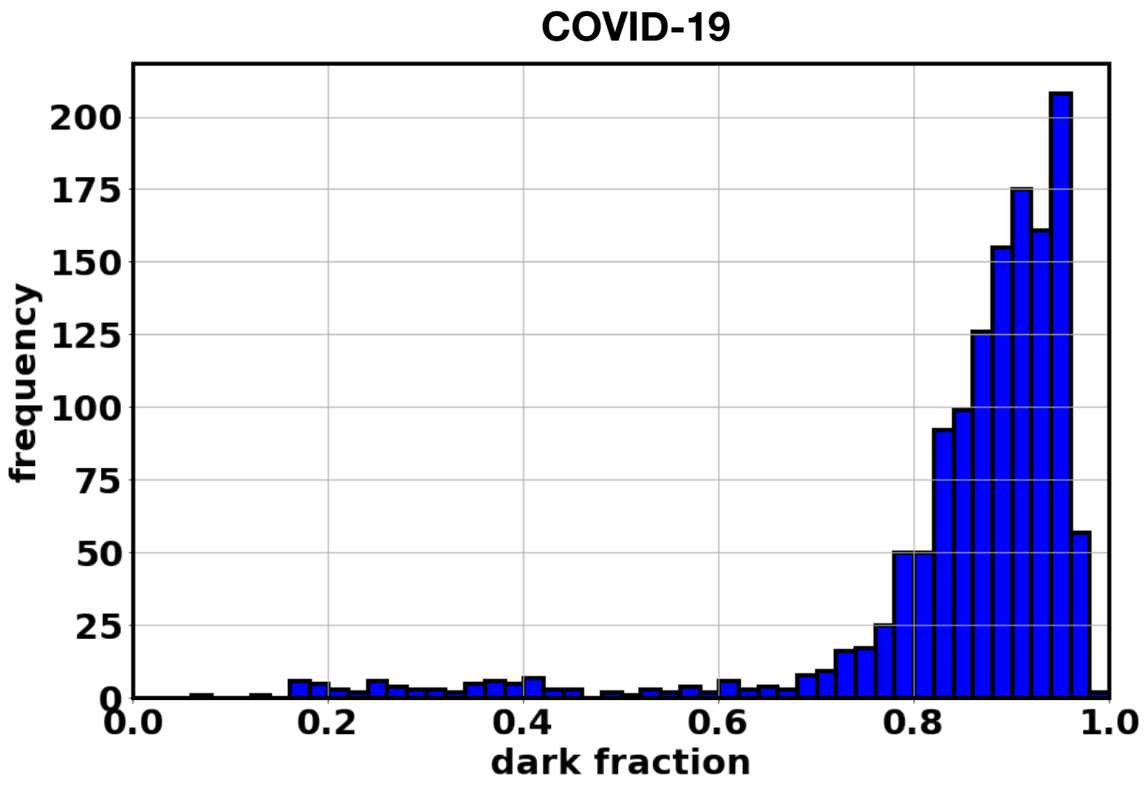


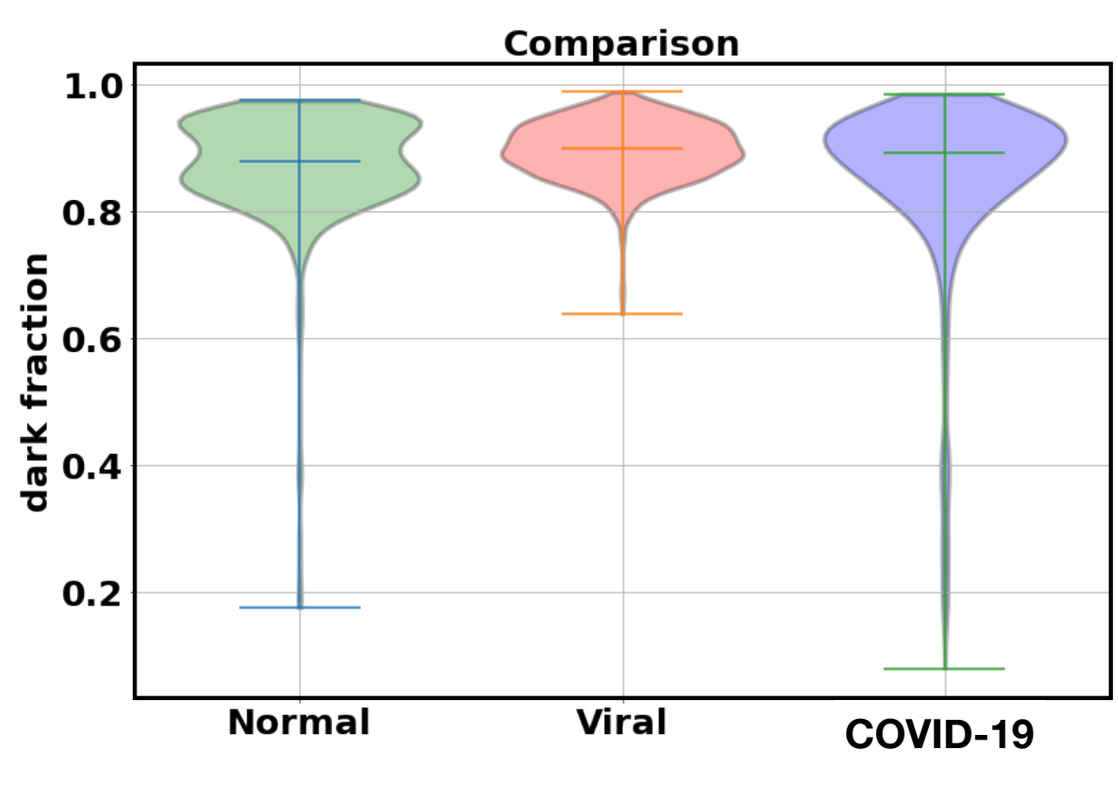
Fraction of black pixels for segmentation using contouring

