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# QUALITY ASSESSMENT OF CHEST RADIOGRAPHS

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## CODE DESCRIPTION

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## ABSTRACT

The COVID-19 pandemic has created the need to analyse a huge number of chest radiographs. However, not all radiographs are acquired with the same parameters or conditions and many radiographs that are available present various levels of quality. One way to assess the quality of a radiograph is to measure the contrast. In the particular case of chest x-rays, the contrast of interest is between the regions of the lungs and surrounding regions, the edges of the ribcage and the sternum. This work describes an algorithm to assess the quality of the chest radiographs based on the intensity projections of images.

**Keywords** Radiograph · COVID-19 · X-Ray

## 1 Introduction

Assessment of quality of PA Chest Radiographs This code derives a quality metric based on the contrast between the intensity of the regions of lungs (which should be dark) and the intensity of the chest and the edge of the ribs (which should be brighter). This contrast is measured by detecting the median intensity projection over each column of the radiograph. The projection should roughly resemble the shape of a "W" with three peaks and two valleys.

## 2 Algorithm Description

### 2.1 Peak detection

This algorithm detects three peaks: it discards any peaks that are close to the edges of the radiograph. In case there are more than three, it selects the three with highest prominence. If there are only 2, it detects the central one and sets the third one at the opposite side, at the same distance as the existing one.

### 2.2 Valley detection

Once the peaks have been detected, valleys are detected. Any valley that is outside the peaks (left or right) is discarded. If there are no valleys detected (imagine a very low contrast radiograph), these are set at the midpoints between peaks and the same is done in case there is only one detected. If there are more than two, then the most prominent ones are selected.

### 2.3 Metric calculation

An absolute metric is calculated as the minimum of the two intensity differences between the intensity of the valleys and the average intensities of the peaks at each side. In a normal case, these two intensities are similar, but if one lung is

much brighter than the other, then the intensity is different. An alternative is to take the average instead of the minimum.

Then, to make this as a relative metric, the intensity is analysed with order statistics to determine a lower value (6%) and a higher value (99%). The higher value is closer to the maximum as it is only necessary to discard the maximum values which can be due to labels on a radiograph. However, the lower value should be higher than a 1% to cover for dark pixels which can be background.

Finally, the metric is the ratio of the absolute metric previously calculated divided by the difference between the high and low values of the order statistics.

## 2.4 Graphical display

The function returns the actual metric (values between 0 and 1) and if requested a graphical display with a figure with 4 subplots: 1) the original radiographs, 2,3) intensity projections over the rows and columns, (maximum intensity projection, - black, minimum intensity projection - magenta, median intensity projection - red) 4) the radiograph with the contrast adjusted to the low and high values.

The intensity projection of each column shows the location of the peaks (blue circles), lines connecting the peaks (dashed blue lines), valleys (green stars), the intensity differences between the level of the valleys and the intermediate points of the peaks (thin vertical green lines), the lower and higher intensity values (magenta and black respectively). The function is called with two parameters, the image itself, and an optional parameter to plot (1). The only output parameter is the metric.

## 3 Examples

A few examples are shown below. The images are read from the Covid-Chest-dataset compiled by Joseph Paul Cohen in the GitHub repository "ieee8023" [1].

### 3.1 Example 1

```
currImage=imread('https://raw.githubusercontent.com/ieee8023/covid-chestxray-dataset/master/images/covid-19-pneumonia-30-PA.jpg');
quMetric = QualityChestXray(currImage,1);
```

