

### Exercise on MATLAB programming

Write down the output in the space provided.

```
a = 0; j = [];  
ind = [1 2 5];  
for i = -30:5:30  
    if(i)  
        a = a + i;  
    else  
        a = a - i;  
    end  
    j = [j i];  
end  
a  
j(ind)
```

Output:

a = 0

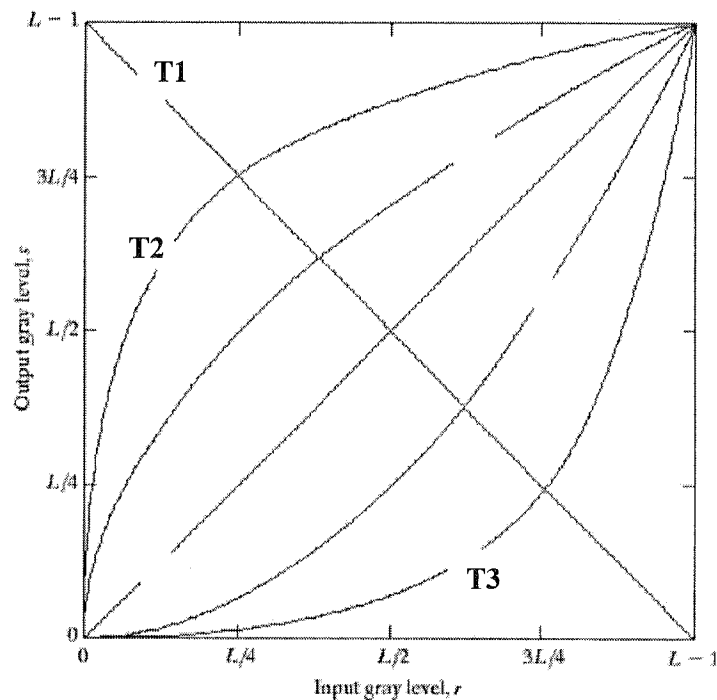
j(ind) = -30 -25 -10

For example, if  $x = [2, 4, 6]$

$j = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]$

then  $j(x)$  gives 2 4 6

## Exercise on Gray-level Transformations



The above figure shows several basic gray-level intensity transformation functions. For each transformation function, e.g., T1, T2 and T3, describes the visual effect when the transformation function is applied to a gray-level image with  $L$  intensity levels.

(a) T1:

It generates image negatives.  
Black turns to white and white turns to black.

(b) T2:

The image becomes brighter.

(c) T3:

The image becomes darker.

### Exercise on Histograms

Below are the histograms of two 10-by-10 pixel, 8-gray level (0-7) images. If Image 1 is represented by matrix A and Image 2 is represented by matrix B, their sum image (Image 3) is calculated by  $A+B$ . What will be the histogram of their sum image of Image 3?

Intensity levels	0	1	2	3	4	5	6	7
Frequencies (Image 1)	0	0	0	100	0	0	0	0
Frequencies (Image 2)	16	24	12	28	20	0	0	0
Frequencies (Image 3)	0	0	0	16	24	12	28	20

## Exercise on Image Restoration and Filtering

What are the values after applying the adaptive median filter at position (4, 4) and (5, 3), where  $(x,y)=(\text{row\#,column\#})$ , given that  $S_{\max} = 5$ ?

6	3	5	7	8	2	1
2	3	5	2	1	3	7
3	1	1	5	3	4	2
2	2	2	5	5	2	3
4	4	4	2	1	3	8
5	2	1	3	5	1	9
6	3	4	2	7	7	2

Starting from the figure above, the new value at position (4, 4) 3

Starting from the figure above, the new value at position (5, 3) 4

Assume that

$Z_{\min}$  and  $Z_{\max}$  are min. and max. grey levels in a window  $S_{xy}$  respectively,

$Z_{\text{med}}$  represents the median of grey level in  $S_{xy}$ ,

$Z_{xy}$  represents grey level at coordinates  $(x, y)$ , and

$S_{\max}$  denotes the max. allowed window size of  $S_{xy}$ .

The filter is defined as follows.

Level A:  $A1 = Z_{\text{med}} - Z_{\min}$ ;  $A2 = Z_{\text{med}} - Z_{\max}$   
 If  $A1 > 0$  and  $A2 < 0$ , go to level B.  
 Else increase the window size.  
 If window size  $\leq S_{\max}$  repeat level A.  
 Else output  $Z_{xy}$ .

Level B:  $B1 = Z_{xy} - Z_{\min}$ ;  $B2 = Z_{xy} - Z_{\max}$   
 If  $B1 > 0$  and  $B2 < 0$ , output  $Z_{xy}$ .  
 Else output  $Z_{\text{med}}$ .

# Exercise on Morphological Image Processing

Dilation on an image  $A$  with a structuring element  $B$  is defined as

$$A \oplus B = \left\{ z \mid \left( \hat{B} \right)_z \cap A \neq \emptyset \right\}.$$

Perform dilation on the following input image and complete the output image accordingly.

Input Image							
0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0
0	1	1	1	1	1	1	1
0	0	1	0	1	0	0	1
0	0	1	1	1	0	0	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Output Image							
*	*	*	*	*	*	*	*
*	/	/	/	o	o	o	*
*	/	/	/	/	/	/	*
*	/	/	/	/	/	/	*
*	/	/	/	/	/	/	*
*	/	/	/	/	/	/	*
*	/	/	/	/	/	/	*
*	*	*	*	*	*	*	*

Structuring element (SE)  $B$  with the origin located at the center of the matrix:

1	1	1
1	1	1
1	1	1

**Remark:** Fill in all pixels with either zero or one. Do not leave any pixel blank. Boundary pixels of output image are set to \* and you do not need to consider those ones.