Student: Melis Kilic

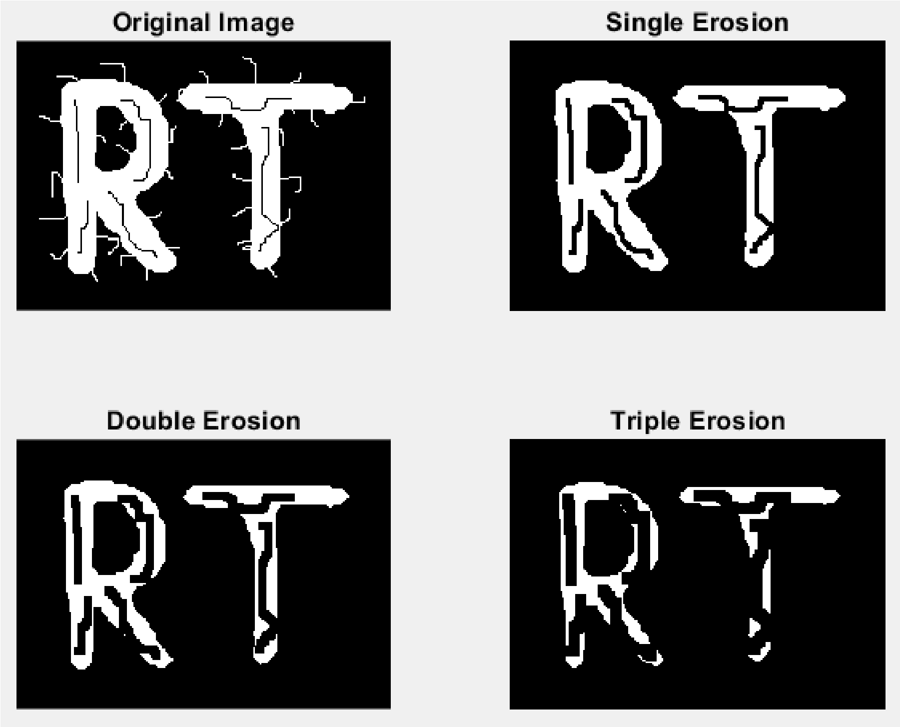
Morphological operations for binary images - report

MB-1. Erosion, dilation, opening and closing

Task 1a Erosion and multiple erosion

```
%% Task 1a
clearvars;
close all;
clc;

originalImage = imread('ertka.bmp');

se = strel('square', 3);

singleErosion = imerode(originalImage, se);
doubleErosion = imerode(singleErosion, se);
tripleErosion = imerode(doubleErosion, se);

% Display
figure;

subplot(2,2,1);
imshow(originalImage);
title('Original Image');

subplot(2,2,2);
imshow(singleErosion);
title('Single Erosion');

subplot(2,2,3);
imshow(doubleErosion);
title('Double Erosion');

subplot(2,2,4);
imshow(tripleErosion);
title('Triple Erosion');
```

Result of the code:

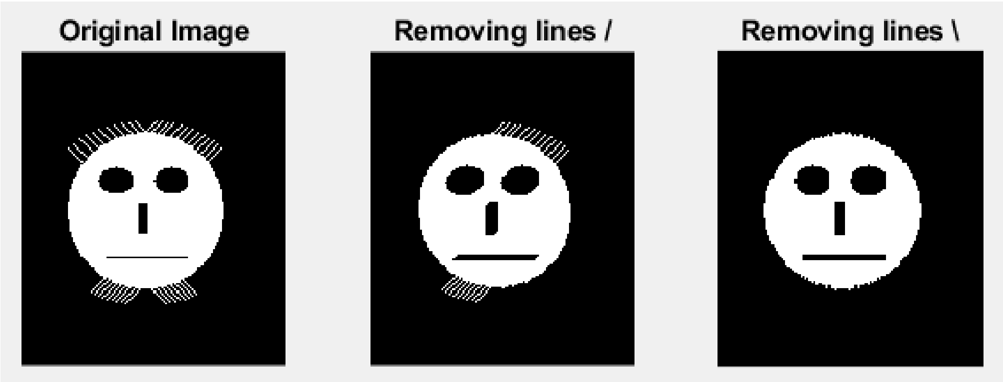


Task 1b Erosion with a dedicated structuring element

```
%% Task 1b
clearvars;
close all;
clc;

image = imread('face.bmp');

se_diagonal = [0 0 1;
               0 1 0;
               1 0 0];

se_vertical = [0 1 0;
               0 1 0;
               0 1 0];

% Erosion
removedLines1 = imerode(image, se_diagonal);
removedLines2 = imerode(image, se_vertical);

% Display
figure;

subplot(1,3,1);
imshow(image);
title('Original Image');

subplot(1,3,2);
imshow(removedLines1);
title('Removing lines /');
```

```
subplot(1,3,3);
imshow(removedLines2);
title('Removing lines \');
```

Result of the code:

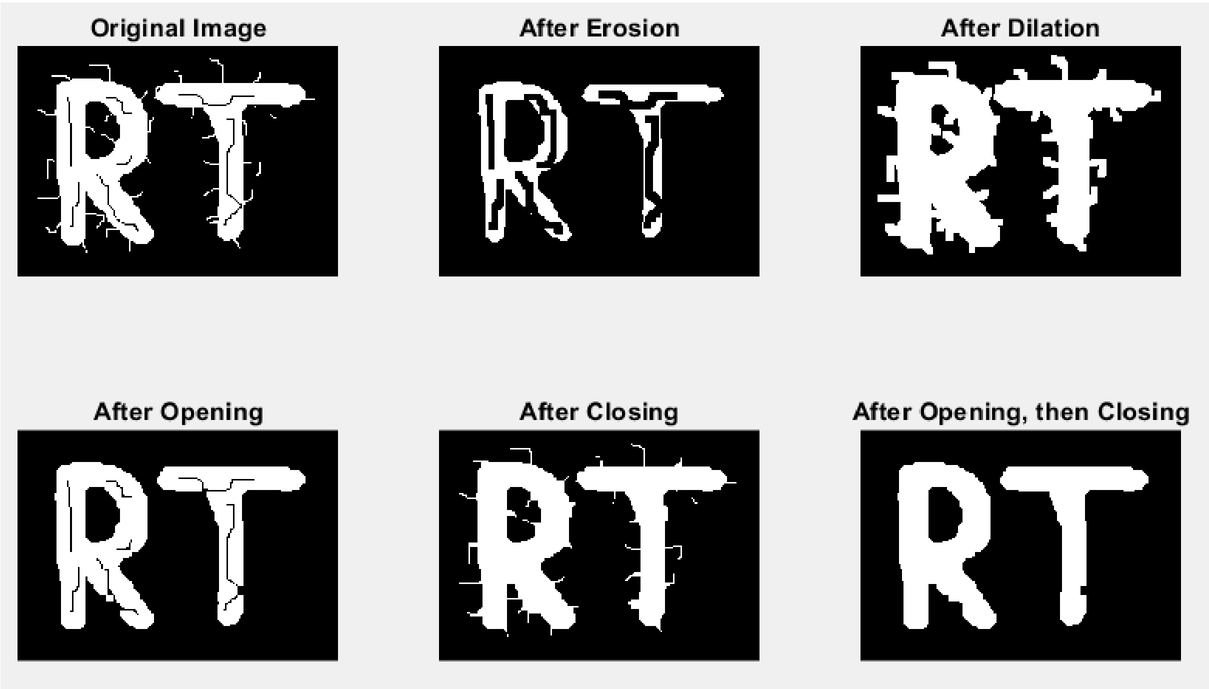


Task 1c Comparison of erosion, dilation, opening and closing

```
%% Task 1c
clearvars;
close all;
clc;

image = imread('ertka.bmp');
se = strel('square', 5);

erosion = imerode(image, se);
dilation = imdilate(image, se);
opening = imopen(image, se);
closing = imclose(image, se);
opening_then_closing = imclose(imopen(image, se), se);

% Display
figure;

subplot(2,3,1);
imshow(image);
title('Original Image');

subplot(2,3,2);
imshow(erosion);
title('After Erosion');

subplot(2,3,3);
imshow(dilation);
title('After Dilation');

subplot(2,3,4);
imshow(opening);
title('After Opening');

subplot(2,3,5);
imshow(closing);
title('After Closing');
```

```
subplot(2,3,6);
imshow(opening_then_closing);
title('After Opening, then Closing');
```

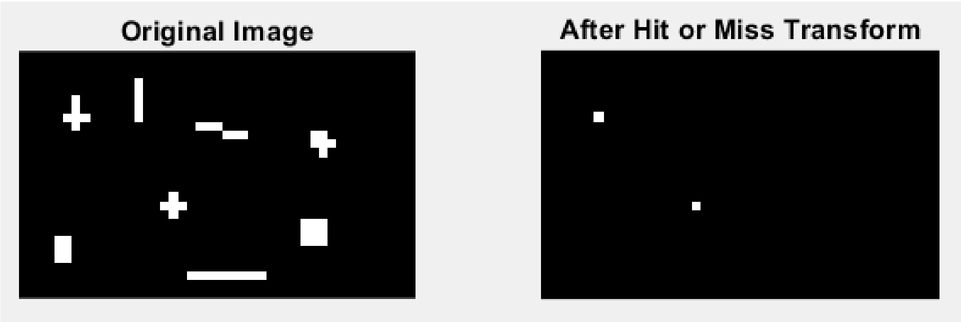
Result of the code:



MB-2. Hit or miss transform

```
clearvars;
close all;
clc;

image = imread('hom.bmp');

SE1 = [0 1 0;
       1 1 1;
       0 1 0];

SE2 = ~SE1;

resultImage = bwhitmiss(image, SE1, SE2);

% Display
figure;

subplot(1,2,1);
imshow(image);
title('Original Image');

subplot(1,2,2);
imshow(resultImage);
title('After Hit or Miss Transform');
```