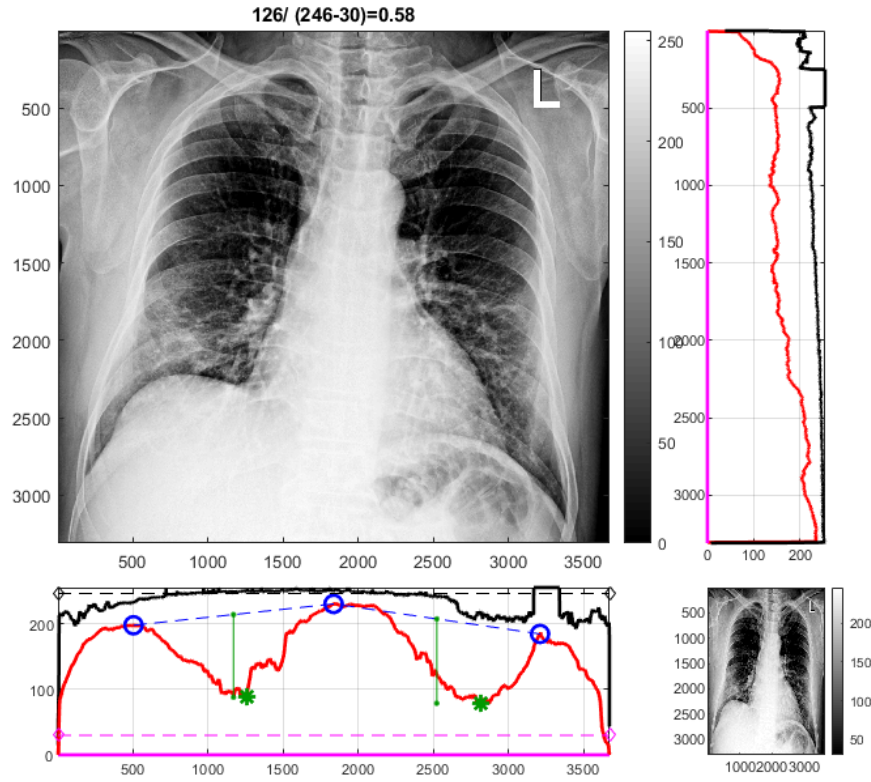


Figure 1: Image with high contrast (Metric = 0.58). The original radiograph is shown in the top left. Projections are shown at the right and bottom and an intensity adjusted radiograph is shown in the bottom right. This example does not change significantly as it has high contrast. For a description of the labels, see section 2.4.

### 3.2 Example 2

```
currImage=imread('https://raw.githubusercontent.com/ieee8023/covid-chestxray-dataset/master/images/pneumocystis-pneumonia-12.png');
quMetric = QualityChestXray(currImage,1);
```

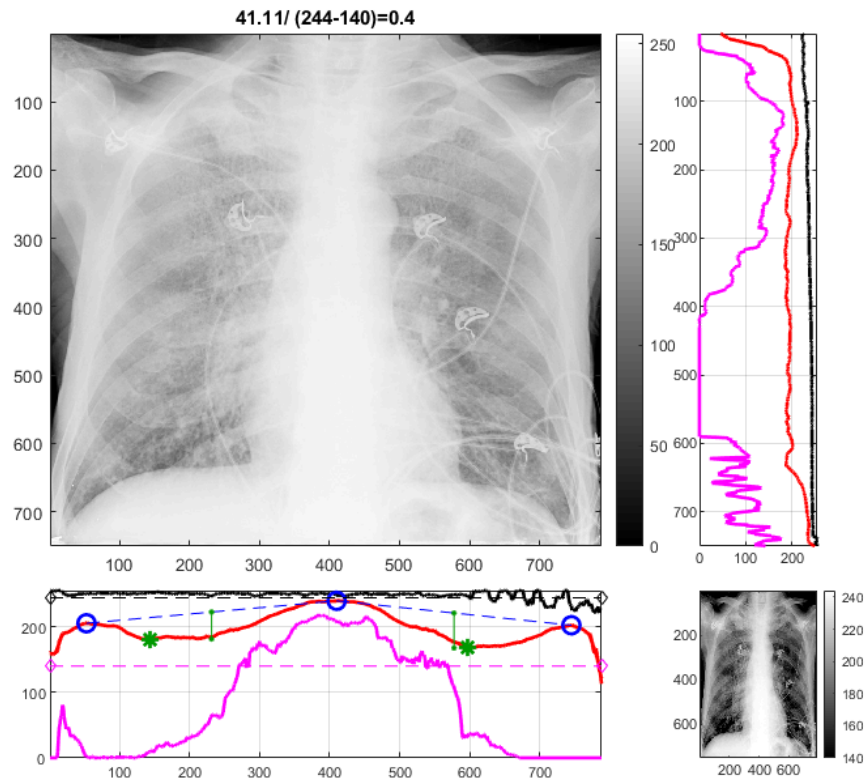


Figure 2: Medium Contrast (0.40). Notice the difference between the original radiograph and the intensity adjusted one.