Segmentation by contouring



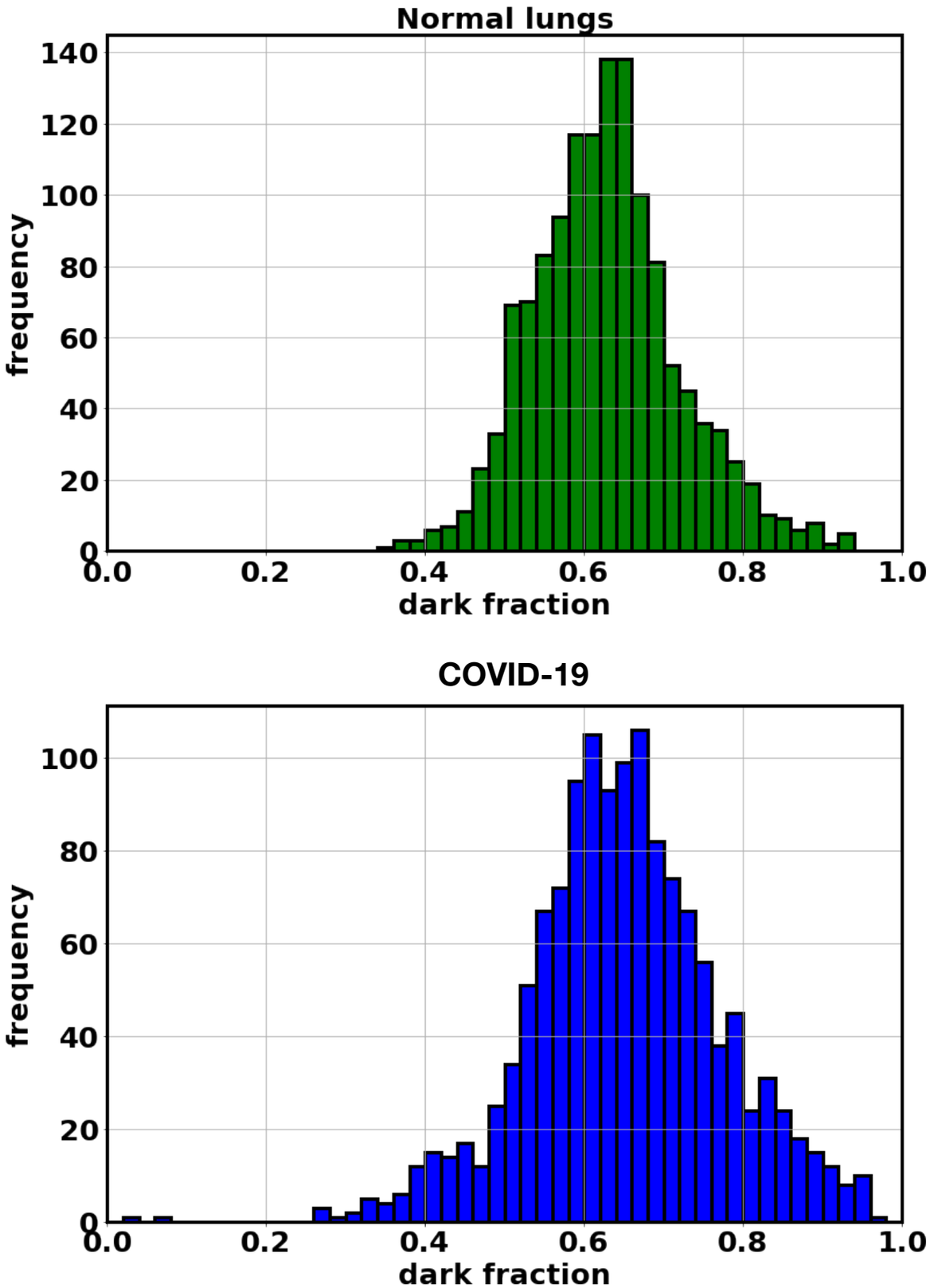


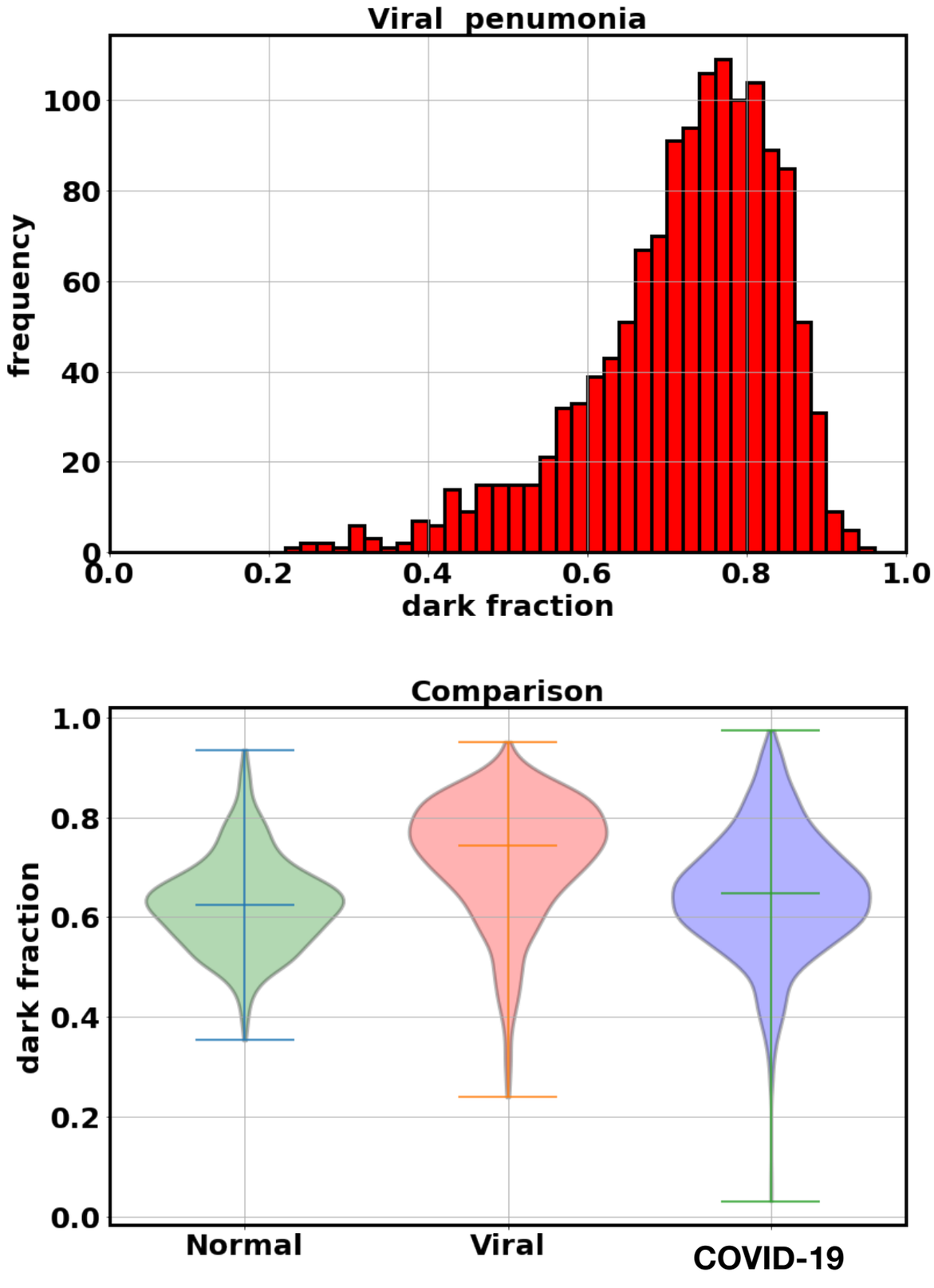




Fraction of black pixels