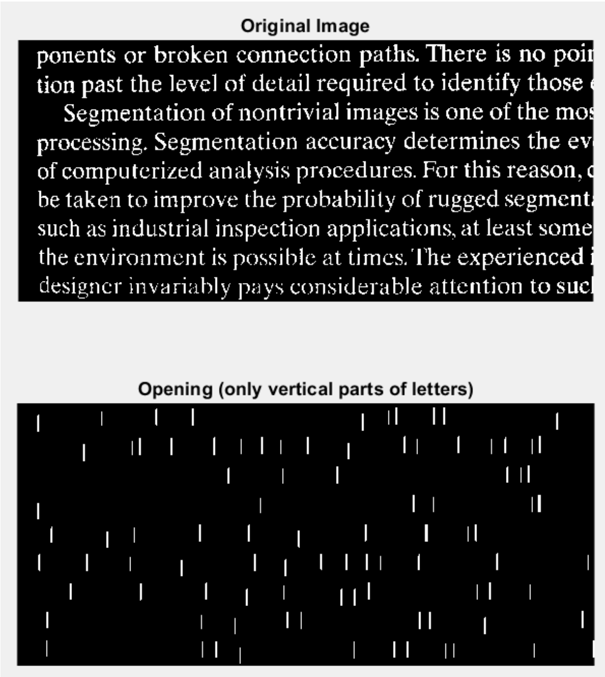
```
Result of the code:
```

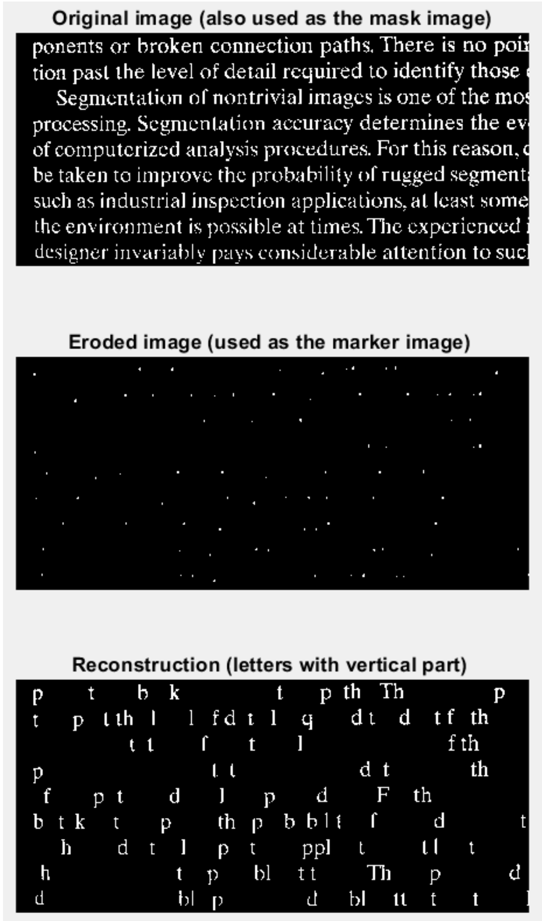


MB-3. Morphological reconstruction

```
clearvars;
close all;
clc;

image = imread('text.bmp');
vertical_mask = ones(51, 1);

opened_image = imopen(image, vertical_mask);

figure;

subplot(2, 1, 1);
imshow(image);
title('Original Image');

subplot(2, 1, 2);
imshow(opened_image);
title('Opening (only vertical parts of letters)');

%-----------------------------

eroded_image = imerode(image, vertical_mask);
reconstructed_image = imreconstruct(eroded_image, image);

figure;

subplot(3, 1, 1);
imshow(image);
title('Original image (also used as the mask image)');

subplot(3, 1, 2);
imshow(eroded_image);
title('Eroded image (used as the marker image) ');

subplot(3, 1, 3);
imshow(reconstructed_image);
title('Reconstruction (letters with vertical part) ');
```

Result of the code:





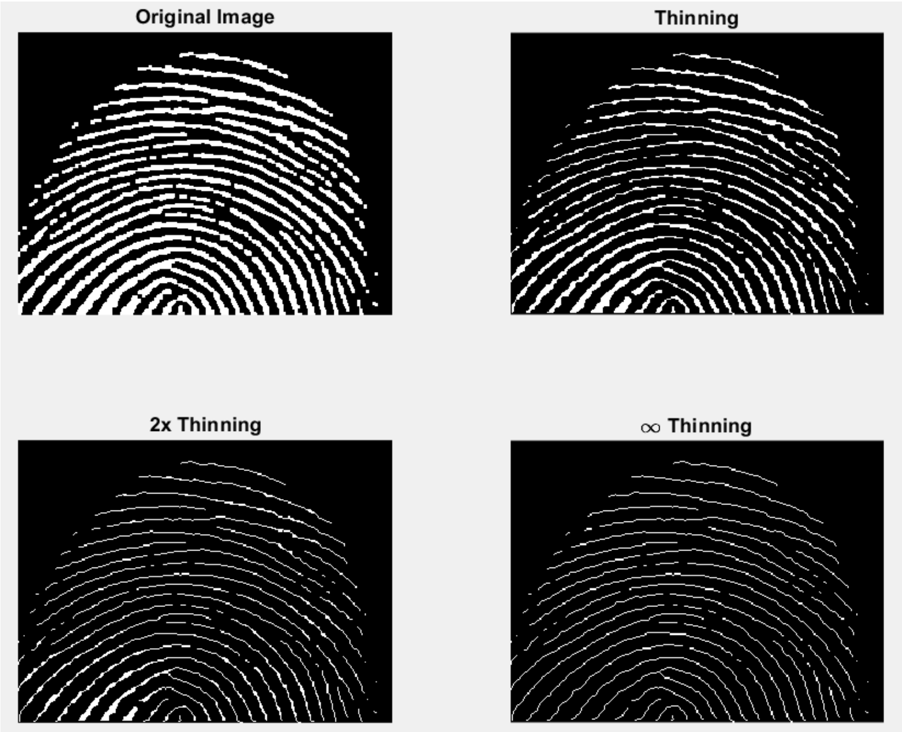
MB-4. Other morphological operations: thinning, skeletonization, filling holes, clearing borders

