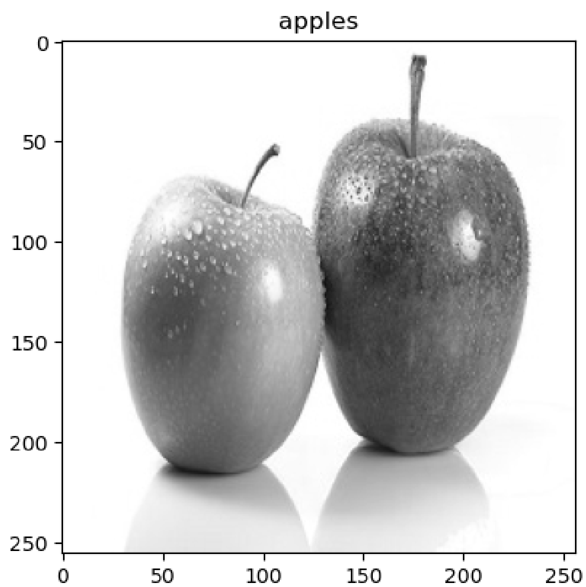
Name: Giovanni Scialla - Matr: 239181

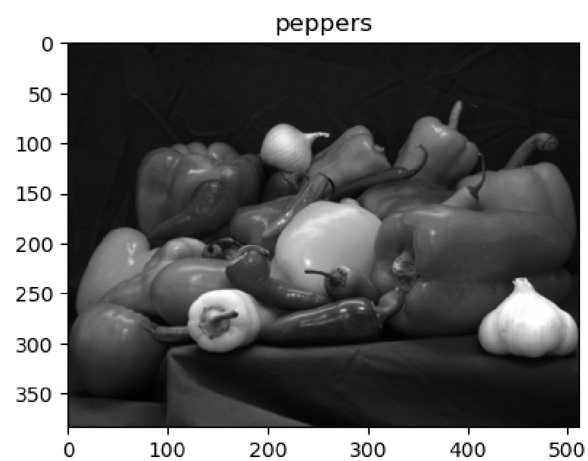
Region Detection
Examination session: 21/02/2023

Signals, images and videos

Region Growing

To test the various algorithms we will be using two different kind of images on a gray-scale level. The first one showing two apples with some tricky points of light and shadow while the second one, more challenging, showing a variety of vegetables at different levels , shapes and intensity color.