for segmentation using thresholding

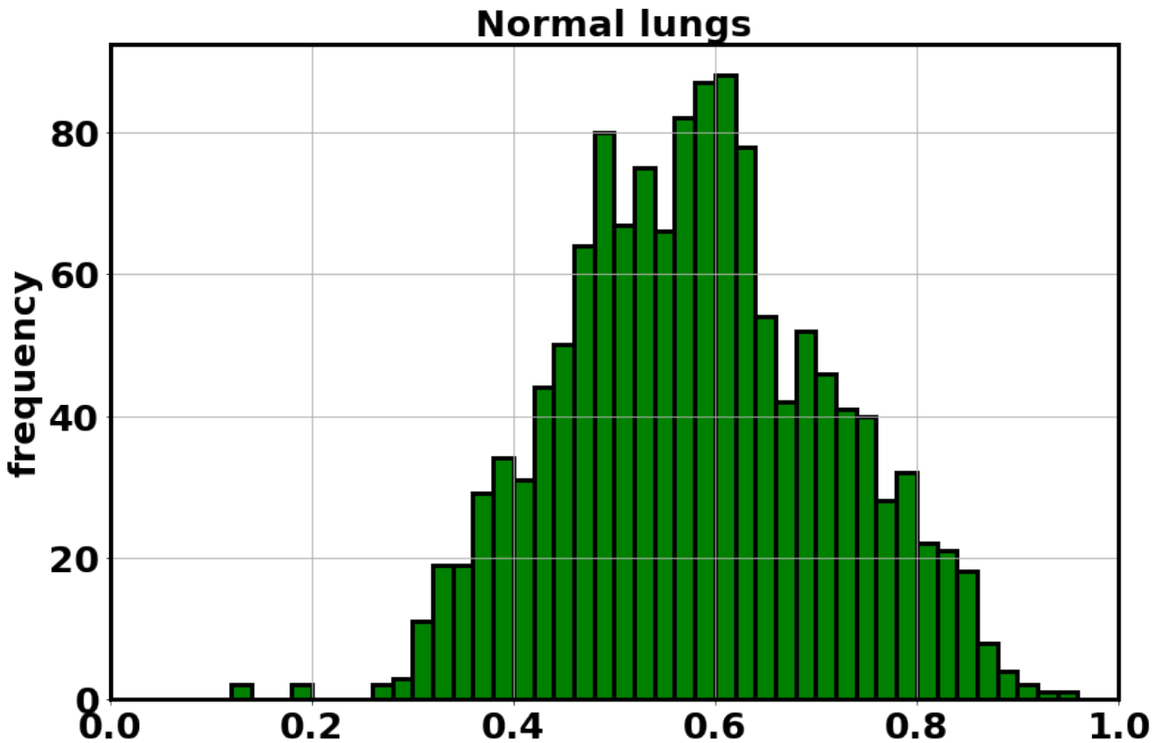
Segmentation by thresolding

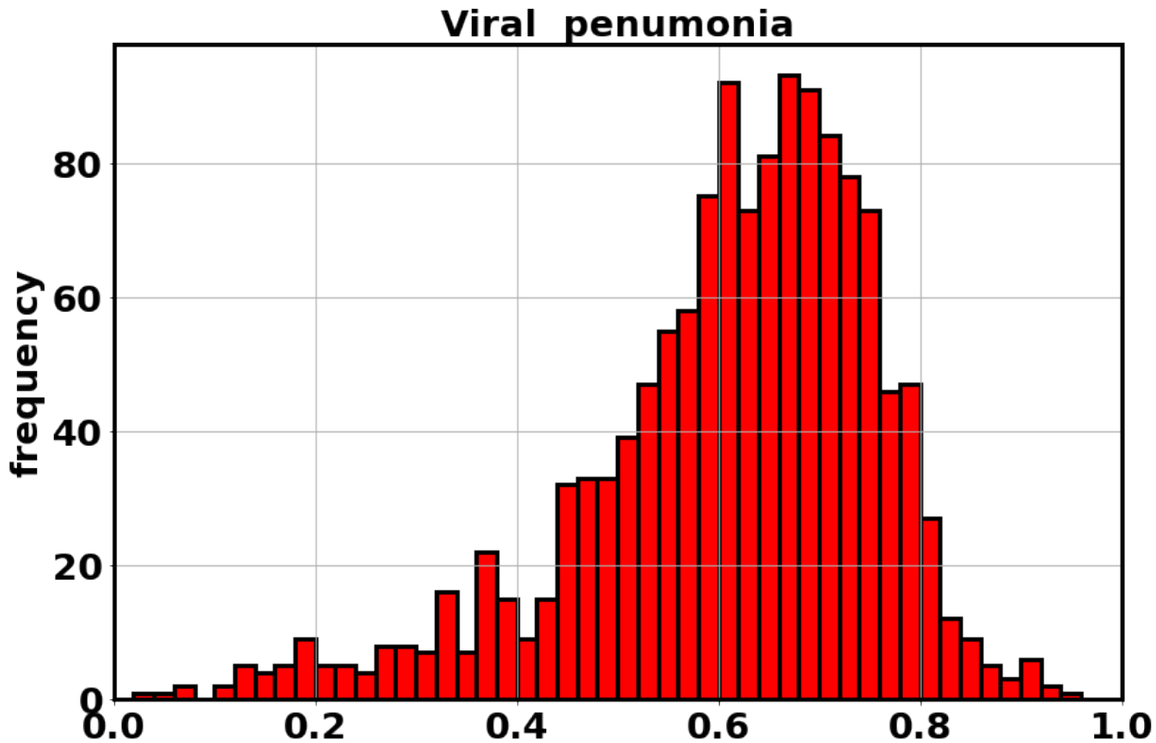