Task 4a Thinning

```
%% Task 4a

clearvars;
close all;
clc;

image = imread('fingerprint.bmp');

thinned_image_1 = bwmorph(image, 'thin', 1);
thinned_image_2 = bwmorph(image, 'thin', 2);
thinned_image_inf = bwmorph(image, 'thin', Inf);

figure;

subplot(2, 2, 1);
imshow(image);
title('Original Image');

subplot(2, 2, 2);
imshow(thinned_image_1);
title('Thinning');
```

```
subplot(2, 2, 3);
imshow(thinned_image_2);
title('2x Thinning');

subplot(2, 2, 4);
imshow(thinned_image_inf);
title('\infty Thinning');
```

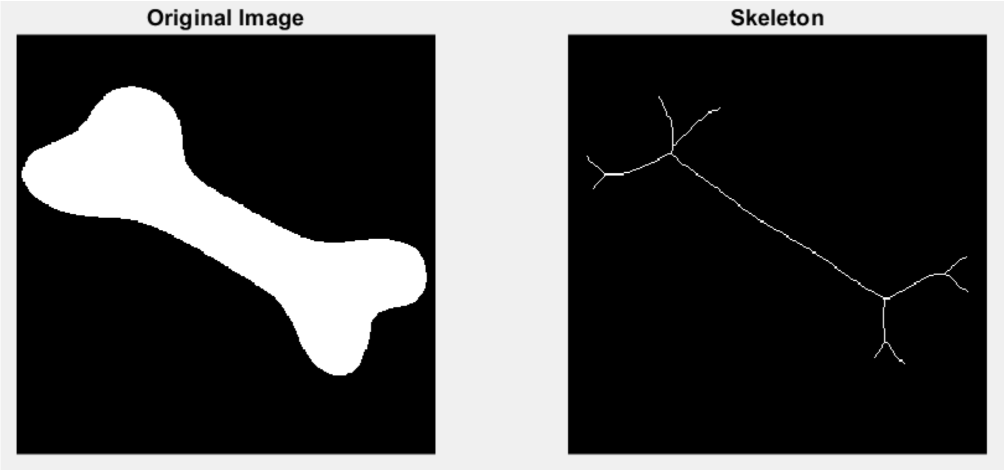
Result of the code:



Task 4b Skeletonization

```
%% Task 4b

clearvars;
close all;
clc;

image = imread('bone.bmp');
skeleton_image = bwmorph(image, 'skel', Inf);

figure;

subplot(1, 2, 1);
imshow(image);
title('Original Image');

subplot(1, 2, 2);
imshow(skeleton_image);
title('Skeleton');
```