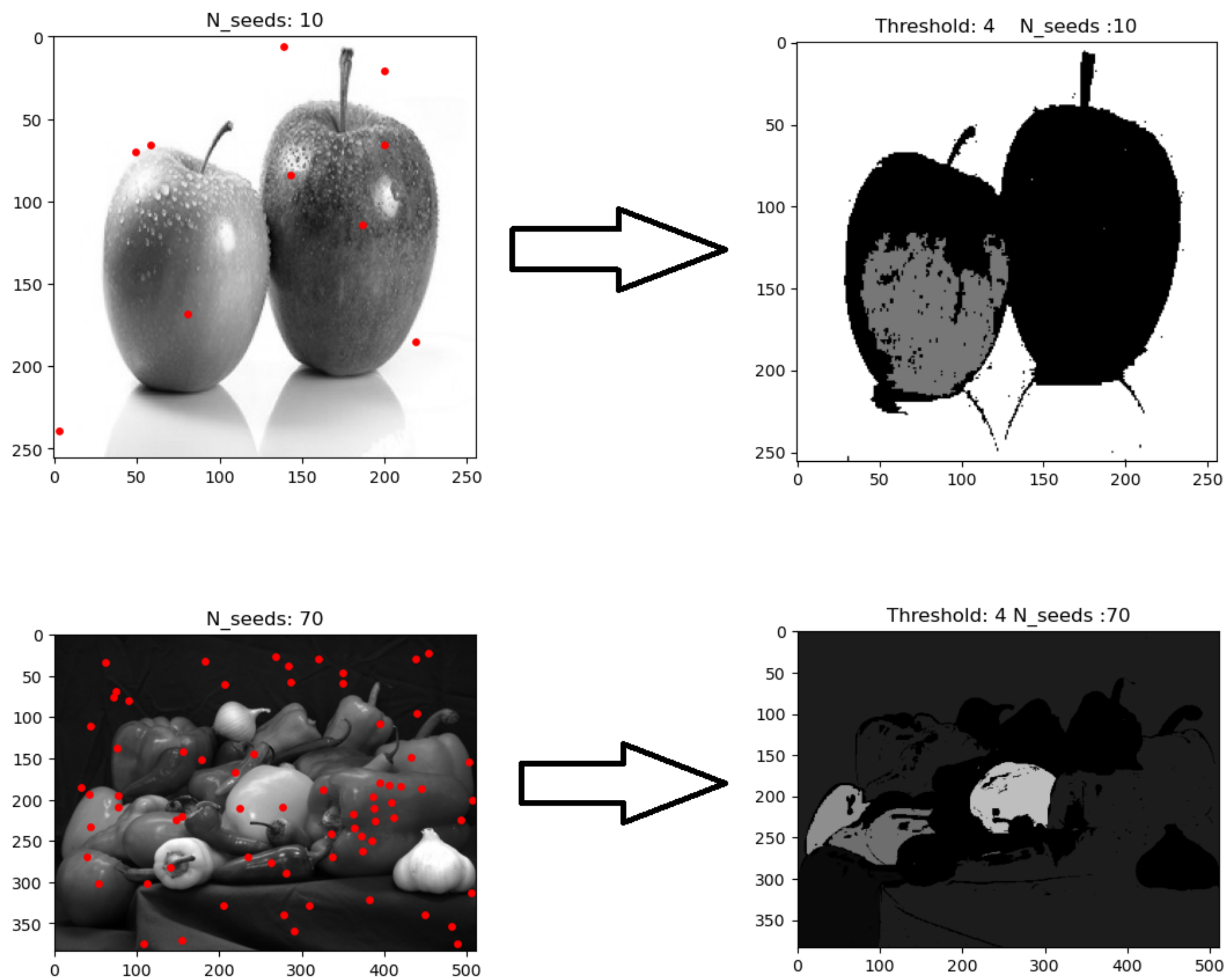




The algorithm starts from a set of atomic elements called seeds (in our case each seed is a single pixel) and from them it starts to grow regions by iteratively checking the 4-connected neighbors pixels and merging them if they satisfy some homogeneity rule. we will be using the intensity difference as a rule for merging regions.

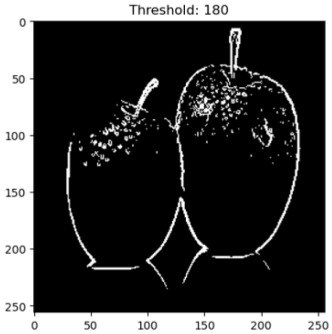
0.1 Random Seeding

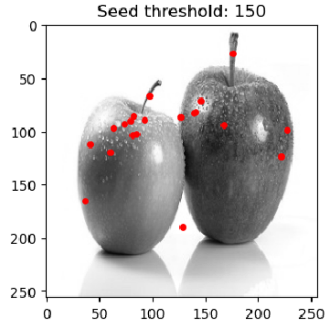
the easiest approach in choosing the initial set of seeds would be to choose a fixed number of seeds randomly. This kind of approach may be sufficient in the case of the apples , even with a small number of initial seeds, since there is an high possibility that each apple will have at least 1 seed from which detect the object. But it performs poorly in the second case image.

