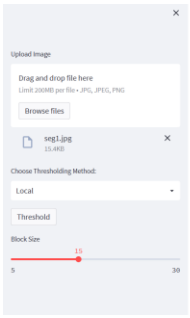
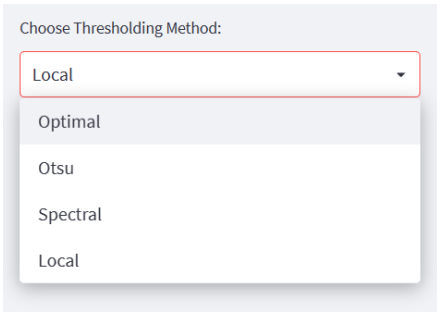
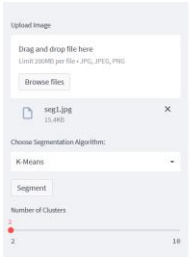
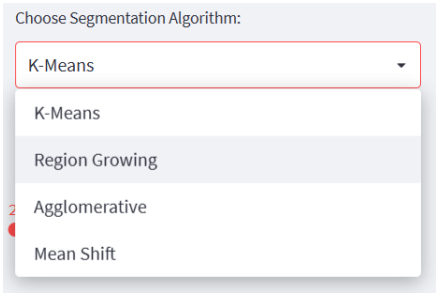
Image thresholding and segmentation

Image thresholding and segmentation are important image processing tasks used to extract useful information from images by dividing them into meaningful regions. In this report, we present several thresholding and segmentation methods commonly used in image processing:





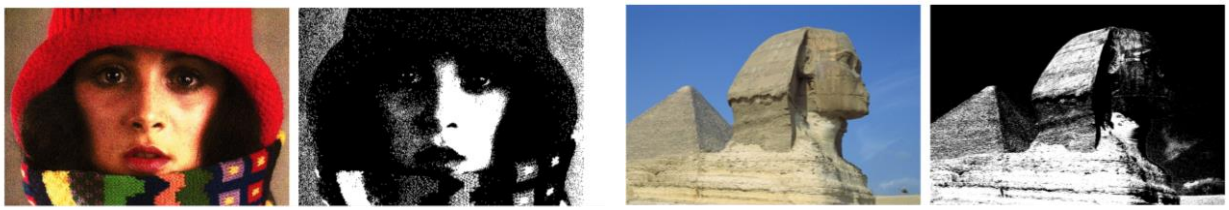




a) Thresholding:

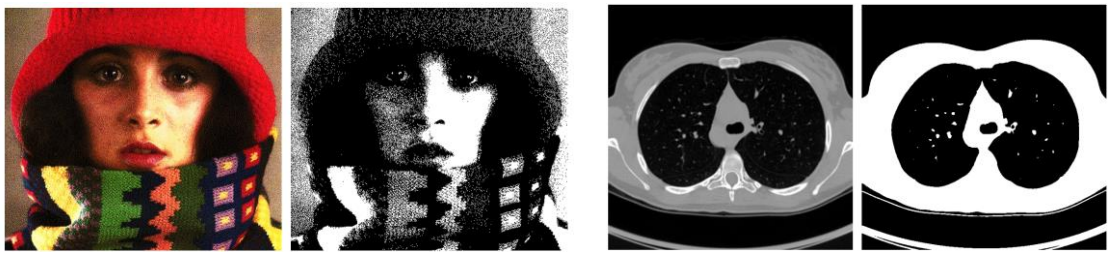
Thresholding is a process of converting a grayscale image into a binary image by selecting a threshold value that separates the image into two regions. The threshold value can be manually set, or it can be determined automatically using various thresholding algorithms.

1. Optimal thresholding:



Optimal thresholding is a method that uses the histogram of the image to determine the optimal threshold value. It calculates the variance between the two regions separated by each possible threshold value and selects the threshold value that maximizes the between-class variance. The optimal thresholding method is good for images with bimodal histograms.

2. Otsu thresholding:

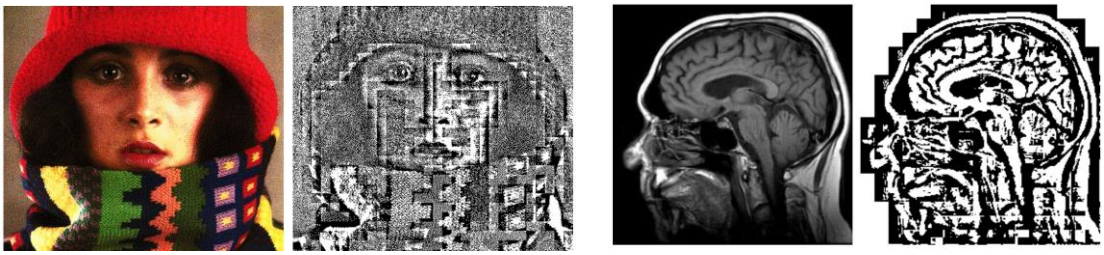


Otsu's thresholding method is a technique that automatically calculates the threshold value by maximizing the variance between the two classes of pixels in the image. It assumes that the image contains two classes of pixels (foreground and background) with different intensities.