### 3.3 Example 3

```
currImage=imread('https://raw.githubusercontent.com/ieee8023/covid-chestxray-dataset/master/images/covid-19-pneumonia-43-day0.jpeg');
quMetric = QualityChestXray(currImage,1);
```

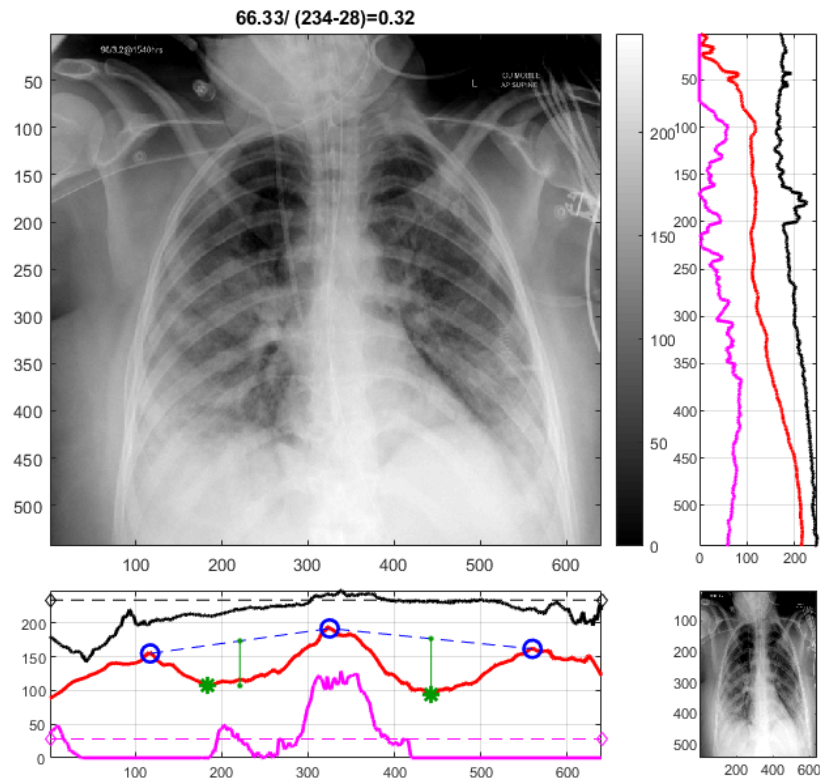


Figure 3: Medium Contrast (0.32)

### 3.4 Example 4

```
currImage=imread('https://raw.githubusercontent.com/ieee8023/covid-chestxray-dataset/master/images/covid-19-pneumonia-41-day-2.jpg');
quMetric = QualityChestXray(currImage,1);
```

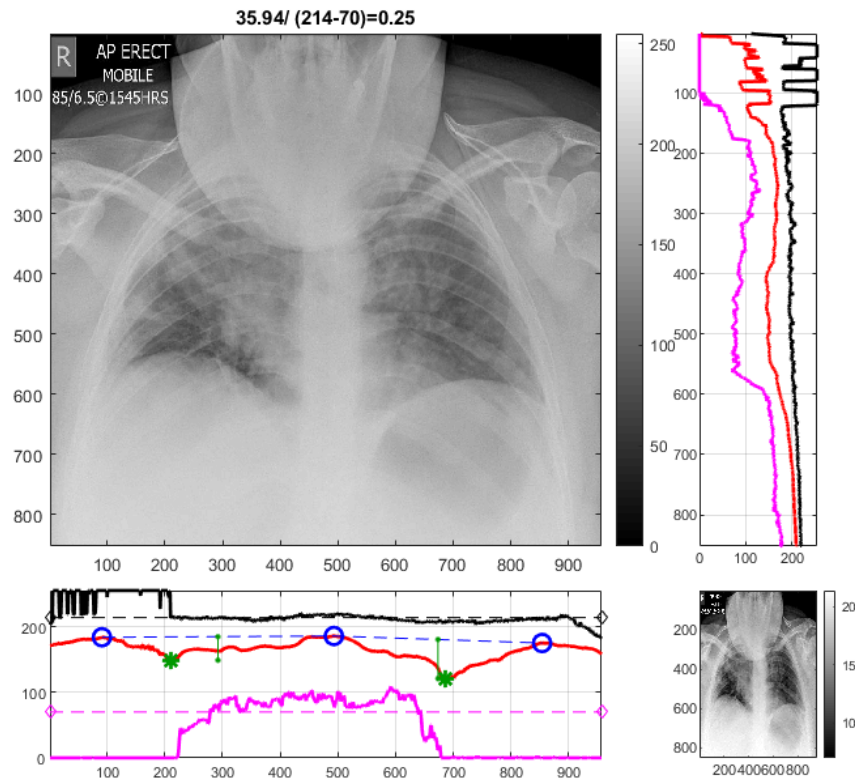


Figure 4: Medium Contrast (0.25)

### 3.5 Example 5

```
currImage=imread('https://raw.githubusercontent.com/ieee8023/covid-chestxray-dataset/master/images/all14238-fig-0002-m-d.jpg');
quMetric = QualityChestXray(currImage,1);
```

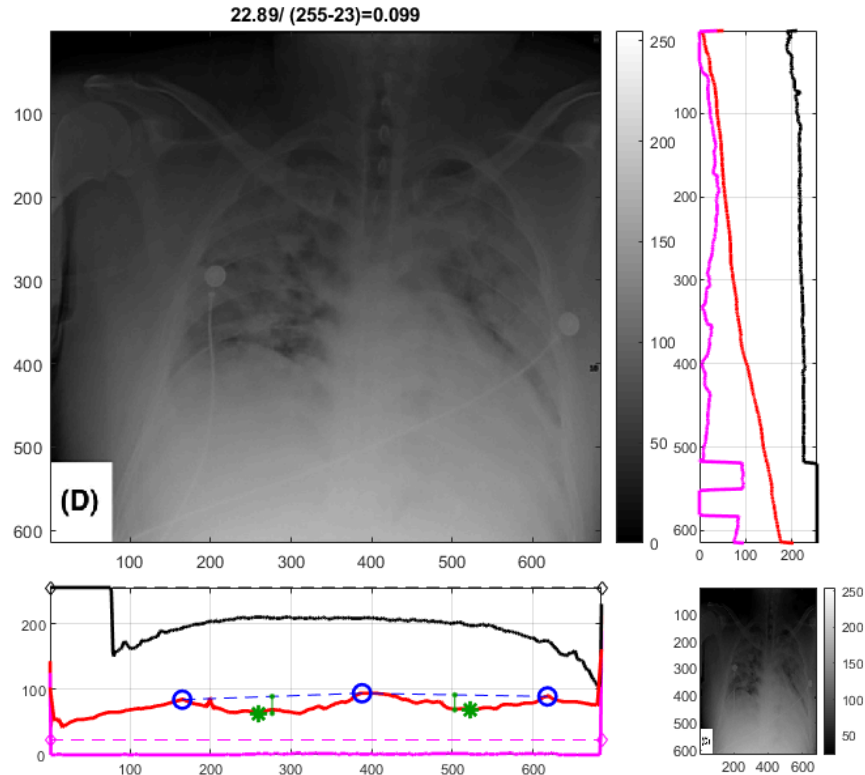


Figure 5: Medium Contrast (0.09). Notice that despite the low contrast of the image, the "W" shape is still detected.

## 4 Code

All the code was developed in Matlab® (The Mathworks<sup>TM</sup>, Natick, MA, USA) and is available open-source in GitHub from: <https://github.com/reyesaldasoro/QualityChestXray>

## References

- [1] Joseph Paul Cohen. <https://github.com/ieee8023/covid-chestxray-dataset>, Jun 2020.