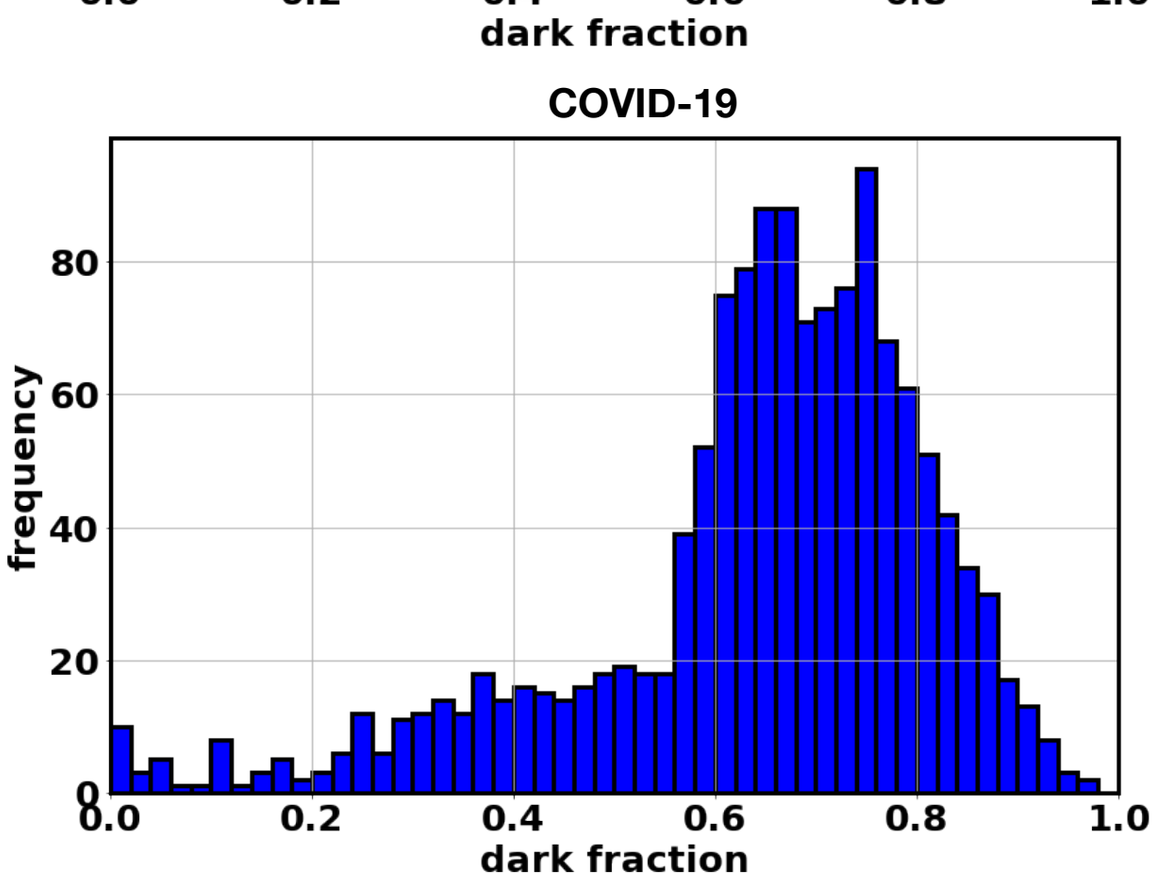


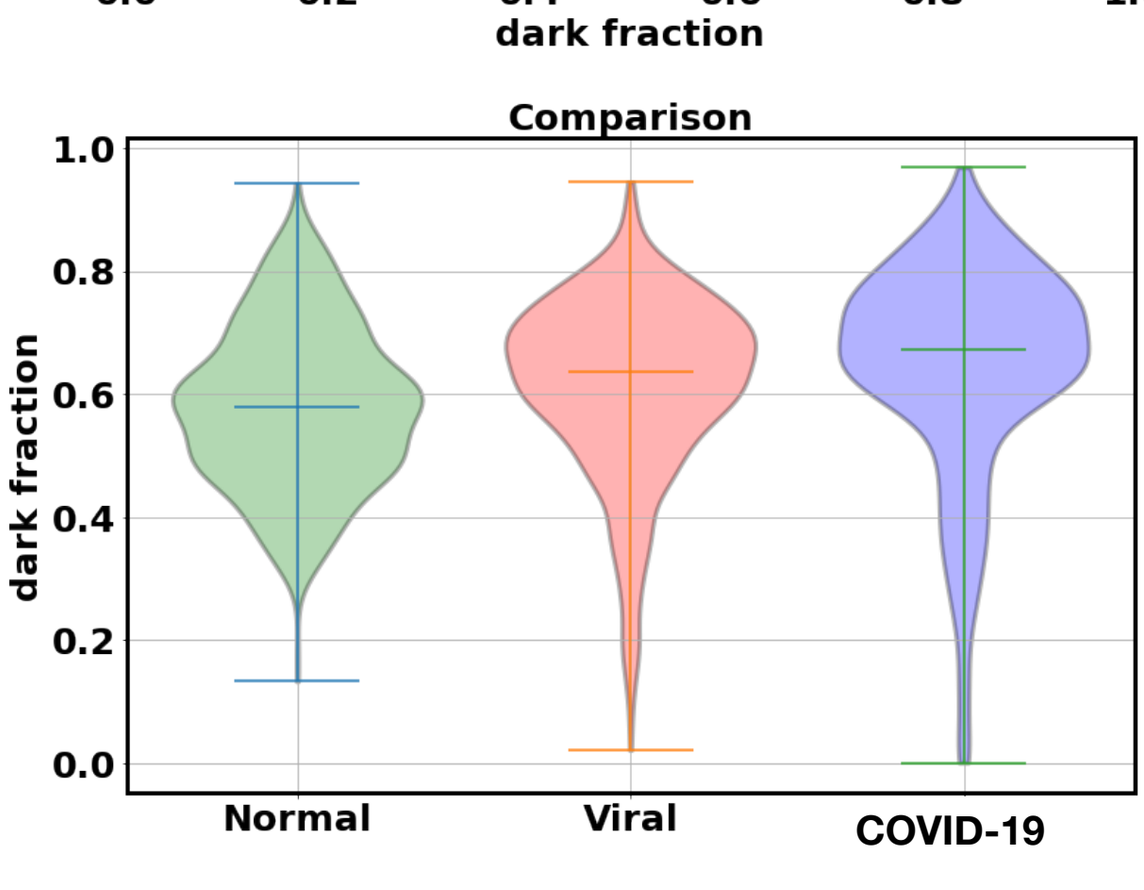
Fraction of black pixels for segmentation using masking

