CMP_SC 7650: Digital Image Processing
Homework 4: Detection and Segmentation of Structures of Interest
By: Mikey Joyce
Due: 10/19/2023

Abstract:

The problem presented in this assignment is to demonstrate competence utilizing preprocessing filtering techniques. With the preprocessed images and image processing libraries, we are to demonstrate Laplacian of Gaussian blob detection and K-means clustering based segmentation.

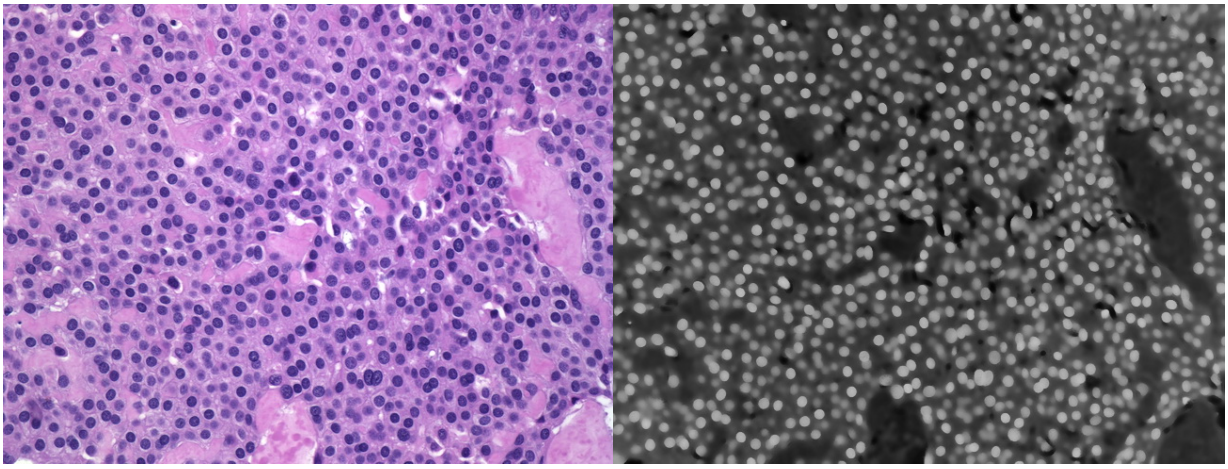
Introduction:

In this assignment two test images were given. This assignment will be broken up into two separate sections. The first section (or experiment) will revolve over the GlomusTumor6.jpg image where the preprocessing, the Laplacian of Gaussian blob detection, and the K-means segmentation will all be performed and reported. The second section will revolve around the metastic-breast-cancer.jpg image and the same items as the first experiment will be performed and reported.

Experiments and Results:

Experiment #1 (Glomus Tumor):

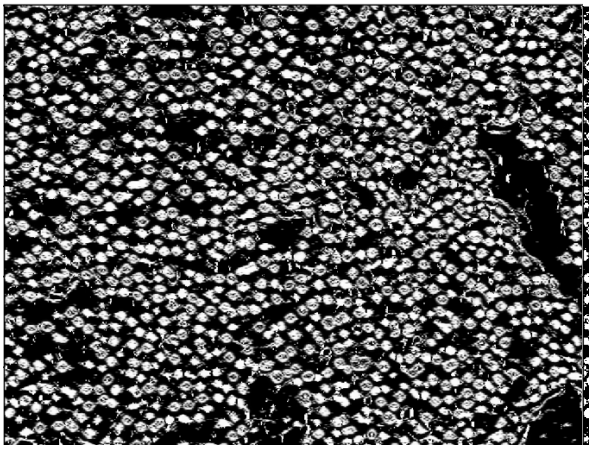
Preprocessing:



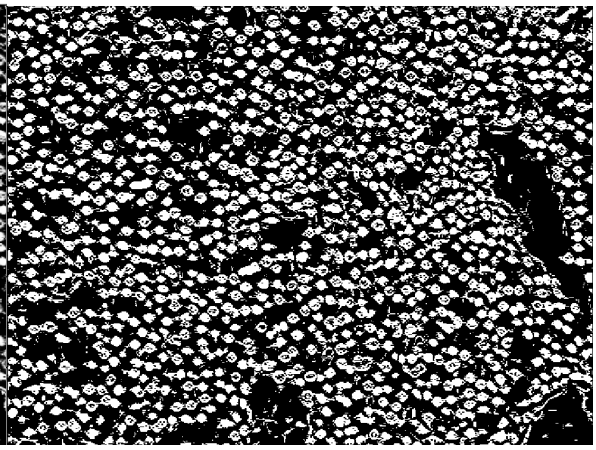
Original Image Preprocessed Image

Laplacian of Gaussian Blob Detection:

LOG output

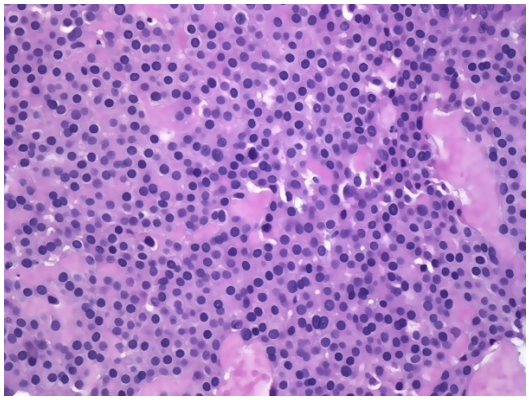


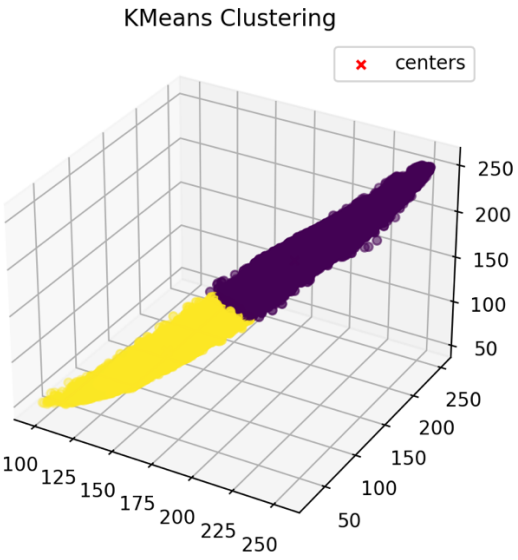
Binary Output



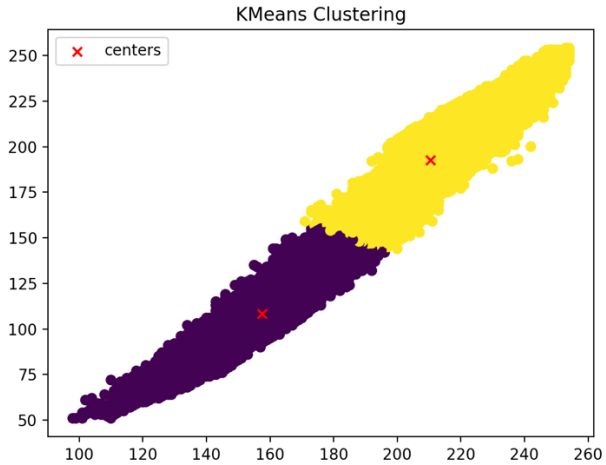
K-means Clustering Segmentation:

Pre-processed image for k-means

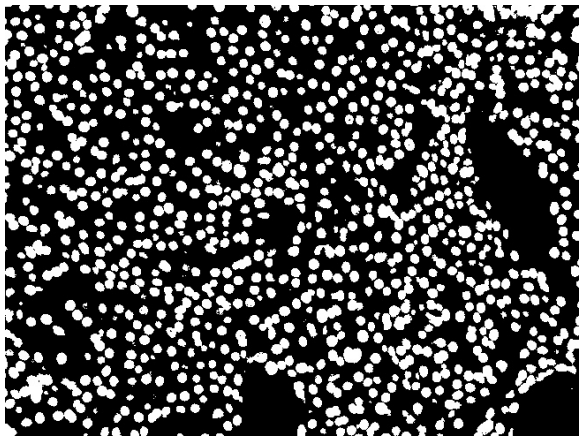




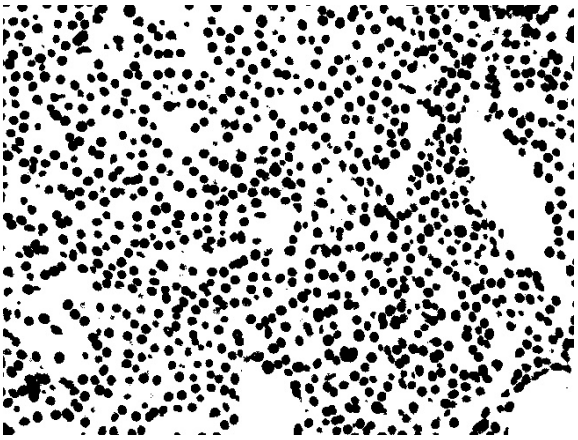
Feature Set #1



Feature Set #2



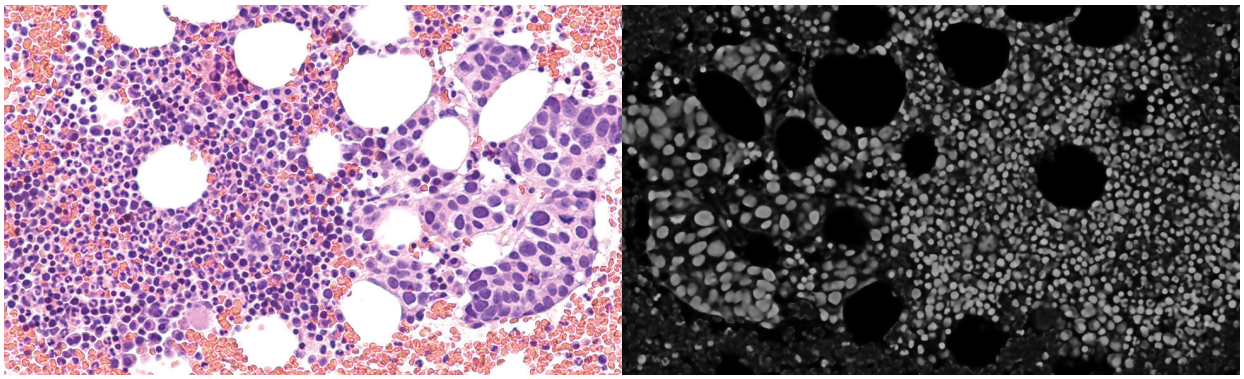
Feature Set #1



Feature Set #2

Experiment #2 (Breast Cancer):

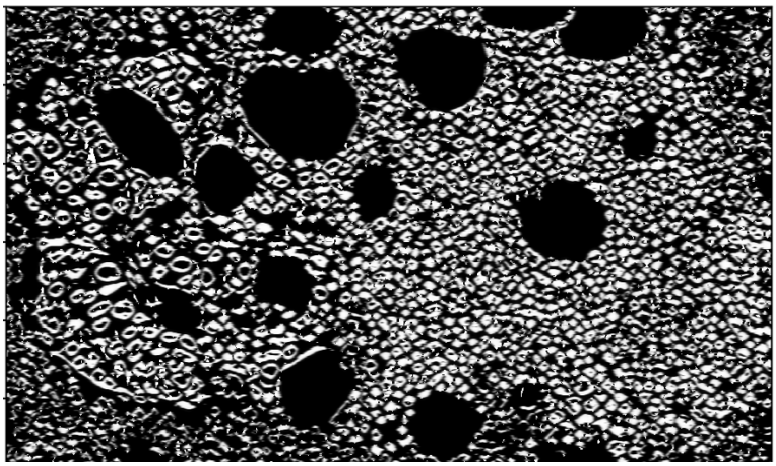
Preprocessing:



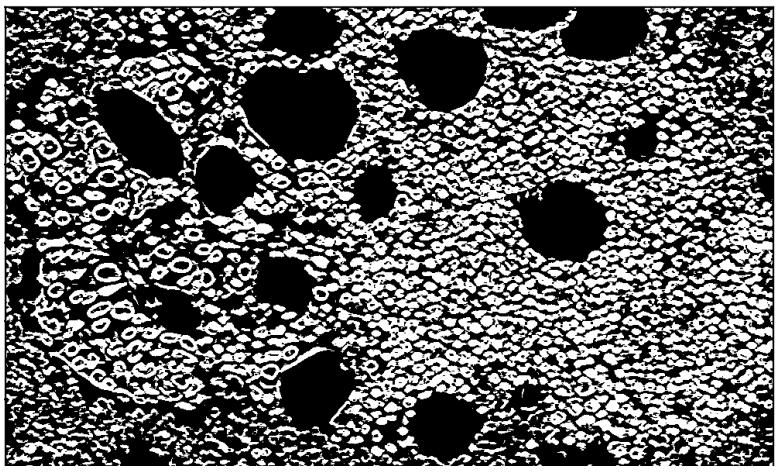
Original Image

Preprocessed Image

Laplacian of Gaussian Blob Detection:

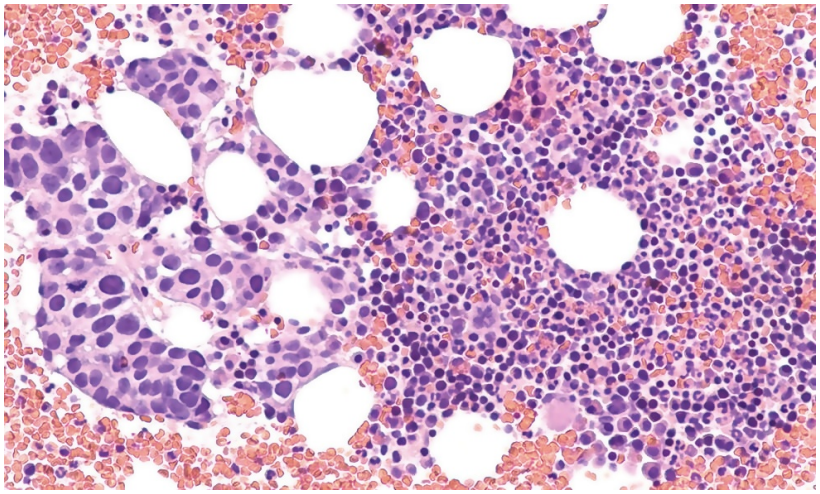


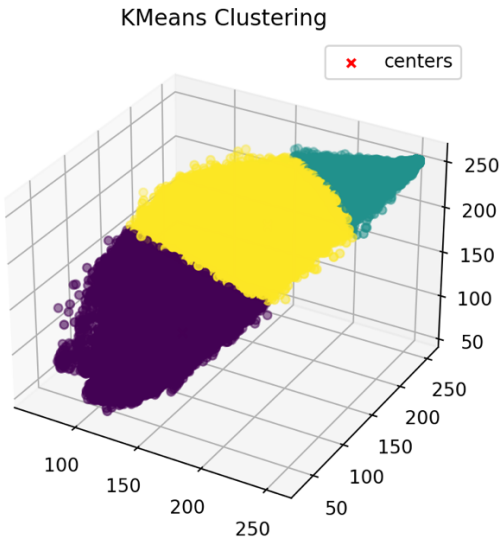
Above: LOC output; Below: Binary output



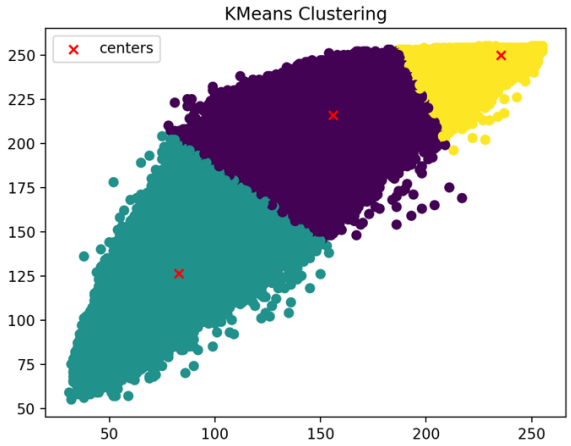
K-means Clustering Segmentation:

Preprocessed image for k-means

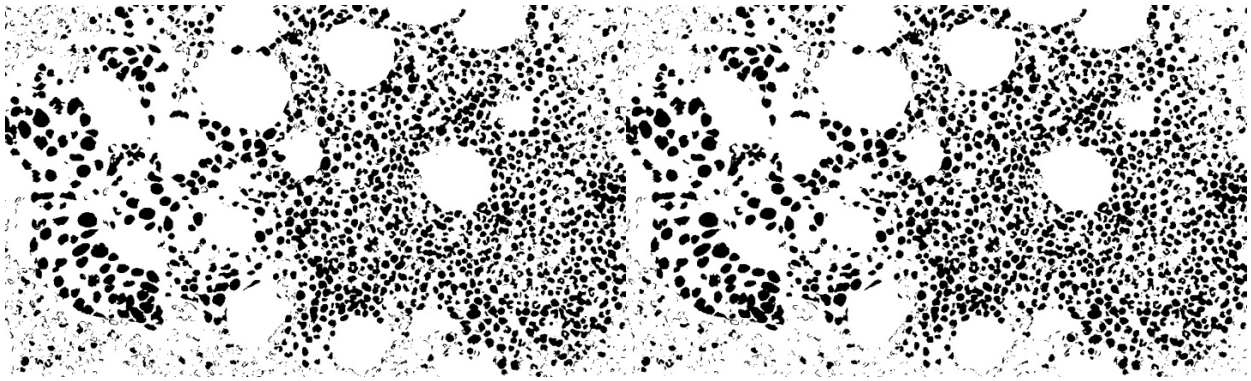




Feature Set #1



Feature Set #2



Feature Set #1 Feature Set #2

Conclusion:

In this conclusion there will be discussion involving the preprocessing of the two given test images and the blob detection and image segmentation that was performed on each image. For the preprocessing step, I decided to use a bilateral filter on both the glomus tumor image and the breast cancer image. I wanted to remove the noise while still preserving the edges of the image and it seemed like a good cleanup with only one line of code. I then picked the red channel for both the images and then inverted the image, so the blobs were white and the background was black, which allowed for the blobs to pop out. I will talk about how the preprocessing of the images differed for k-means when I talk about the k-means clustering.

Next, lets discuss the blob detection using the Laplacian of gaussian (LoG) filter. For the Glomus tumor, I was able to detect a decent amount of the blobs with a scale of sigma=0.9. However, within the image there are still some white spots where it looks as if there are some false positives. One way this could possibly be fixed is by performing an erosion operation and then a dilation operation to get a cleaner detection. For the breast cancer image, it was a bit harder to perform the detection. It seemed a lot more noise was picked up on by the Laplacian filter and is especially prevalent when the binary mask of the image is obtained. The scale of this image was sigma=1.5 in attempt to detect the larger blobs.

Lastly, the k-means clustering segmentation will be discussed. The preprocessing for the k-means clustering was slightly different than for the blob detection. Instead of just choosing the red color channel, I decided to apply the bilateral filter to the entire spectrum of the RGB image. I did this because I wanted to use each color channel in the clustering separately, while still removing the noise of the

images. For both the glomus tumor and the breast cancer the first feature set I utilized was a 3D feature set where R, G, and B all were independent features. When looking at the original glomus tumor image, it appeared like there was only 2 colors, so I decided to set the number of clusters in the K-means to be 2. This produced a satisfactory result that segmented the purple blobs from the image. You can also see the 3D plot of the output of the k-means clustering where you see two separate clusters. The second feature set that I used for the glomus tumor was the red and blue channel, dropping the green channel. The results appear to be similar to the original clustering, showing that the green feature did not really contribute all that much. It is clear that the red feature was the most important feature for the clustering. For the breast cancer, the red, green, and blue was also the original feature set. This time it appeared there were 3 different colors in the image so when running K-means I set the number of clusters to 3. This resulted in obtaining 3 clear clusters which allowed for the segmentation of the image. Since there were 3 different clusters though I had to make the observation that the cluster we wanted to segment out was the cluster with the center with the lowest magnitude (the purple cluster in the 3D plot for the breast cancer K-means). For the 2nd feature set I decided to use only the green and red channel. Similar to the glomus tumor, there was not much of a difference in clustering due to the blue feature not providing much more information, again it is clear that the red feature was the most important feature to cluster this dataset.

References:

- Libraries and tools: PyCharm, OpenCV, NumPy, Matplotlib, Sklearn, SciPy, Preview
- Slides for lecture 9: Blob Detection
- Slides for lecture 10: Clustering Based Segmentation