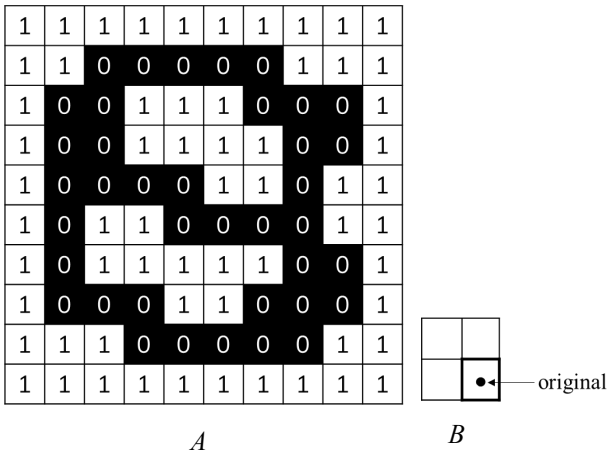
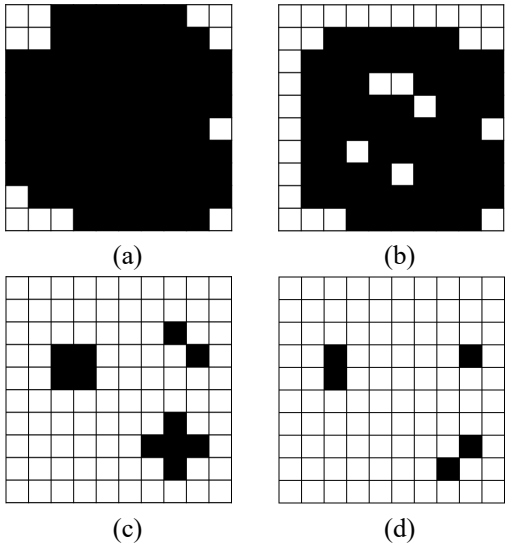
Lab 09
Image Processing III

A. Multiple Choice (20 points)

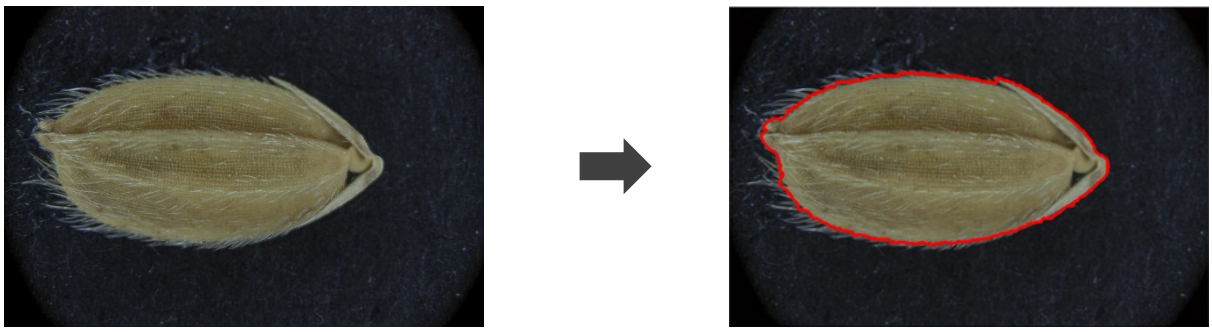
Given an image A and a structing element B as follow, which of the following image is the result of A eroded by B ($A \ominus B$)? Please write codes to verify it.





B. Find the Contour (20 points)

Write a script to identify the contour of the rice grain in image 'SingleRice.jpg'. The program should be able to exclude the brush from the contour. Draw the contour on top of the rice grain in the image.



C. Image Enhancement (25 points)

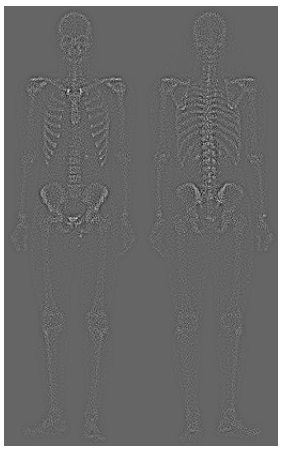
Successful image enhancement is typically not achieved using a single operation. Rather a range of techniques are combined in order to achieve a final result. This example will focus on enhancing an image of bone scan. Apply the following techniques to "Xray.png":

(a) Apply Laplacian filter to the original image
(b) Subtract the image from (a) from the original image to obtain a sharpened image
(c) Apply both the horizontal and vertical Sobel filter to the image from (b)
(d) Smooth image from (c) using a 5×5 averaging filter
(e) Element-by-element multiply the images from (b) and (d)
(f) Add the image from (e) to the original image to obtain a sharpened image
(g) Apply power-law transformation (i.e., $g_o = (g_i)^{0.5}$) to adjust the image contrast

Power-law transformation (a.k.a. gamma correction) is an approach to adjust the contrast of an image. In the transformation, the gray level of the pixels was adjusted by the equation $g_o = c(g_i)^r$, here g_o is the gray level of the output image, g_i is the gray level of the input image, and c and r are pre-determined constants. The figure below explains the input-output relationship of power-law transformation. Note that in this example, we set $c = 1$.