Segmentation by 50% masking



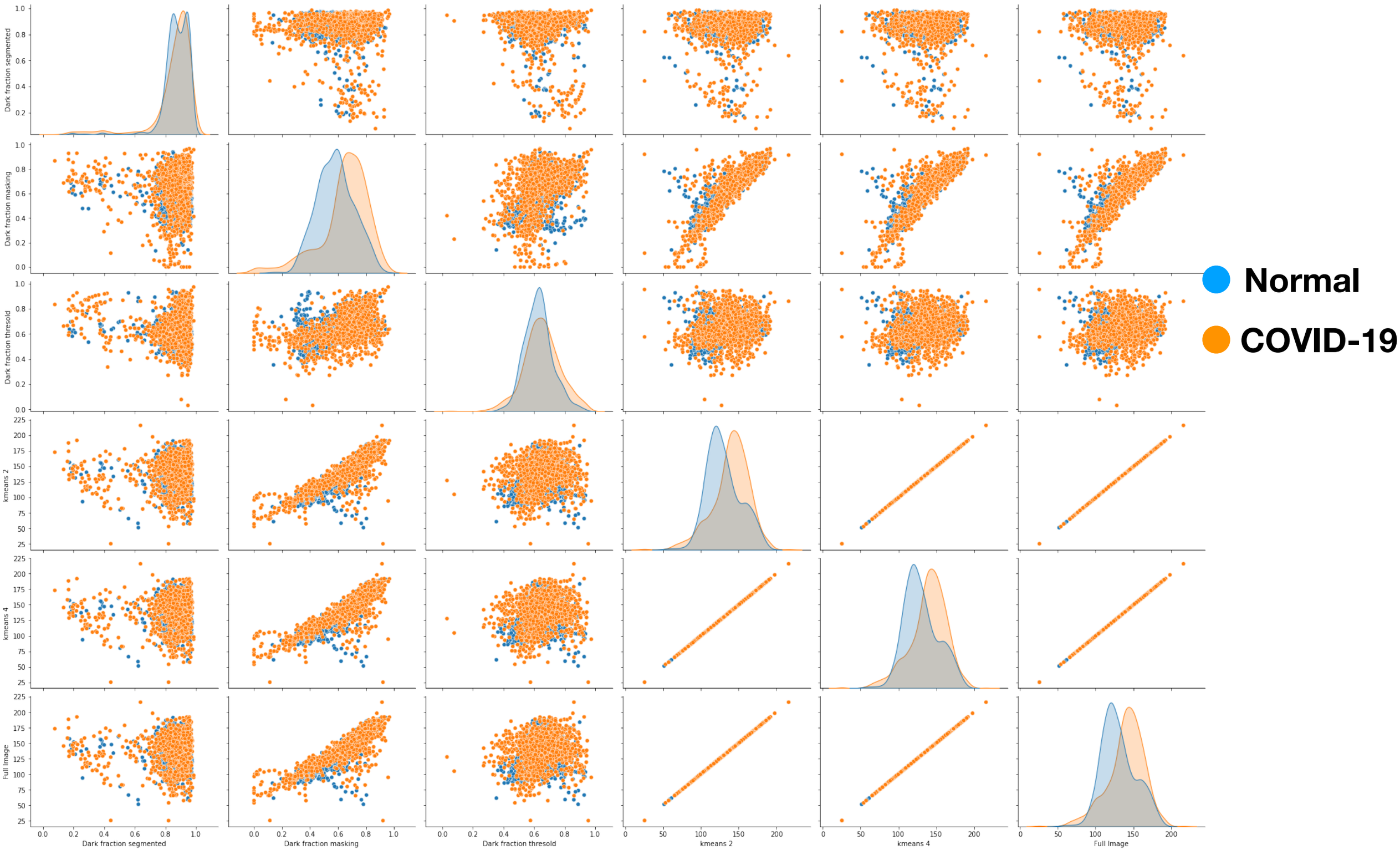




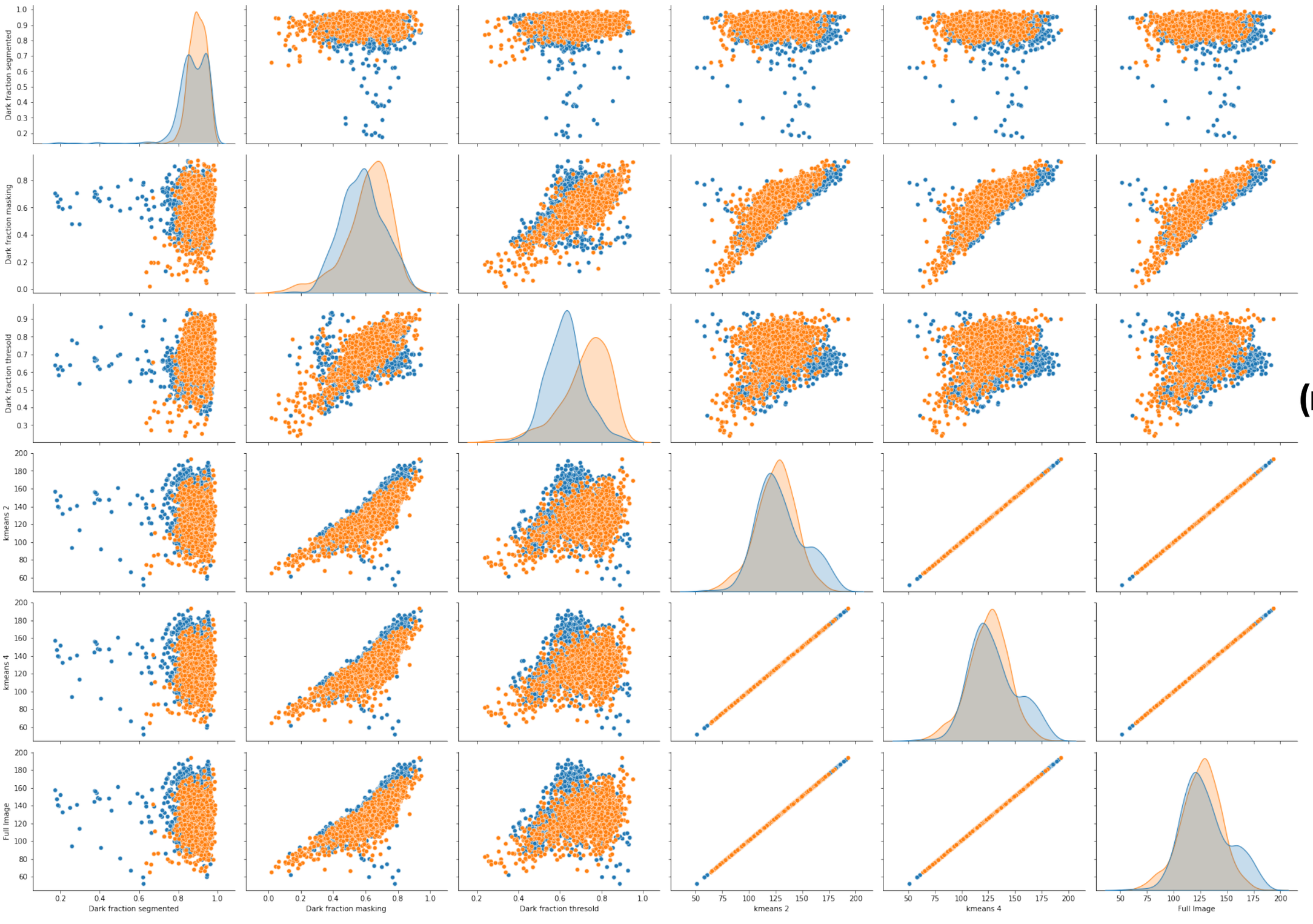


Now using these values from different segmentation techniques as inputs and the class of the images as output we train a machine