COL783:DIGITAL IMAGE ANALYSIS
Assignment: 4

Submitted by
Dharmeswar Basumatary(2020CS50423)
Mojahid Hussain(2020CH70182)

Part A:

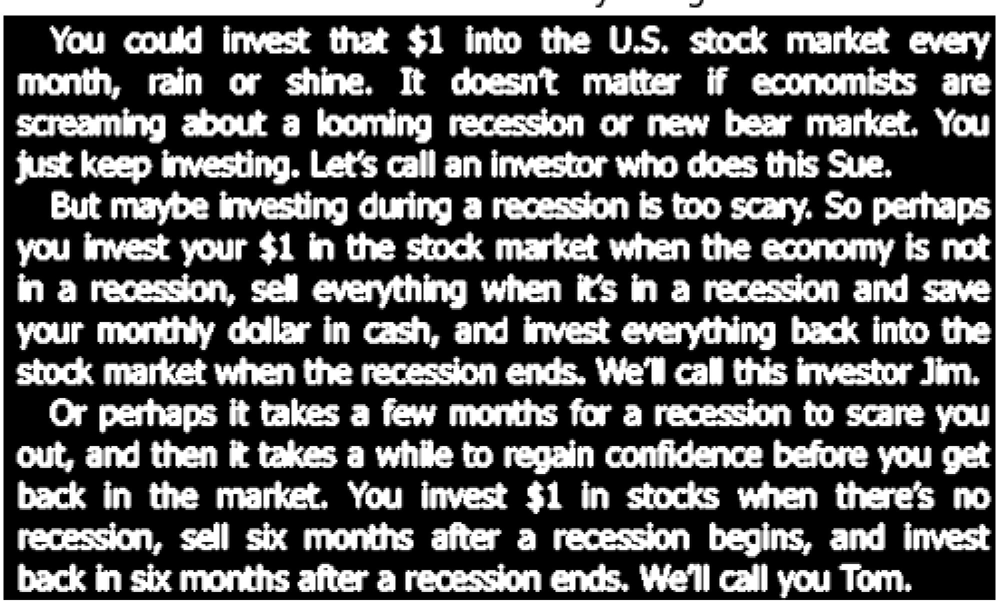
Q1.

a)

Binary Image A

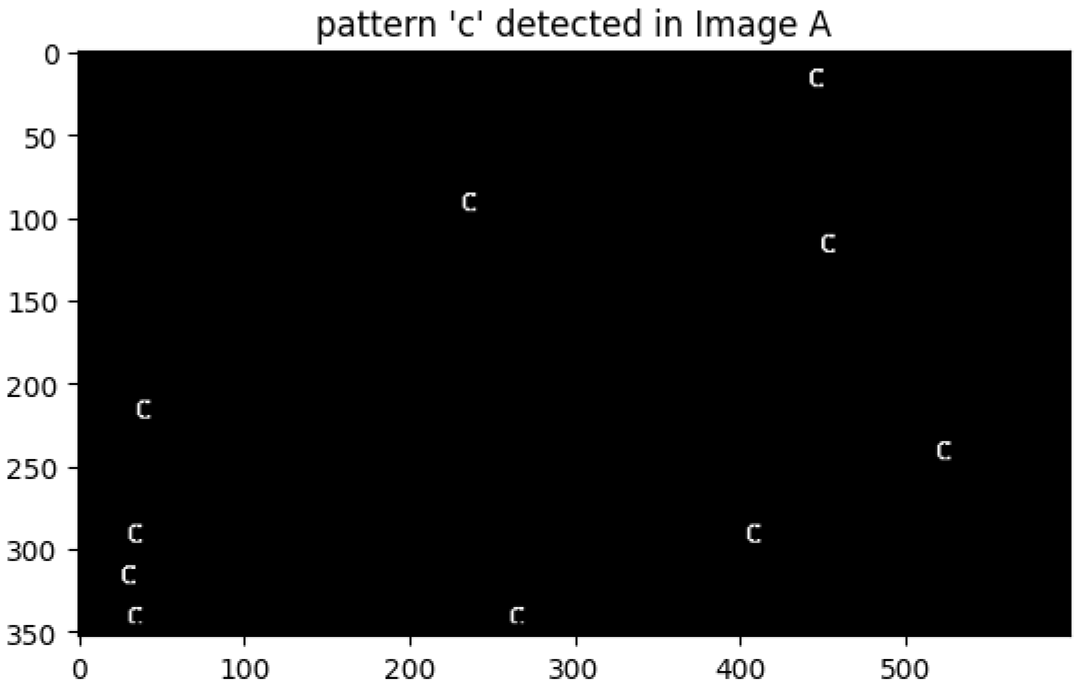

You could invest that $1 into the U.S. stock market every month, rain or shine. It doesn't matter if economists are screaming about a looming recession or new bear market. You just keep investing. Let's call an investor who does this Sue.
But maybe investing during a recession is too scary. So perhaps you invest your $1 in the stock market when the economy is not in a recession, sell everything when it's in a recession and save your monthly dollar in cash, and invest everything back into the stock market when the recession ends. We'll call this investor Jim.
Or perhaps it takes a few months for a recession to scare you out, and then it takes a while to regain confidence before you get back in the market. You invest $1 in stocks when there's no recession, sell six months after a recession begins, and invest back in six months after a recession ends. We'll call you Tom.