3. Spectral thresholding:

Spectral thresholding is a method that identifies more than two modes in the histogram of the image. It uses spectral clustering to group the pixels into clusters based on their intensity values. The number of clusters is determined by the eigenvalues of the Laplacian matrix of the image.

4. Local thresholding:

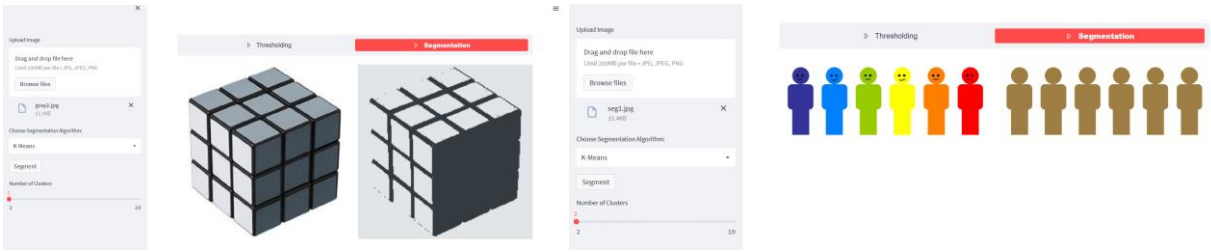


Local thresholding is a method that calculates the threshold value for each pixel based on the values of the surrounding pixels. It is useful for images with non-uniform illumination.

b) Unsupervised Segmentation:

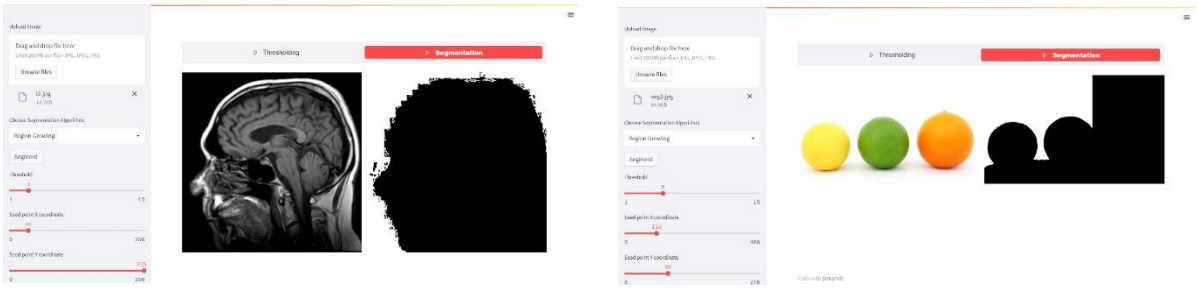
Unsupervised segmentation is a process of dividing an image into multiple regions or segments without any prior knowledge of the image. It is a challenging task as it requires identifying the boundaries of different objects in the image.

1. K-means:



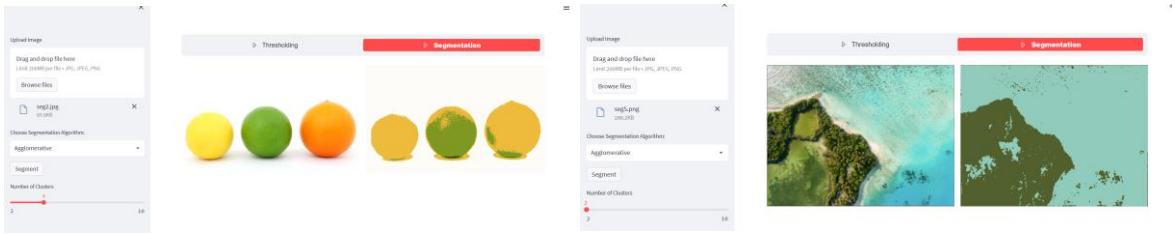
K-means is a clustering algorithm that groups the pixels into K clusters based on their similarity. The algorithm works by randomly selecting K initial cluster centers and then iteratively updating the cluster centers until convergence.

2. Region growing:



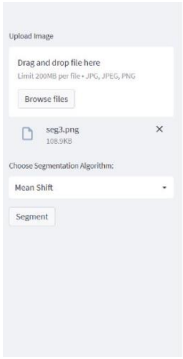
Region growing is a method that groups adjacent pixels with similar intensity values into a region. It starts with a seed pixel and grows the region by adding neighboring pixels with similar intensity values.

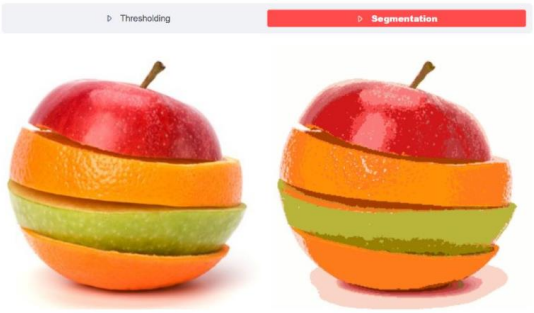
3. Agglomerative:



Agglomerative clustering is a hierarchical clustering algorithm that starts with each pixel as a separate cluster and then iteratively merges the closest clusters until only one cluster remains.

4. Mean shift:





Mean shift is a clustering algorithm that groups pixels based on their density. It works by iteratively shifting each pixel towards the mean of the pixels within a certain radius until convergence. The resulting clusters are defined by the modes of the density function.