learning model to differentiate between these three classes. We do pairwise analysis.

Normal vs COVID pairwise correlation plot



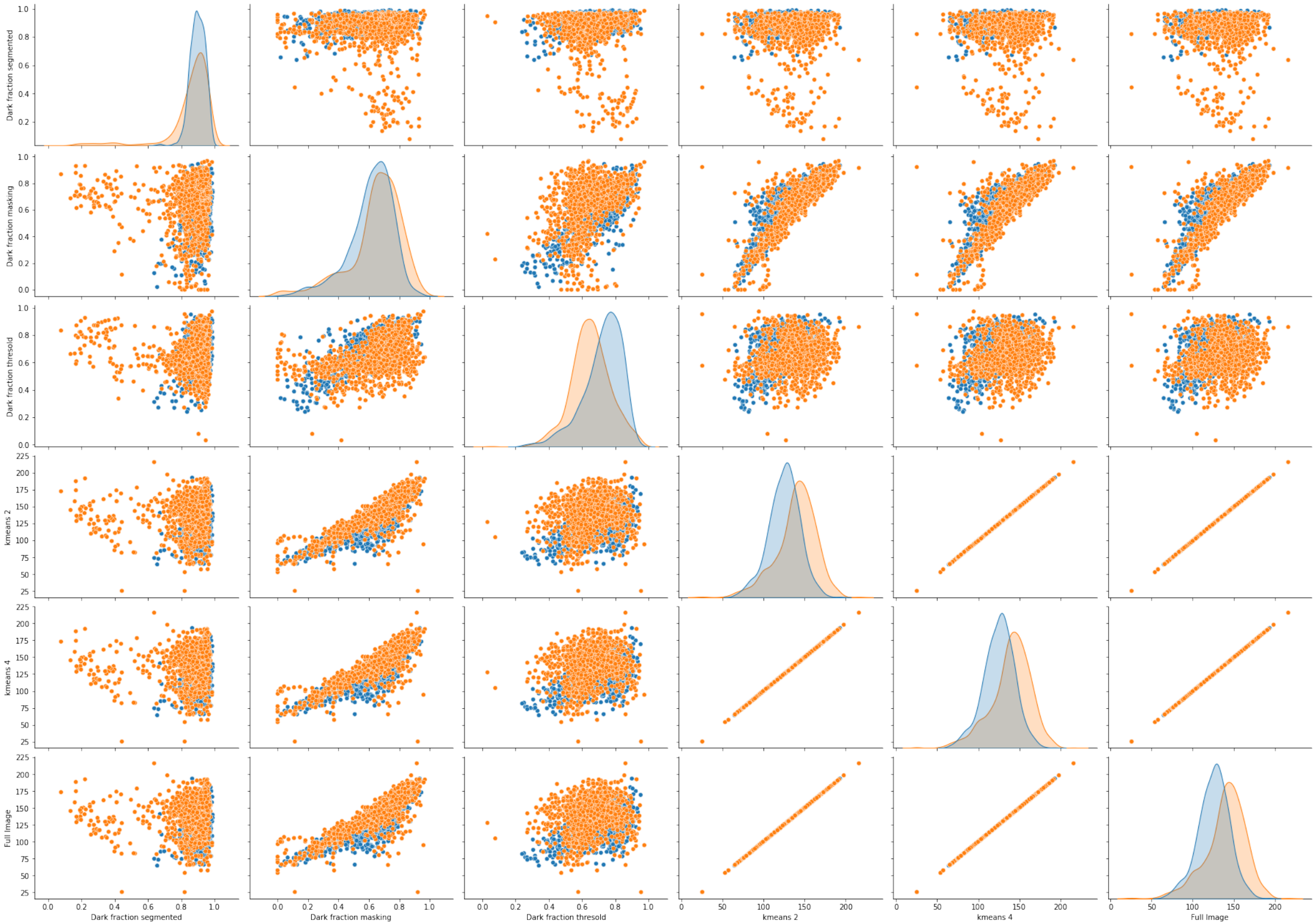
Normal vs Viral pneumonia pairwise correlation plot



Normal

Viral (non COVID)