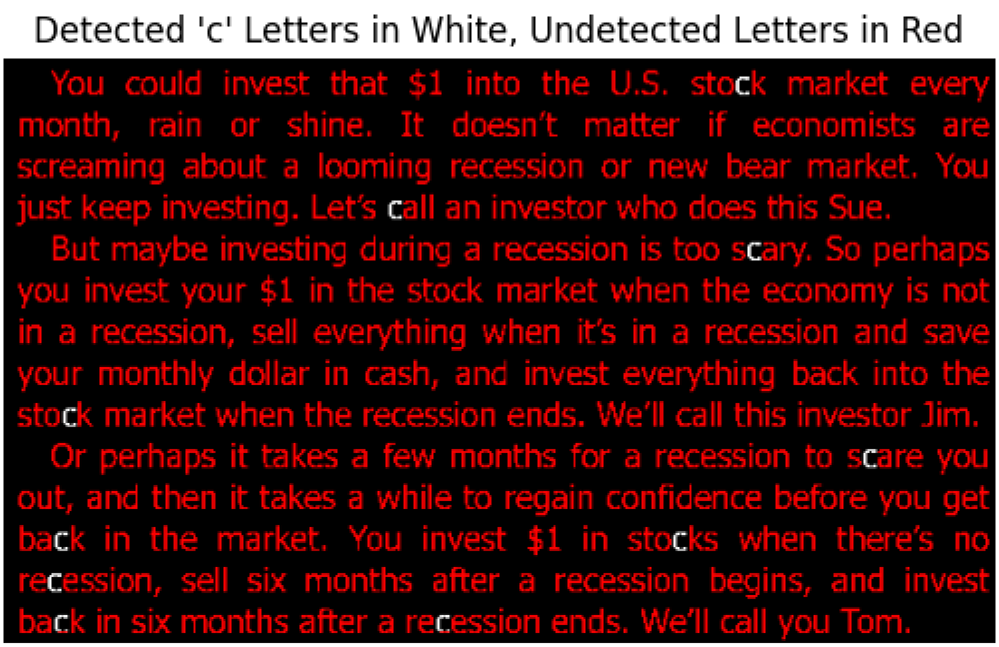
After dilation of Binary image A


You could invest that $1 into the U.S. stock market every month, rain or shine. It doesn't matter if economists are screaming about a looming recession or new bear market. You just keep investing. Let's call an investor who does this Sue.
But maybe investing during a recession is too scary. So perhaps you invest your $1 in the stock market when the economy is not in a recession, sell everything when it's in a recession and save your monthly dollar in cash, and invest everything back into the stock market when the recession ends. We'll call this investor Jim.
Or perhaps it takes a few months for a recession to scare you out, and then it takes a while to regain confidence before you get back in the market. You invest $1 in stocks when there's no recession, sell six months after a recession begins, and invest back in six months after a recession ends. We'll call you Tom.

b)

All 'c' are not detected because variations in font, size, rotation, or noise make them differ from the structuring element, preventing exact matches in the opening operation. Only "c"s closely resembling the structuring element are detected.

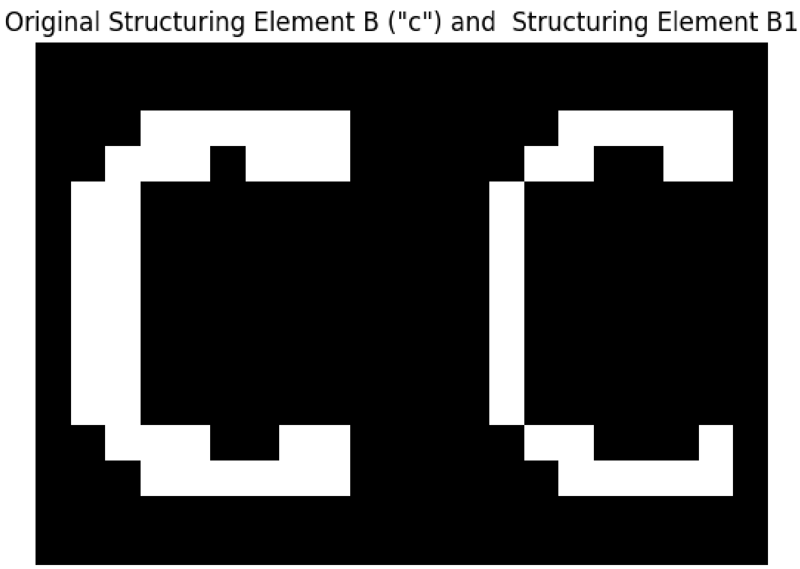


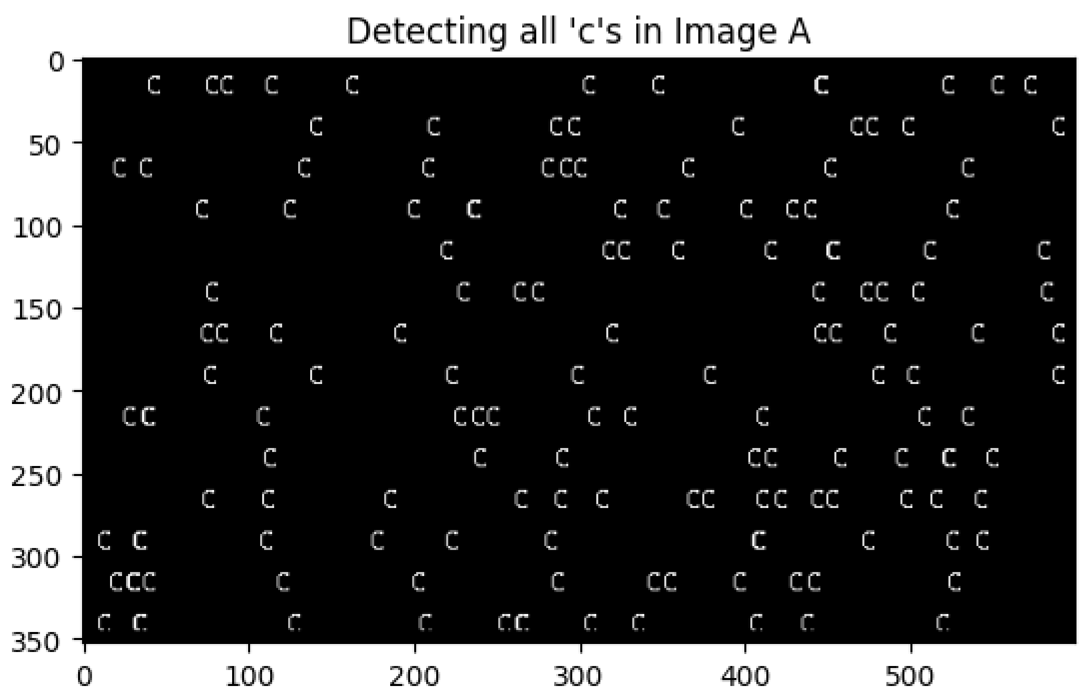


c)