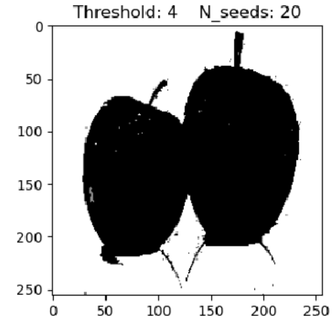


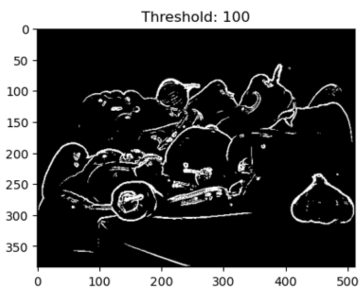
0.2 Gradient Seeding

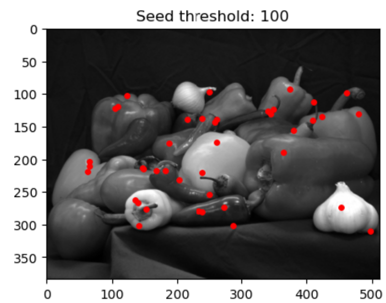
A more sophisticated technique would be to choose the initial set of seeds based on the centroids of minimum gradient areas. First we calculate the gradient of the image and get the associated binary map , secondly we compute the centroid of each component and finally we can obtain the pixels with low gradient magnitude. If the gradient magnitude is less than a given threshold, the centroid is considered to be part of a region with low gradient magnitude

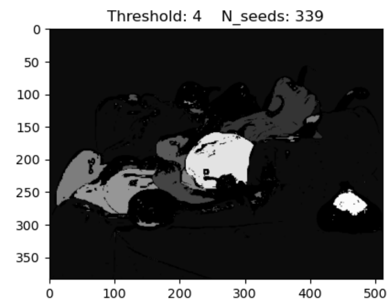








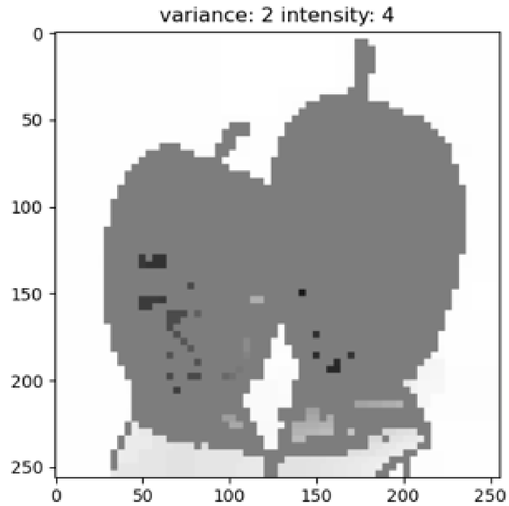


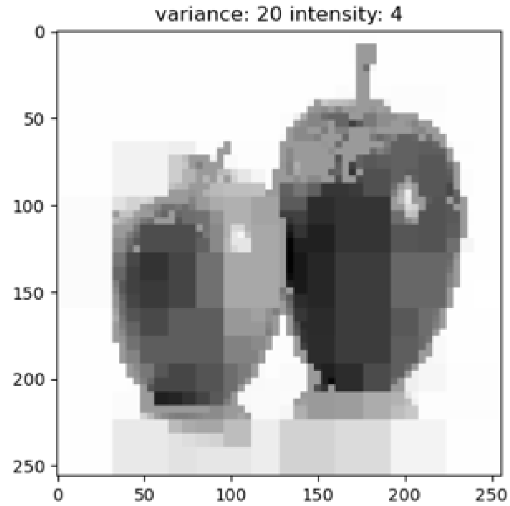


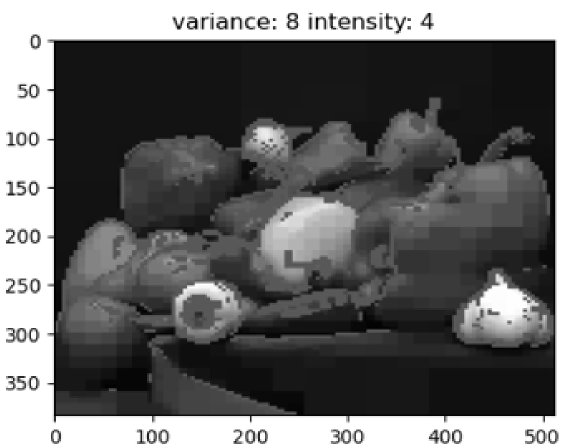
This technique is more well-suited in the case of the peppers

