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Image Processing
Use of algorithms to segment images

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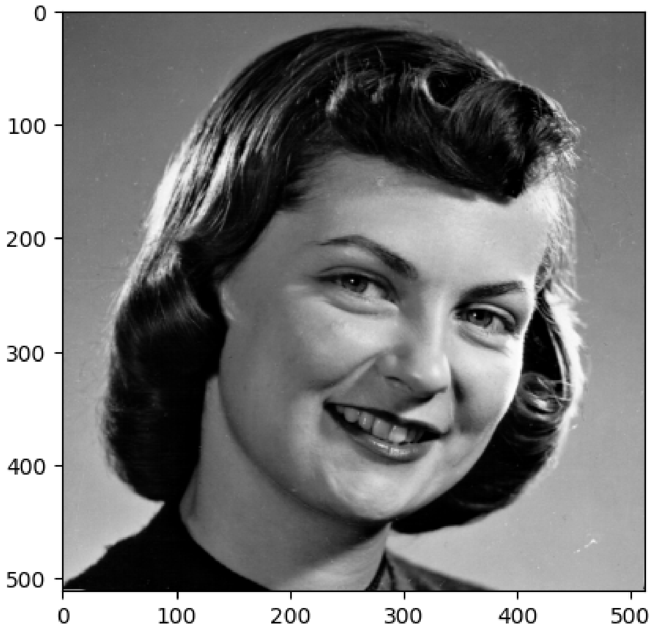
Summary

Using a variety of algorithms, we want to segment an image and search for valuable insights of it, while exploring with the parameters or restrictions we manage on it.

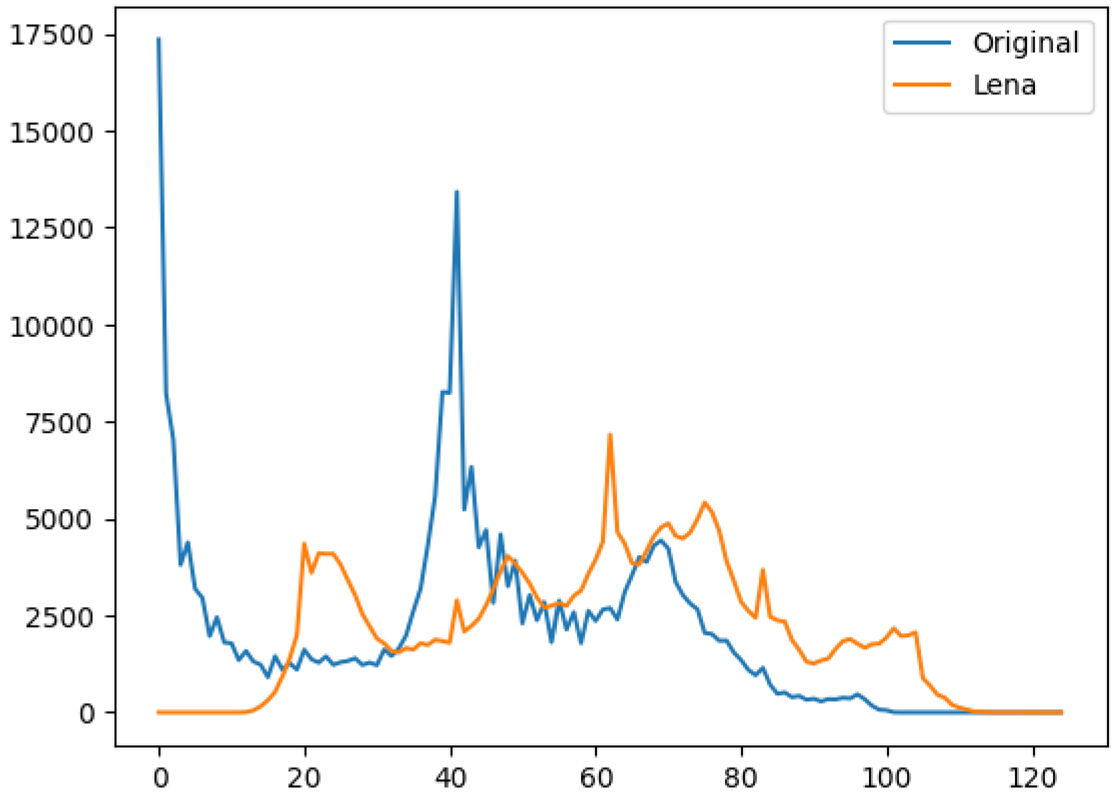
ROC curves, ground truth segmentation, mean-shift and region growing are the selected algorithms for this report.