The images (pixel values adjusted for displaying) of each step are shown below.

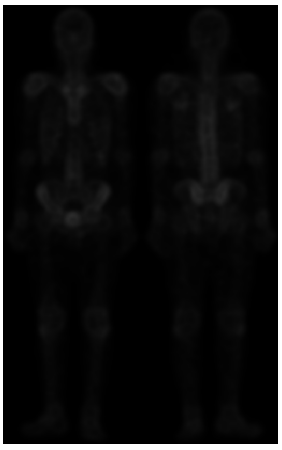
Original image



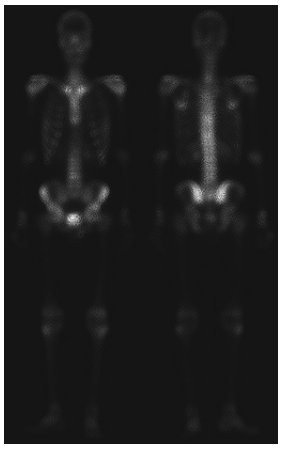
(a)

(b)

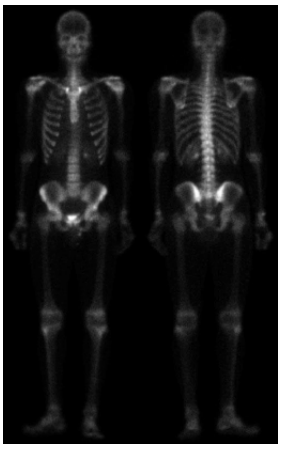
(c)



(d)



(e)



(f)

(g)

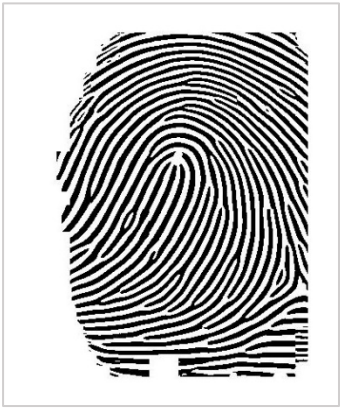
D. Fingerprint Analysis (35 points)

Fingerprint identification is one of the most well-known and publicized biometrics. Because of their uniqueness and consistency over time, fingerprints have been used for identification for over a century, more recently becoming automated (i.e. a biometric) due to advancements in computing capabilities.

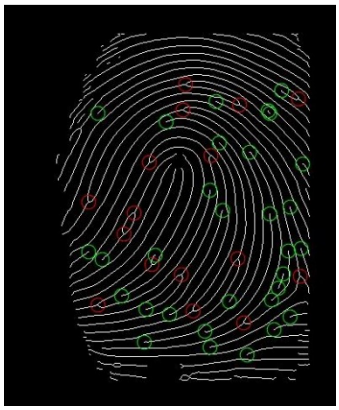
A fingerprint usually appears as a series of dark lines that represent the high, peaking portion of the friction ridge skin, while the valley between these ridges appears as white space and are the low, shallow portion of the friction ridge skin. Fingerprint identification is based primarily on the minutiae, or the location and direction of the ridge endings and bifurcations (splits) along a ridge path.

In this exercise, you are going to implement a serious of image processing algorithms to extract the features of "Fingerprint.tif". If interested in, you may further move to perform feature extraction on fingerprints. To extract features, you will need to first improve the quality of the raw image, then use thinning, a morphological algorithm that identifies the skeletons of foreground objects. Only typical features, ridge-ending and bifurcation, are required to be extracted. However, if interested in, you may further move to perform extraction on other features.

Original image

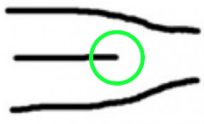


Reconstruct image

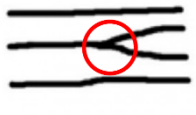


Skeletonize image

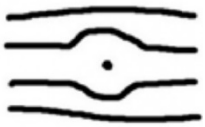
Features founded



Ridge-ending

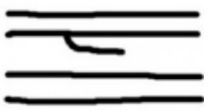


Bifurcation



Dot

Island



Hook

Eye

Bridge

Trifurcation