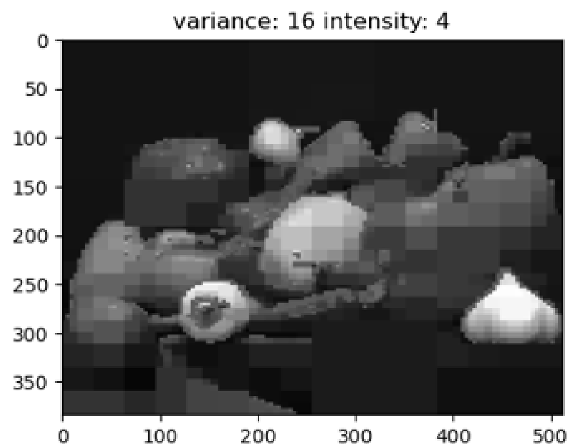
Split & Merge

The split and merge algorithm is a sophisticated technique that consist in two distinct phases.
During the split step the image is recursively divided into 4 equally-sized sub-regions based on the standard deviation within each sub-image. This process continues until all sub-regions satisfy the homogeneity rule or a minimum size is reached.
During the merge step pairs of adjacent blocks are progressively fused together if their difference of intensity is below a certain threshold. To keep track of adjacent regions the Region Adjacency Graph (RAG) structure is used.









Transformations

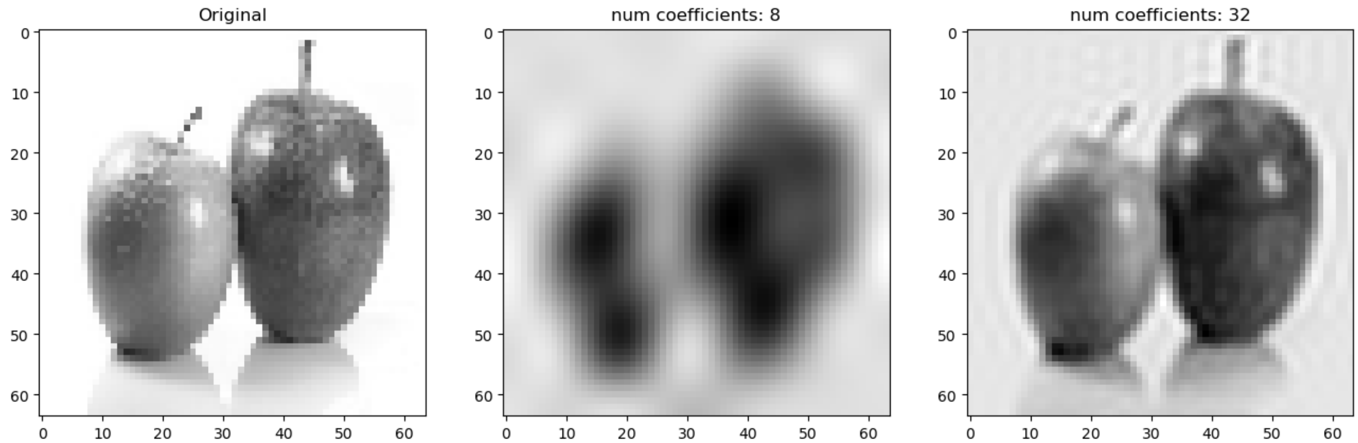
One of the use of these transformations functions are to use them as a pre-processing step to smooth the signal or image in a way that it can be better interpreted and manipulated by the next processing steps or to remove some background noise

0.3 Discrete Cosine Transform (DCT)

$$G_{u,v} = \frac{1}{4}\alpha(u)\alpha(v)\sum_{x=0}^{7}\sum_{y=0}^{7} g_{x,y}\cos\left[\frac{(2x+1)u\pi}{16}\right]\cos\left[\frac{(2y+1)v\pi}{16}\right]$$

This function transforms a signal or image from the spatial domain to the frequency domain.
Since this function is very computationally expensive i had to resize the sample image from (256x256) to

(64x64) to speed up the process.

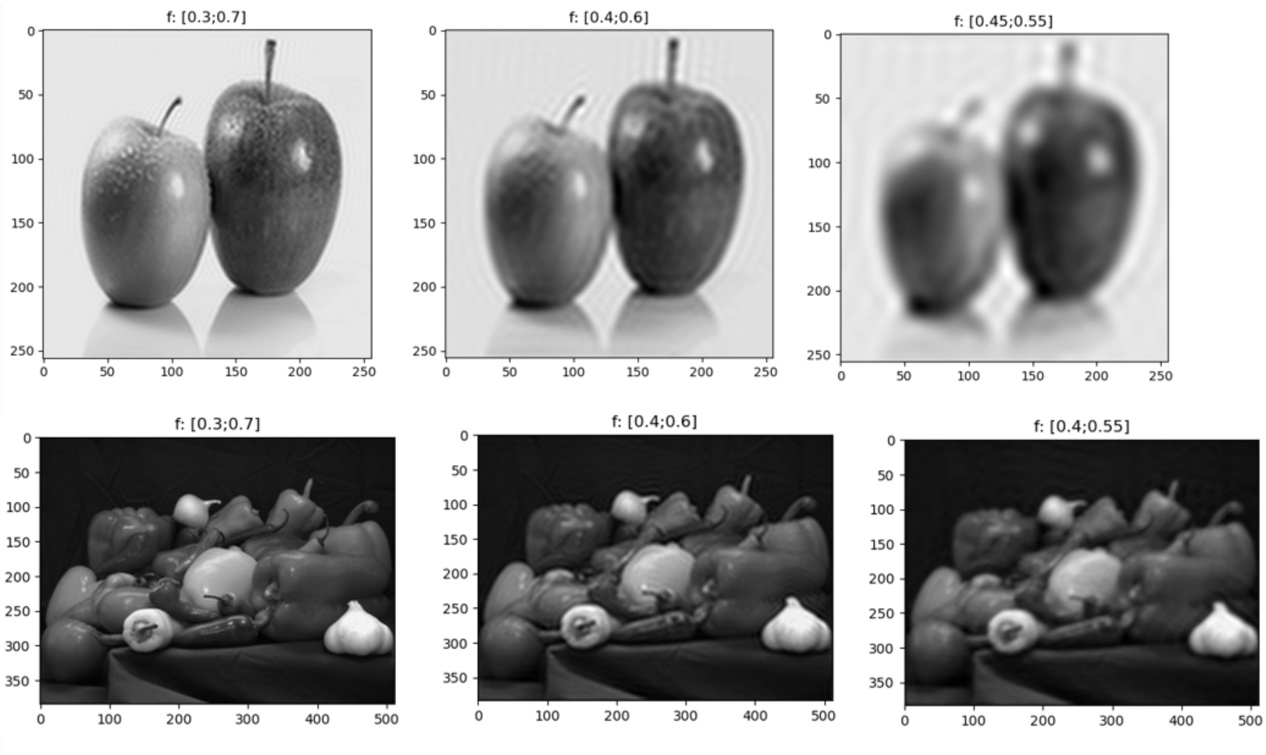


0.4 Fast Fourier Transform (FFT)

The Fast Fourier transformation, as the name suggest, it's a faster way to get an image in the frequency domain.

$$x[k] = \sum_{n=0}^{N-1} x[n] e^{\frac{-j2\pi kn}{N}}$$

The FFT decomposes an image into sines and cosines of varying amplitudes and phases, which reveals repeating patterns within the image.
Low frequencies represent gradual variations in the image; they contain the most information because they determine the overall shape or pattern in the image. while high frequencies correspond to abrupt variations in the image; they provide more detail in the image, but they contain more noise.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f: [0.4;0.6]
f: [0.45;0.55]
f: [0.3;0.7]
f: [0.4;0.6]
f: [0.4;0.55]