

For this project, you may use mathcad or NetBeans

Project tasks:

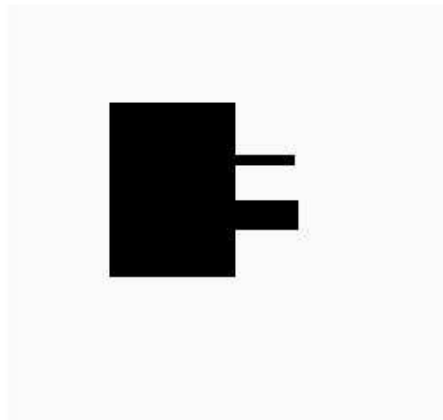
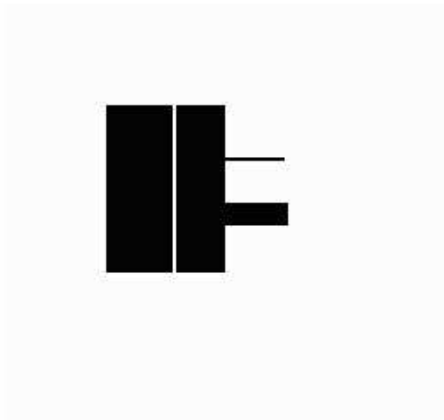
Complete the tasks below and turn in a project report.

Turn in a 9-page report, with page-1 cover sheet, page 2 explaining the methods you used, pages 3 - 9 being 6x6 inch printouts of your images for each of the tasks below. Attach your Mathcad code or Java code as an appendix.

Make sure that you caption each image, clearly stating what the image is.

1. For the binary image morph2.gif, write a program to dilate the image with a 3x3 structuring element (see below), and plot the filtered image. Note that the gif file must be converted to binary form, since the stored values are not zero and one. Similarly, your final result must be converted to white and black (255 and 0 gray-levels).

Below, the input image morph2.gif is illustrated on the left, and a 3x3 dilation is illustrated on the right. Do not use the image below, download the original image from the website.



$$\text{struc} := \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

Caution. In the structuring element, we used 1 for black and 0 for white, but in the image data, we use the normal coding of 0=black and 255=white (actually 3 and 253 in the files).

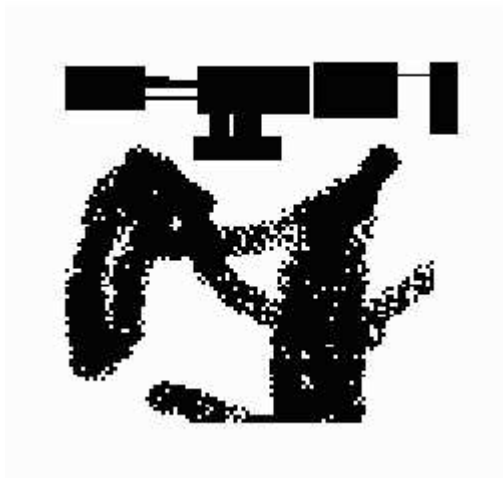
2. Repeat question 1 using the following structuring element:

$$\text{struc} := \begin{pmatrix} 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

3. Repeat question 1 using the following structuring element:

$$\text{struc} := \begin{pmatrix} 0 & 0 & 0 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

4. For the binary image morph1.gif, shown below, write a program to dilate the image with the 3x3 structuring element below, and plot the filtered image.



$$\text{struc} := \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

5. For the binary image morph1.gif, write a program to erode the image with the same 3x3 structuring element, and plot the filtered image.

6. For the binary image morph1.gif, write a program to close the image with the same 3x3 structuring element, and plot the filtered image.

7. For the binary image morph1.gif, write a program to open the image with the same 3x3 structuring element, and plot the filtered image.

Here is an example of code for dilating an image using a 3x3 structuring element

```
dilate3x3(f, struc) :=
  nc ← cols(f)
  nr ← rows(f)
  for rr ∈ 0..rows(f) - 1
    for cc ∈ 0..cols(f) - 1
      zzrr,cc ←  $\begin{cases} 0 & \text{if } f_{rr,cc} < 128 \\ 200 & \text{otherwise} \end{cases}$ 
      preprocess array so that it only
      has values of 0 or 200
  y ← zz
  xxz ← zz
  for rr ∈ 0..rows(f) - 1
    for cc ∈ 0..cols(f) - 1
      for j ∈ -1..1
        for k ∈ -1..1
          mrr ← mod(rr + j + nr, nr)
          mcc ← mod(cc + k + nc, nc)
          ymrr,mcc ← 0 if  $\left[ \left( zz_{rr,cc} = 0 \right) \wedge \left( struc_{j+1,k+1} = 1 \right) \right]$ 
  return y
```

Test image

$$\text{test} := \begin{pmatrix} 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 0 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 0 & 0 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \end{pmatrix} \quad \text{struc} := \begin{pmatrix} 0 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

Caution. In the structuring element, we used 1 for black and 0 for white, but in the image data, we use the normal coding of 0=black and 200=white. we use 200 for white so we can see the borders of the image since the background is off-white.

$$y := \text{dilate3x3}(\text{test}, \text{struc}) \quad y = \begin{pmatrix} 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 0 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 0 & 0 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 0 & 200 & 200 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 0 & 0 & 200 & 200 & 200 \\ 200 & 200 & 200 & 0 & 0 & 0 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 0 & 0 & 200 & 200 & 200 \\ 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 & 200 \end{pmatrix}$$

original test image



test

dilated test image



y