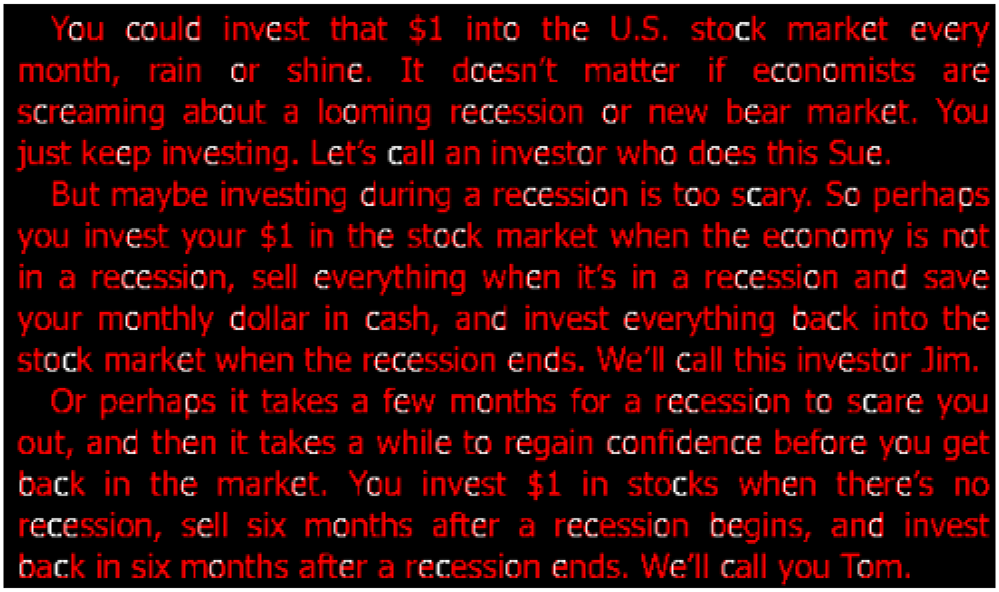
Z = `np.array([[0,0,0],[0,1,1],[0,0,0]])`

B1 = B ⊖ Z





Detected all 'c' and its superset



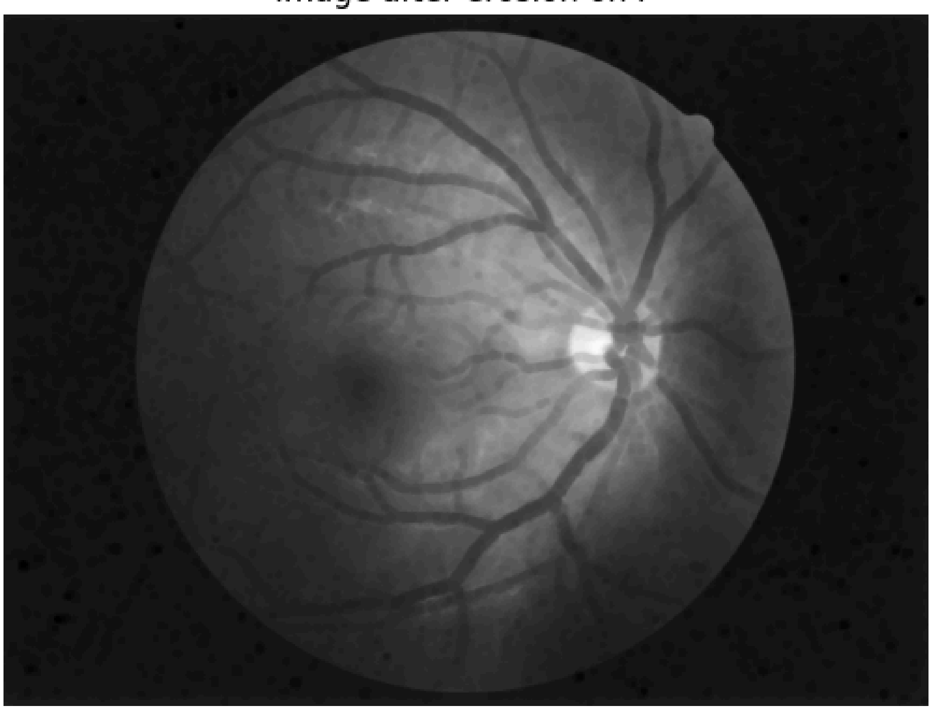
Q2:

a)

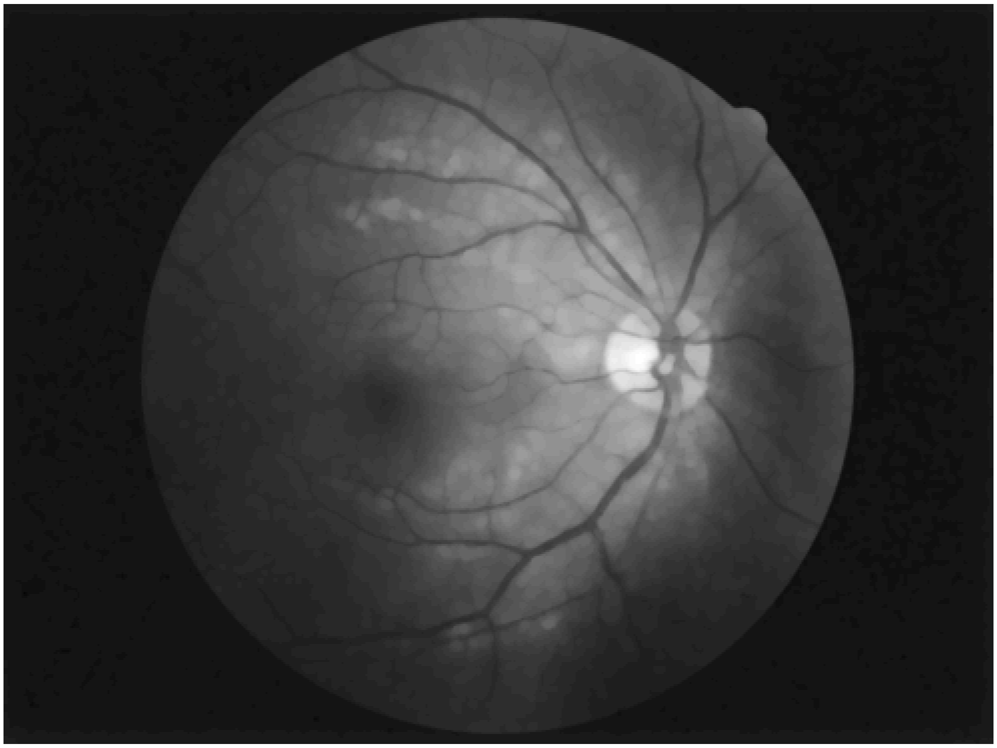
Disk radius = 5 , i.e. 11 X11 structuring element