Viral pneumonia vs COVID pairwise correlation plot

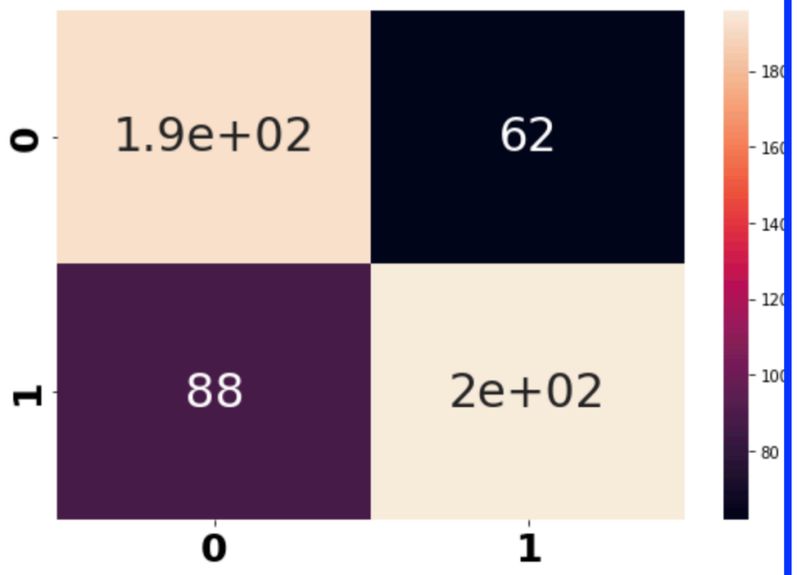


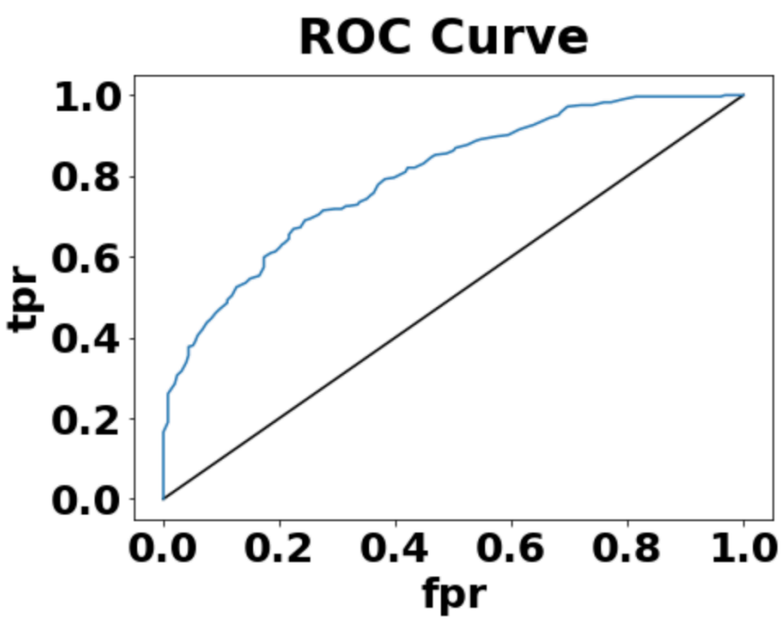
Viral

COVID-19

Confusion Matrix and ROC Curves

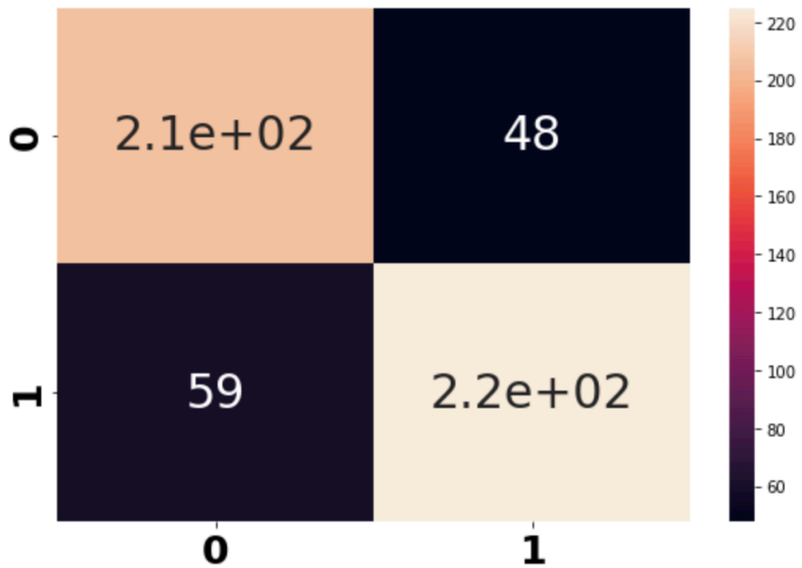
Normal=0 vs COVID-19=1

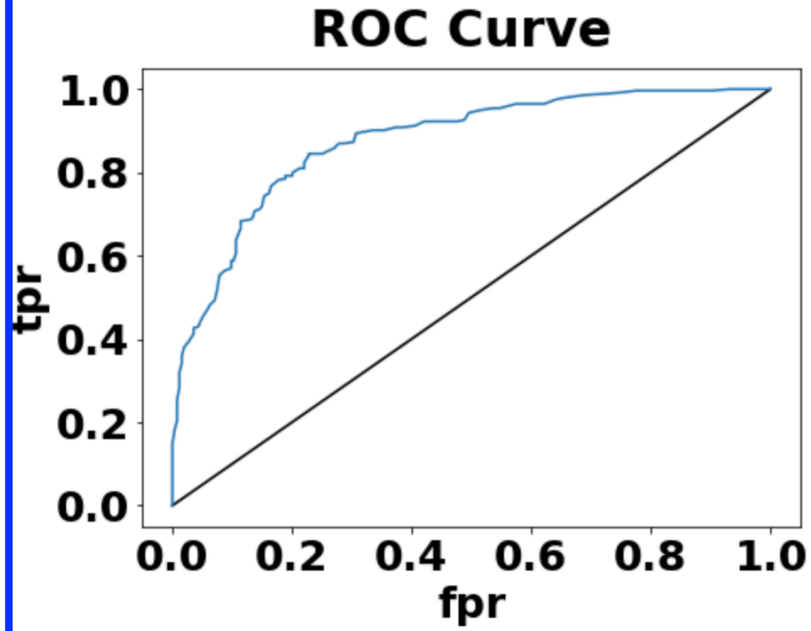




ROC AUC score = 0.798

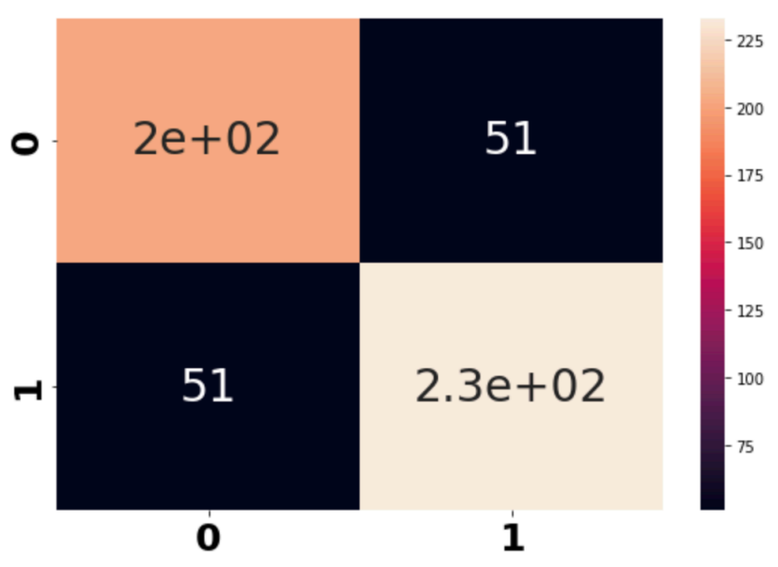
Normal=0 vs Viral=1

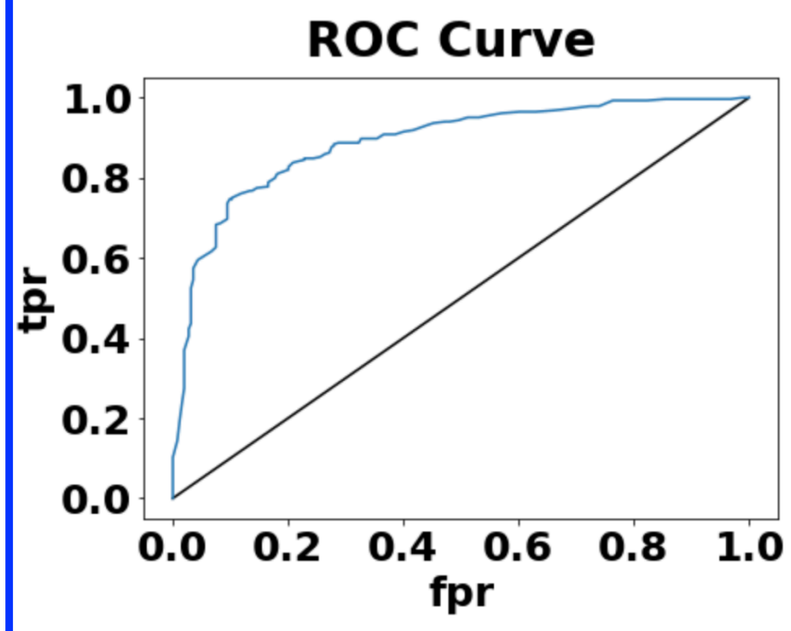




ROC AUC score = 0.875

Viral=0 vs COVID-19=1





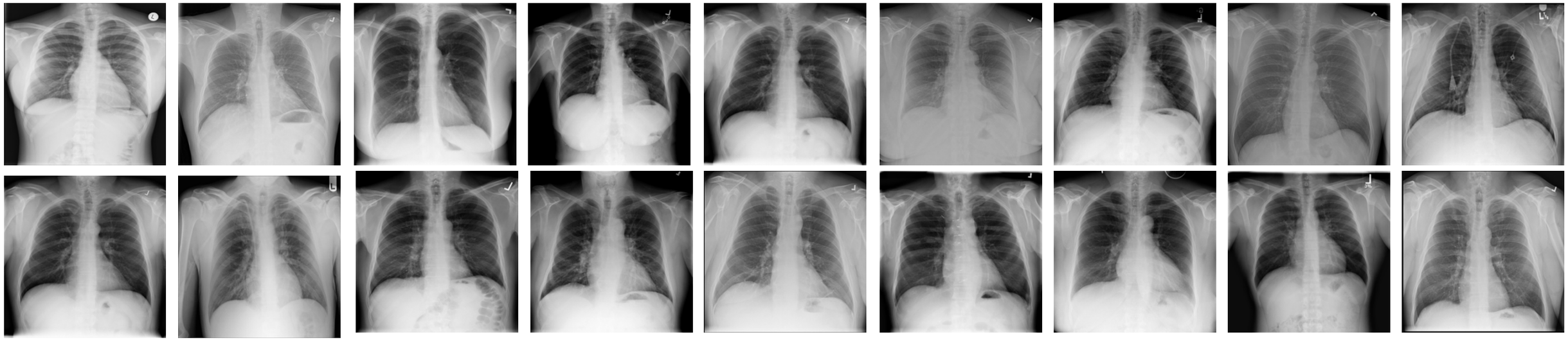
ROC AUC score = 0.888

Future goals

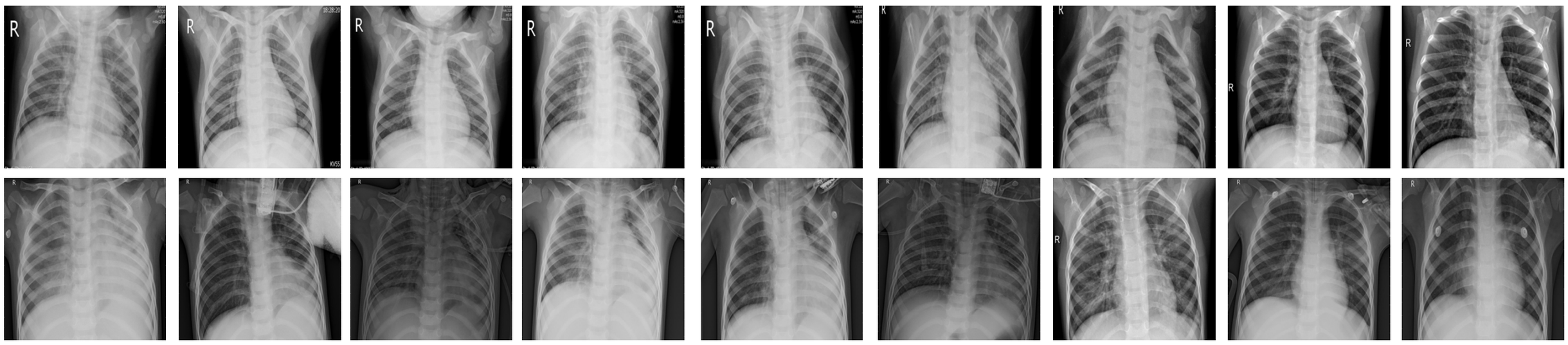
- **Improve accuracy of classification by analyzing initial images for more scenarios and hence have greater training data for the classification model.**

Some example images

Normal



Viral Pneumonia (Non COVID)



COVID-19