The image we will be working with is the following:



Plotting

Our first task is to plot the histogram of the image, to check which values could work for the segmentation. To ensure the histogram is working, and compare the results, we compare these 2 images.



We can clearly see a division around 20 and 50 on the original histogram, being these 2 good values to use as thresholds when using the ground truth segmentation.

1. Threshold = 20

2. Threshold = 50

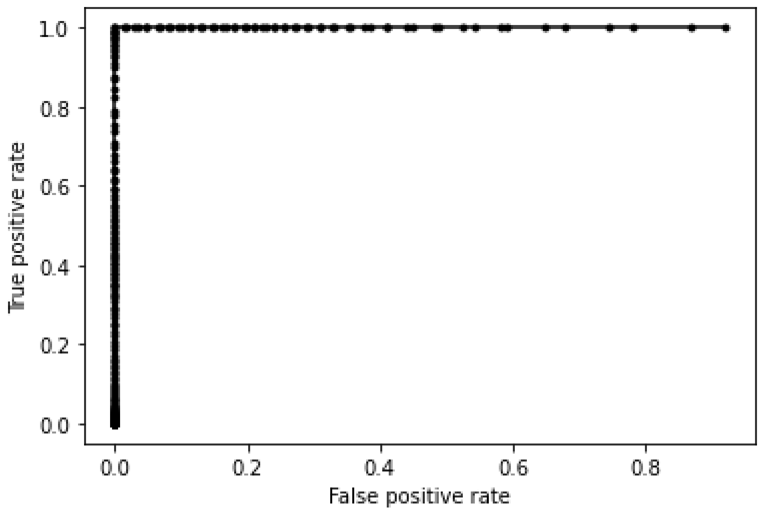
3. Threshold = 80

Using these limits we can denote a good threshold. We can see how using 20 we get a good segmentation. Nevertheless, 50 gives us a better definition at areas such as the eyebrows, mouth and nose, having a more complete facial expression.

If we take 80, the results are good, but areas such as the neck get affected by shadows, and we have noise on the upper borders of the image.

ROC Curve

The ROC curve helps us to represent the proportion over the false positive and true positive rate, to determine if our model is segmenting properly.



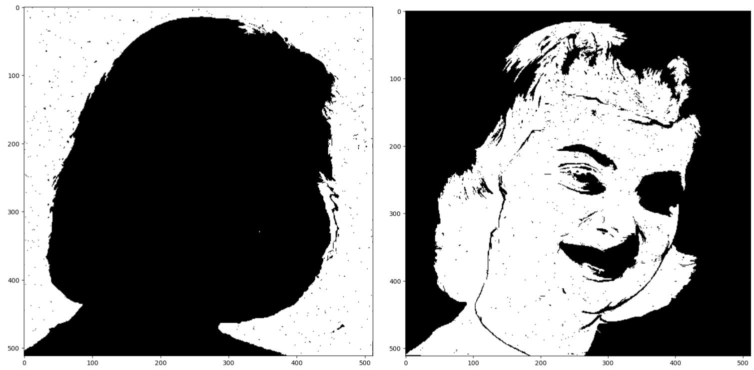
Our graphic shows an incredible performance, bordering on perfection.

Nevertheless, the information is not valuable as the graphics are simply linear. We will have to change how we model the data in order to get better results.

Region growing algorithm

This algorithm is based on selecting certain points, named seeds, and expanding to the neighboring pixels if they meet certain requirements, as having similar values. The concept is similar to how flood fill works.

In our implementation, seeds are being generated randomly. We visit the 8 neighbors of the pixel in the image (if existing), and calculate how different it is from the original with the absolute difference, that if it’s behind a threshold we set it and add it to the visited stack.



As we can see in the images, this method works well when we have specific seeds over where we want to expand from. We cannot control which regions to encapsulate if we randomly select the seeds though.

In order to get better results, we have to be more selective on the seeds, starting on areas we specifically want to segment, and try with multiple thresholds or ranges where we want to select our pixels.

Mean shift algorithm

The mean shift algorithm searches for the centroid over certain seeds. As an iterative method, every iteration it searches for a better centroid and keeps improving until it converges.

The results are really good, it works well to define areas as the hair, eyes, eyebrows, mouth, and cluster with 2 different colors the face over the shades created by the light incidence.

The implementation of the algorithm requires an optimization if we want it to make it run faster, but even though it works well with the current complexity.

This algorithm, although runs slower than the previous one, has smoother results and a better segmentation over certain places in the image.