Fundus image , F

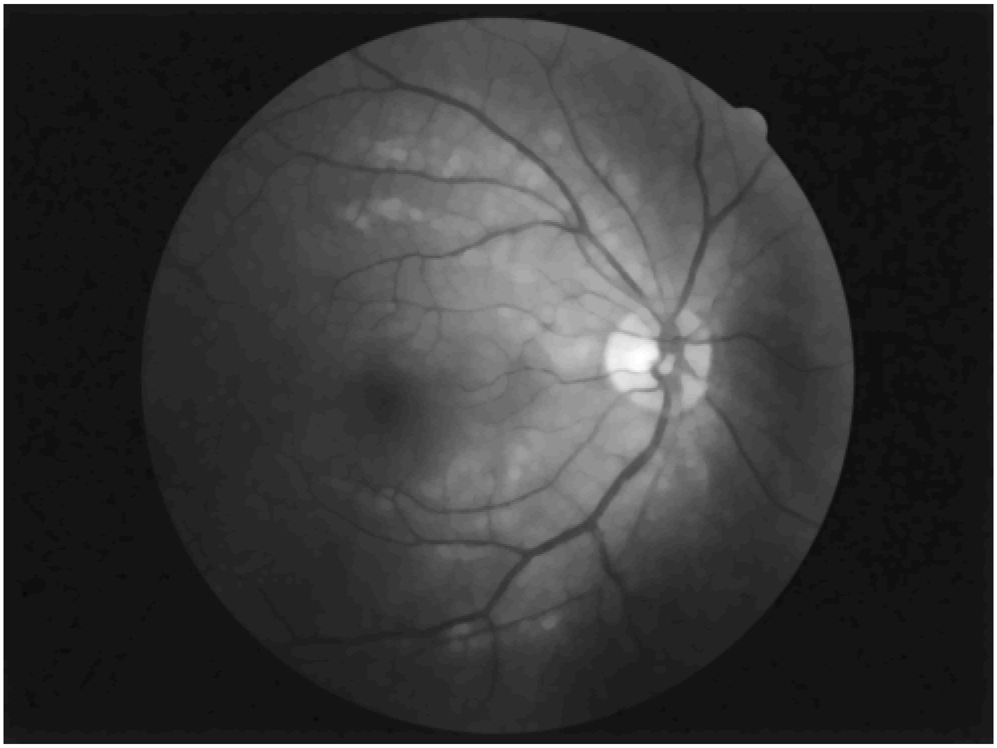
Image after erosion on F



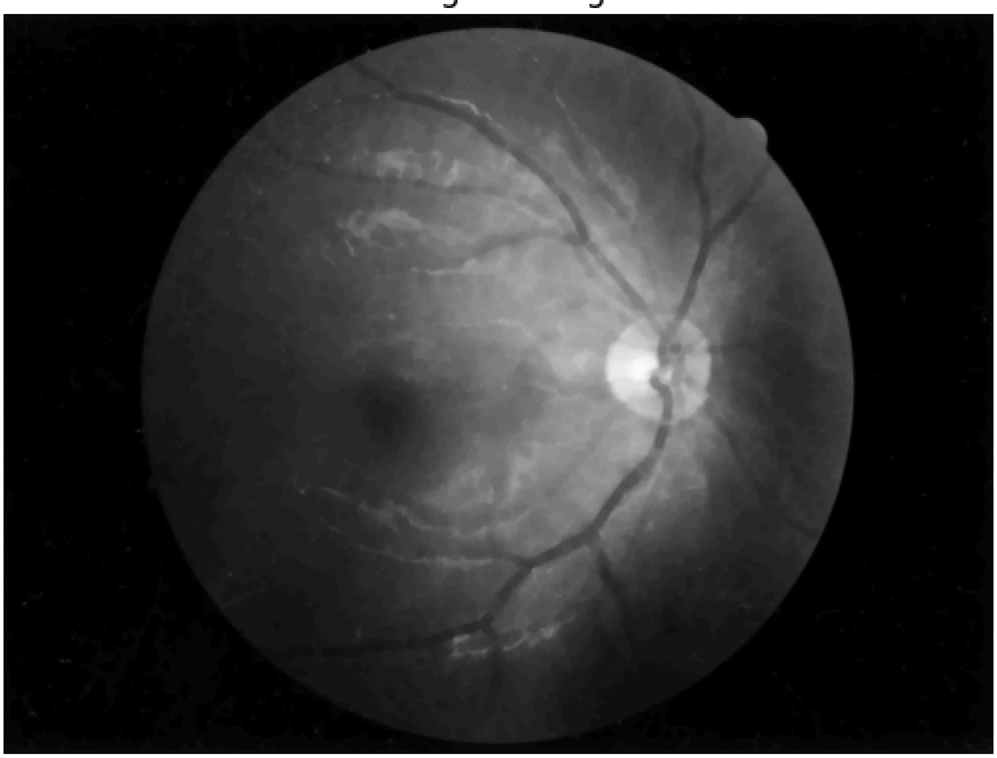
Dilation on Image F



Opening on Image F

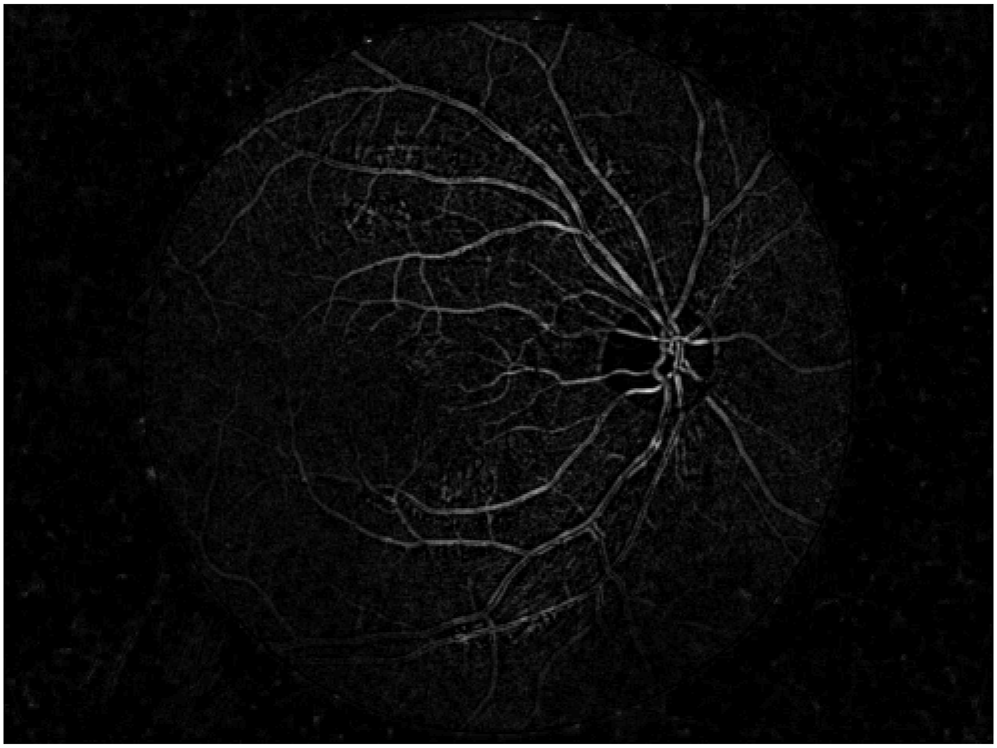


Closing on Image F

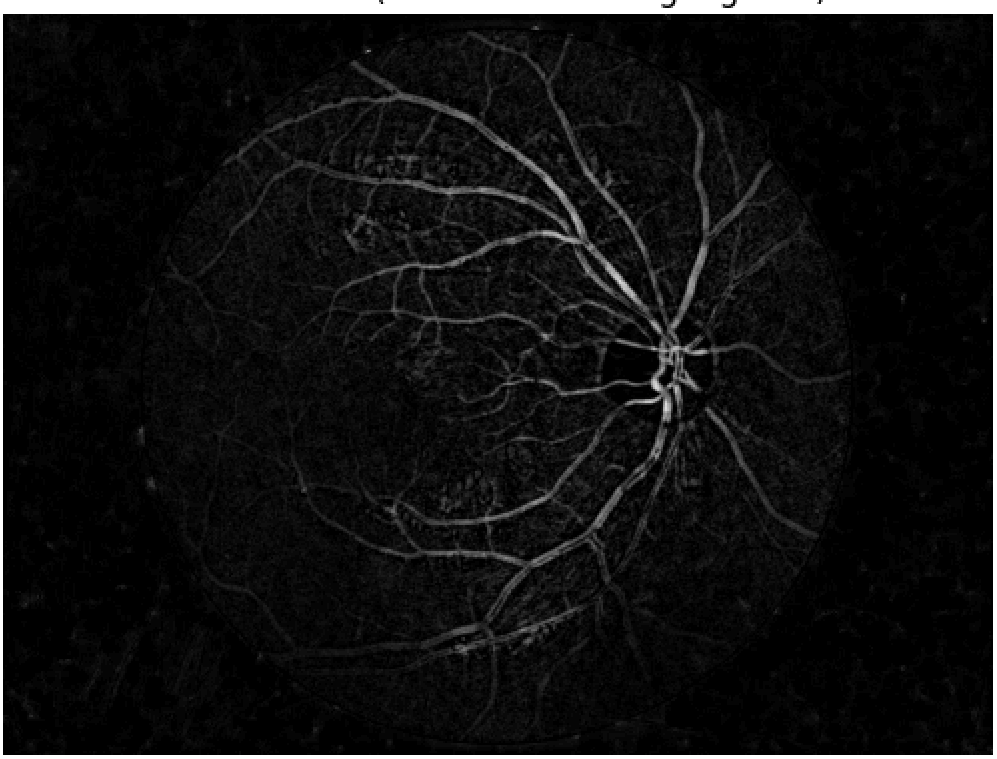


b)

Bottom-Hat Transform (Blood Vessels Highlighted) radius =5

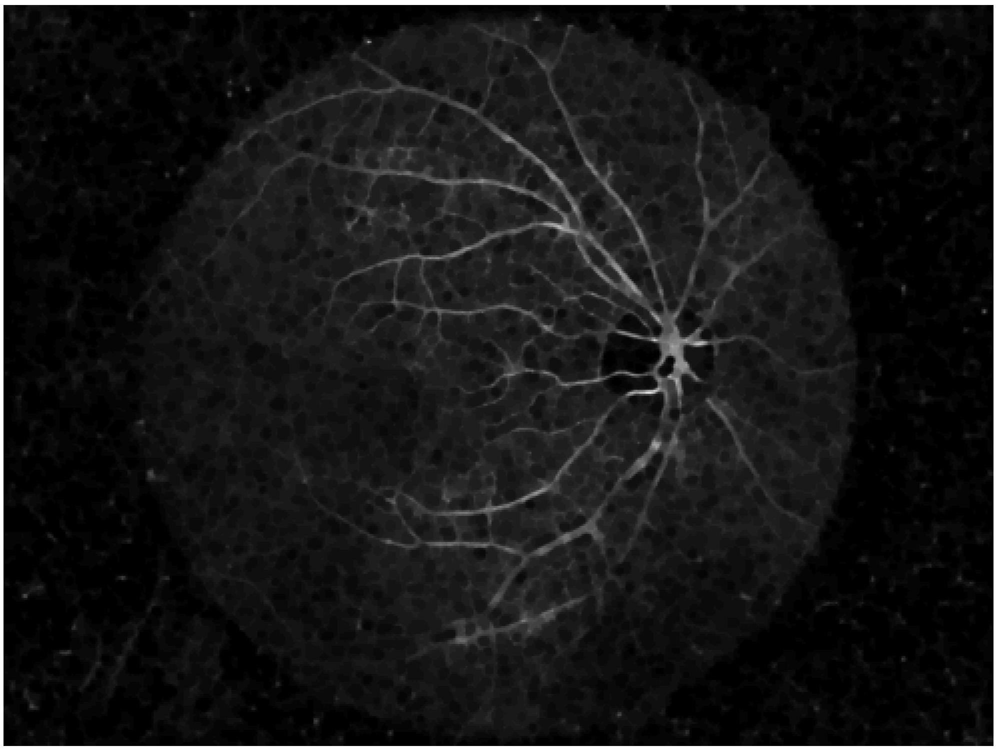


Bottom-Hat Transform (Blood Vessels Highlighted) radius =7



c)
Removing bright highlights on BHT transformed image(with disk of radius 7)
Done closing on BHT using a SE(disk) of radius 7

Vessels after Removing Highlights



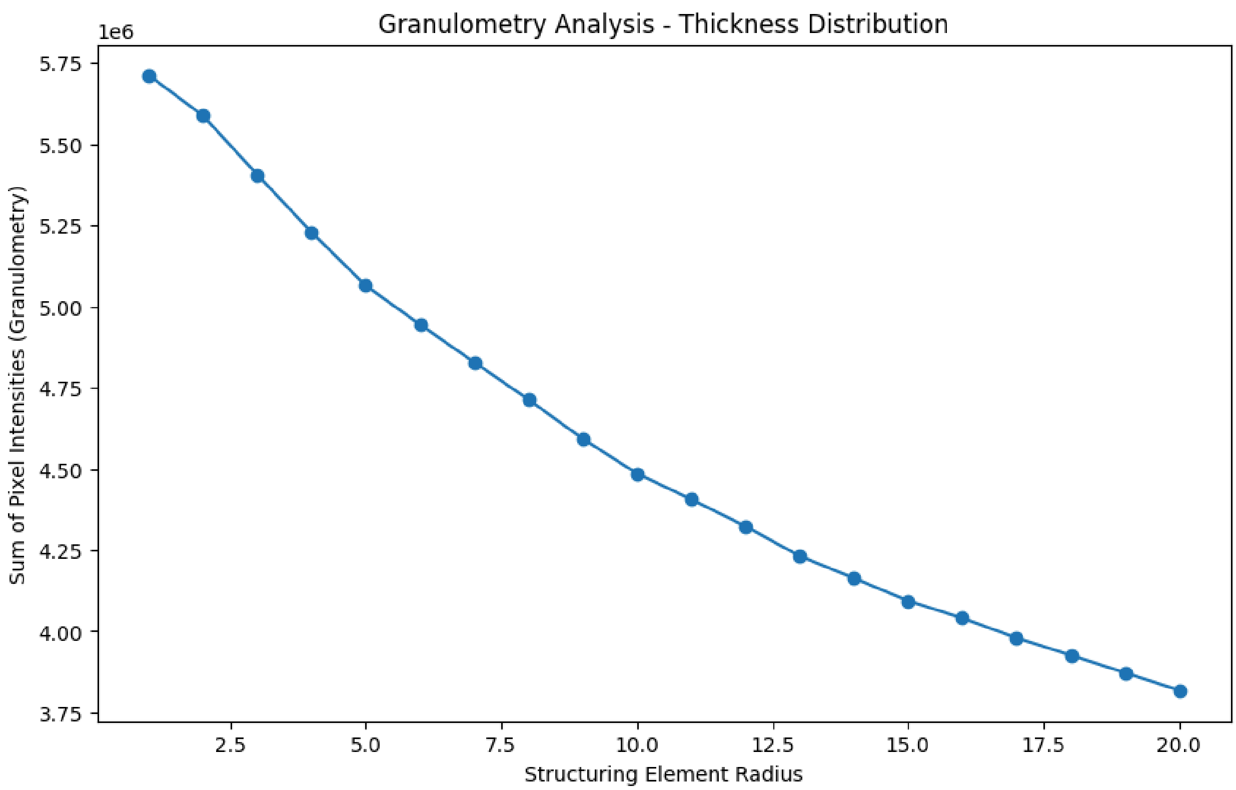
d)
Procedure:

1) **Calculated morphological opening for the image using disk structural element by varying the radius from: 1 to 20 (step size =1)**

2) **Granulometry Calculation: After each opening operation, the sum of pixel intensities in the resulting opened image is computed.**
3) **Plotting: The granulometry values are then plotted against the radii. As the structuring element size increases, larger structures are removed, resulting in lower sums of pixel intensities.**

Conclusion:

The thickness distribution shows a concentration of smaller vessels, as indicated by the rapid decline in granulometry. The downward trend reflects the presence of smaller vessels.The gradual decrease at higher radius reflects the less frequent nature of larger vessels.

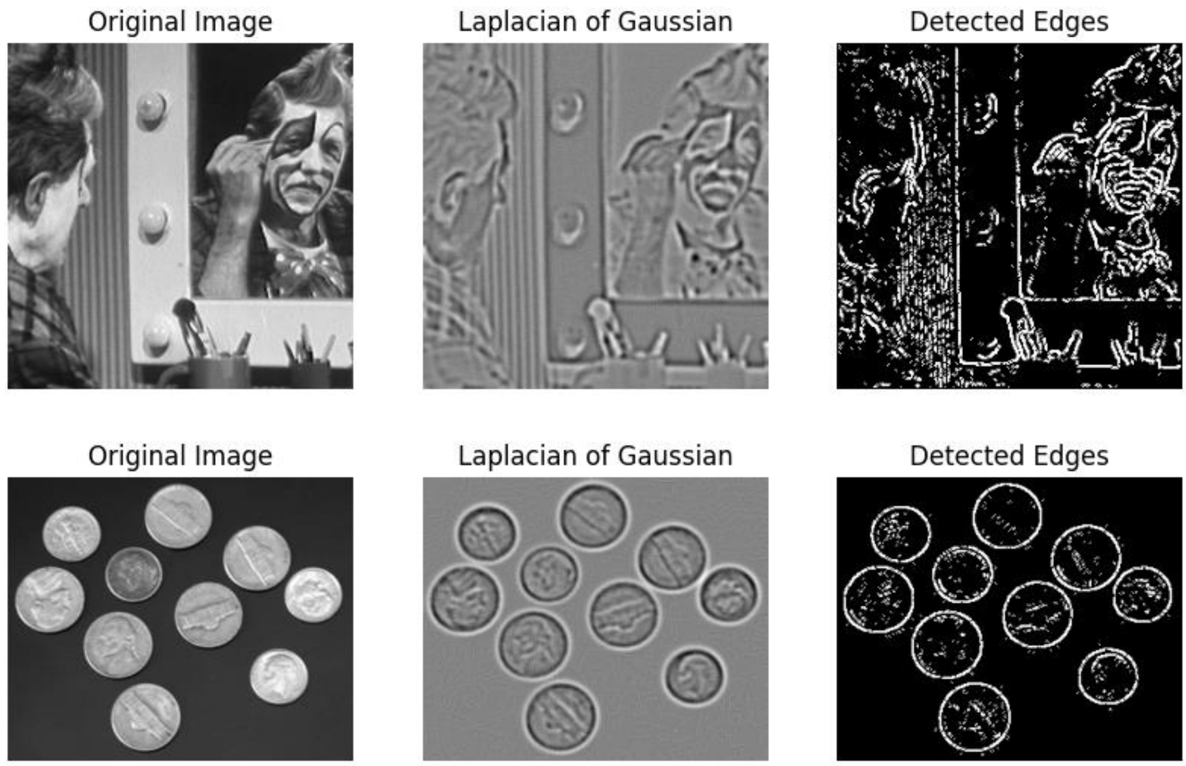


Part 2

Q3. Part A

Steps to perform Marr-Hildreth edge detection:

1. Apply Gaussian filter to smooth the image
2. Apply Laplacian to detect edges
3. Detect zero-crossings by checking sign changes
4. keep only strong edges: $|g(x+1,y) - g(x-1,y)| >$ threshold
5. Those positions follows step 3 & 4, make their intensity 255 else 0.



Parameters used:

σ = 2
Laplacian kernel size = 3
Threshold = 15 (only strong edges detected)

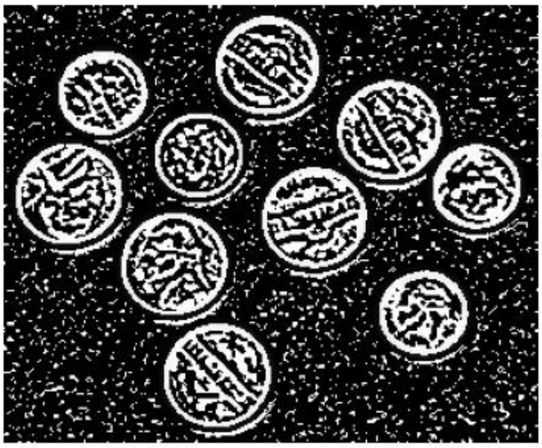
Q3. Part B

Original Image

DOG

Original Image

DOG

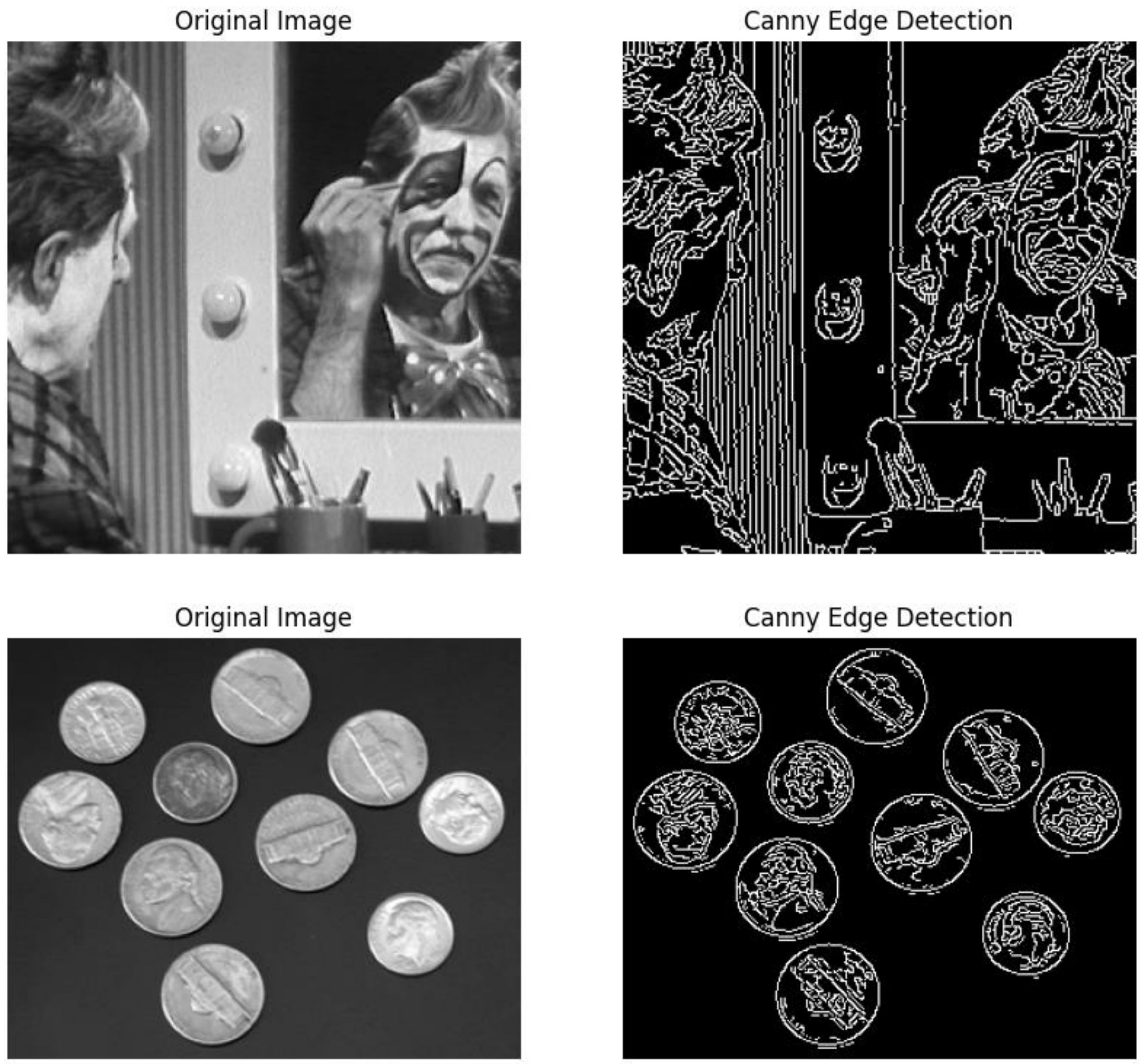


$$\sigma^2 = \frac{\sigma_1^2 \sigma_2^2}{\sigma_1^2 - \sigma_2^2} \ln\left[\frac{\sigma_1^2}{\sigma_2^2}\right]$$

$\sigma = \sigma$ for LOG

σ_1 & σ_2 for DOG ($\sigma_1 = 1.6\sigma_2$)

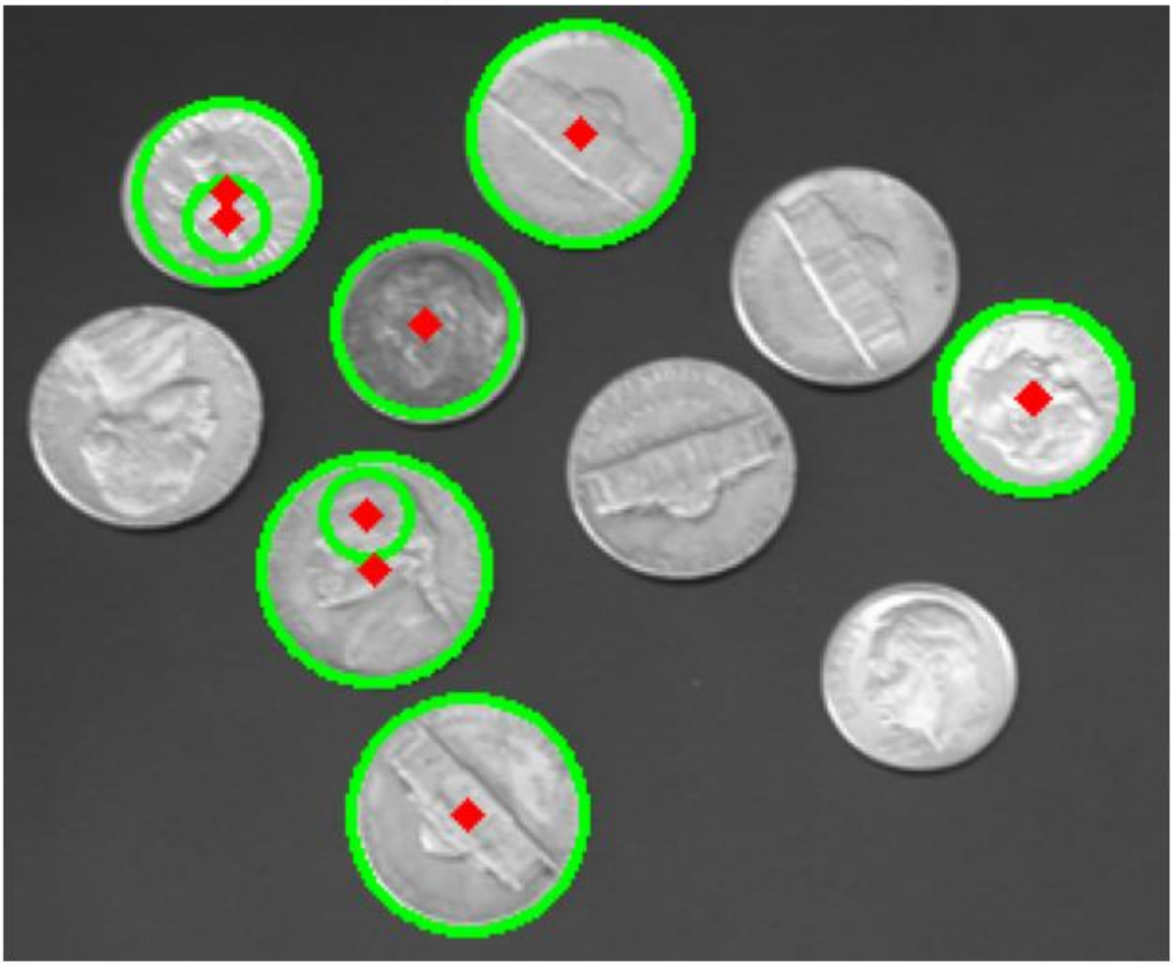
Q3. Part C



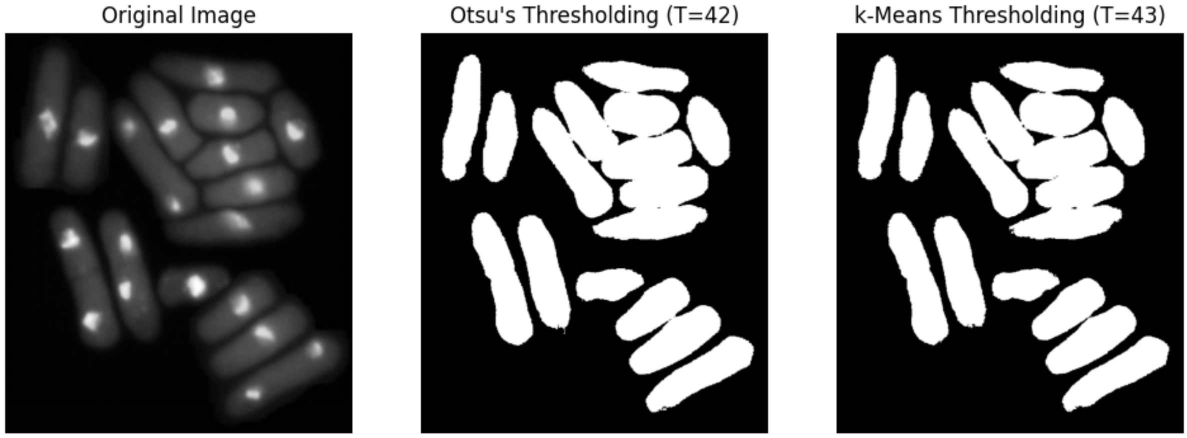
Low threshold = 50 and High threshold = 150

Q3. Part D

Top 8 Detected Circles



Q4. Part A



Otsu's Method:

Threshold = 42,
Within-Class Variance = 397.10443971363355,
Between-Class Variance = 693.8300285196959

k-Means Method:

Threshold = 43,
Mean1 = 15.044552826597554,
Mean2 = 71.5253290678386,
Within-Class Variance = 397.1170367677733,
Between-Class Variance = 693.8174314655562

Q4 Part B

Here, K = 3

Run 1
BCV: 14627.48

Run 2
BCV: 14625.94

Run 3
BCV: 14628.80

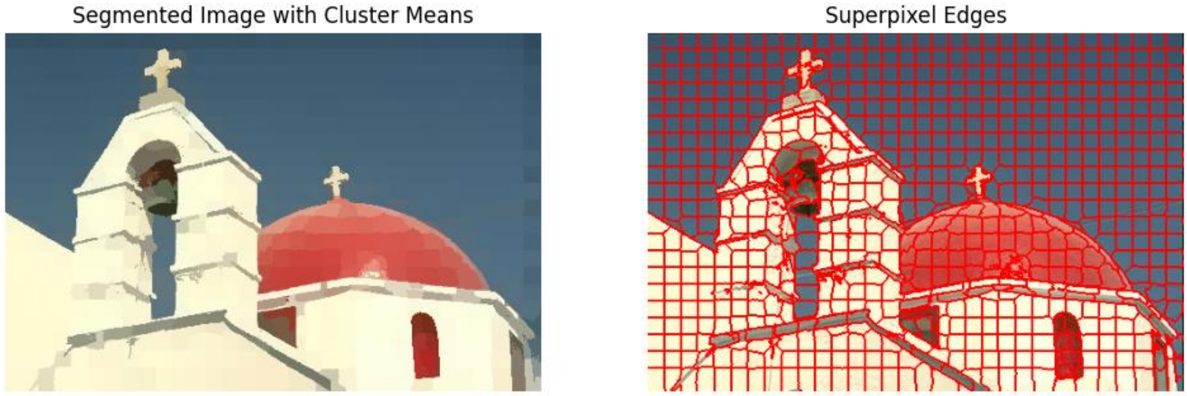
Run 4
BCV: 14624.26

Run 5
BCV: 14627.41

Run 6
BCV: 14627.16

There is very less variability in between-class-variance and visual outputs. This indicating less sensitivity to initialization.

Q4. Part C



S = 15