Image Processing 1, Exercise 7

1 Nonlinear Filtering

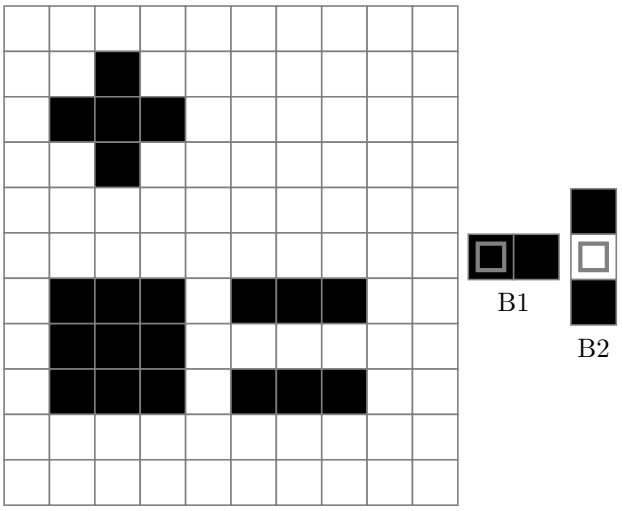
[basic] The median filter is commonly used in practice in spite of being nonlinear. Here we consider whether there might be a separable implementation of the median filter.

Provide an example of data on which a 3×3 median filter is not equivalent to a 1×3 median filter followed by a 3×1 median filter.

2 Binary Morphological Operators

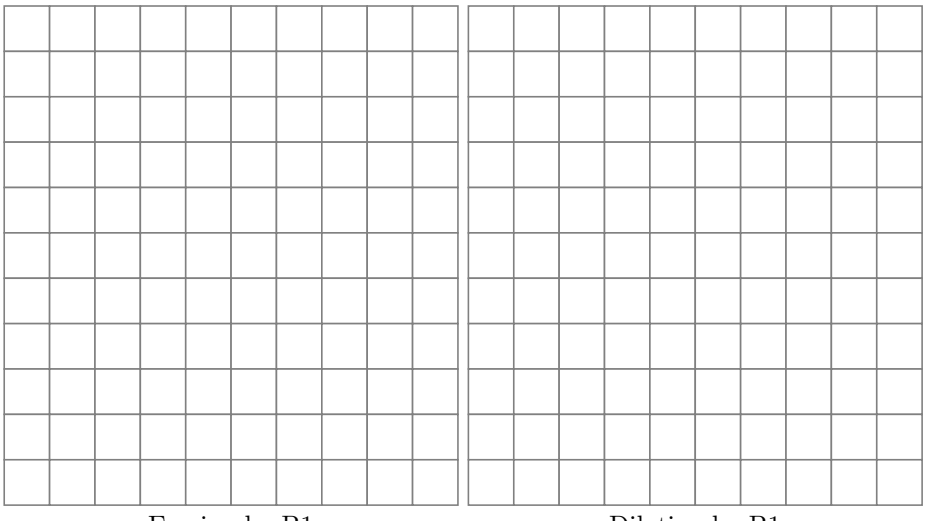
[basic] We apply some binary morphological operators in order to understand their mathematical definitions and how they affect binary images.

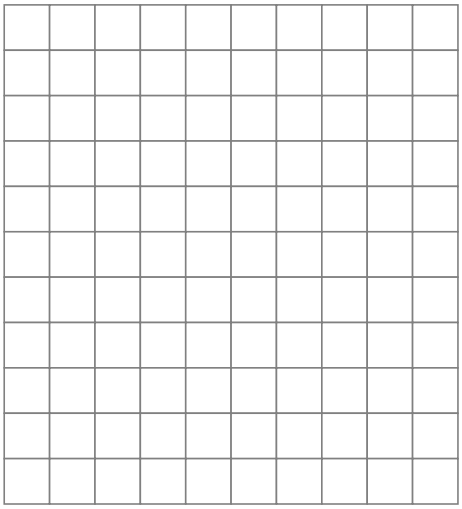
We use the convention:  and
1 0



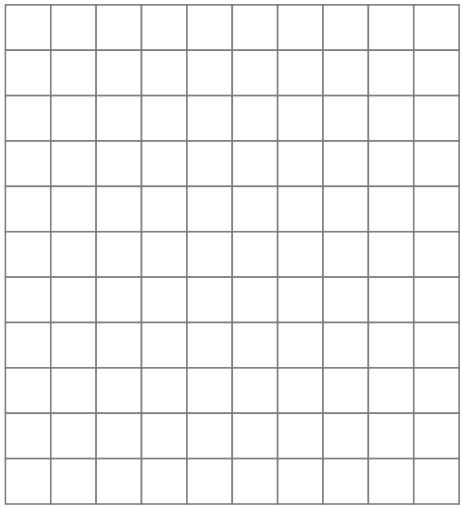
Image

(a) Draw the erosion and the dilation of this image using the two structuring element B1 and B2


Erosion by B1 Dilation by B1

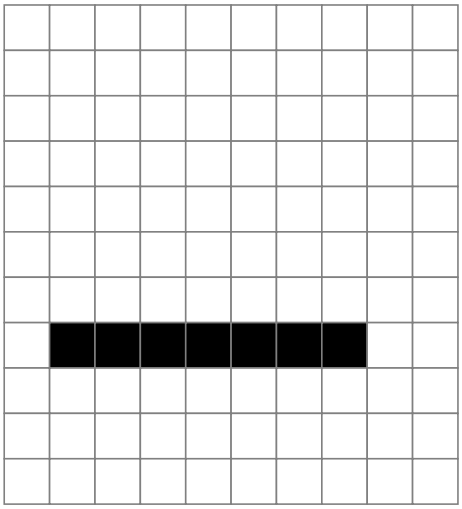


Erosion by B2



Dilation by B2

(b) [intermediate] Find a sequence of operations that results in this image.



Image

3 Grayscale Morphological Operators

[basic] We apply some morphological operators in order to understand their mathematical definitions and how they affect grayscale images.

Let $a = \left[\ldots \quad \times \quad 0 \quad 3 \quad 4 \quad \boxed{-1} \quad 4 \quad 6 \quad \times \quad \ldots\right]$ be some $\times$-padded sequence, where the presence of a symbol $\times$ indicates the absence of valid data at the corresponding location in the sequence. Apply to a the grayscale morphological operations indicated in the table, with the $\times$-padded structuring elements $b_1 = \left[\begin{array}{ccc} 0 & \boxed{0} & 0 \end{array}\right]$, $b_2 = \left[\begin{array}{ccc} 0 & \boxed{\times} & 0 \end{array}\right]$, and $b_3 = \left[\begin{array}{cc} \boxed{0} & 1 \end{array}\right]$. For structuring elements, the presence of a $\times$ symbol indicates that the contribution of the sample at that location should be ignored.

k	-4	-3	-2	-1	0	1	2	3
a	$\times$	0	3	4	$\boxed{-1}$	4	6	$\times$
Dilation of a by b_1: $a \oplus b_1$								
Closing of a by b_1: $a \bullet b_1 = (a \oplus b_1) \ominus b_1$								
Dark top-hat of a by b_1: $(a \bullet b_1) - a$								
Erosion of a by b_2: $a \ominus b_2$								
Opening of a by b_2: $a \circ b_2 = (a \ominus b_2) \oplus b_2$								
Bright top-hat of a by b_2: $a - (a \circ b_2)$								
Dilation of a by b_3: $a \oplus b_3$								
Erosion of a by b_3: $a \ominus b_3$								
Gradient of a by b_3: $(a \oplus b_3) - (a \ominus b_3)$								