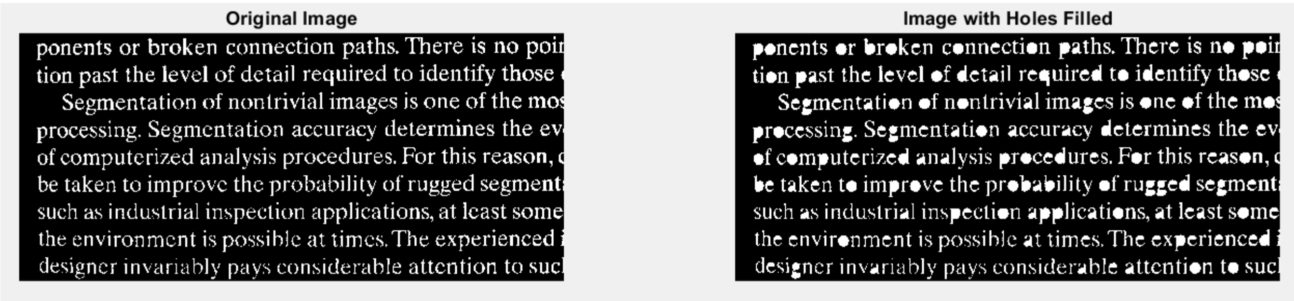
Result of the code:



Task 4c Filling holes

```
%% Task 4c

clearvars;
close all;
clc;

image = imread('text.bmp');
filled_image = imfill(image, 'holes');

figure;

subplot(1, 2, 1);
imshow(image);
title('Original Image');

subplot(1, 2, 2);
imshow(filled_image);
title('Image with Holes Filled');
```

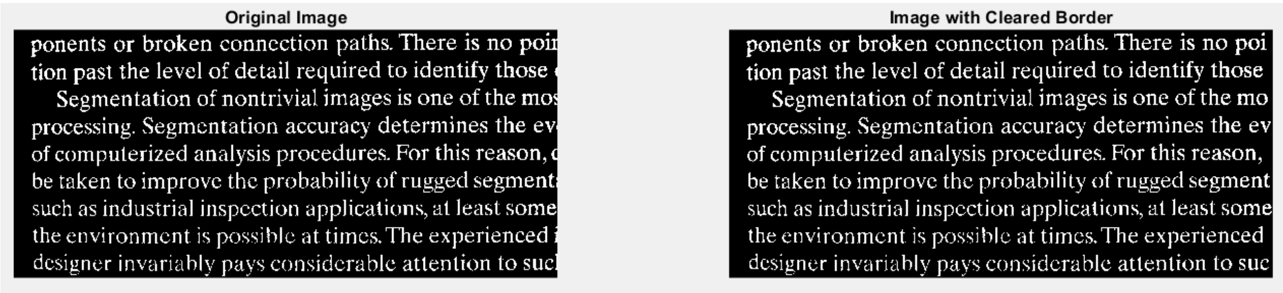
Result of the code:



Task 4d Clearing the boarder

```
%% Task 4c

clearvars;
close all;
clc;

image = imread('text.bmp');
cleared_image = imclearborder(image);

figure;

subplot(1, 2, 1);
imshow(image);
title('Original Image');

subplot(1, 2, 2);
imshow(cleared_image);
title('Image with Cleared Border');
```

Result of the code:



MB-5. Morphological operations on an artificial image

```
clearvars;
close all;
clc;

% Image
A = zeros(11);
A(3:7, 3:9) = 1;
A(3, 6) = 0;
A(4, 6) = 0;
A(8, 6) = 1;
A(9, 6) = 1;

% Visualize the image using command imagesc(A).
figure;
subplot(2, 3, 1);
imagesc(A);
colormap('gray');
title('Original Image');

se = ones(3);
```

```
eroded_image = imerode(A, se);
subplot(2, 3, 2);
imagesc(eroded_image);
colormap('gray');
title('Eroded Image');

opened_image = imopen(A, se);
subplot(2, 3, 3);
imagesc(opened_image);
colormap('gray');
title('Erosion -> Dilation (Opening)');

dilated_image = imdilate(A, se);
subplot(2, 3, 5);
imagesc(dilated_image);
colormap('gray');
title('Dilated Image');

closed_image = imclose(A, se);
subplot(2, 3, 6);
imagesc(closed_image);
colormap('gray');
title('Dilation -> Erosion (Closing)');
```

Result of the code: