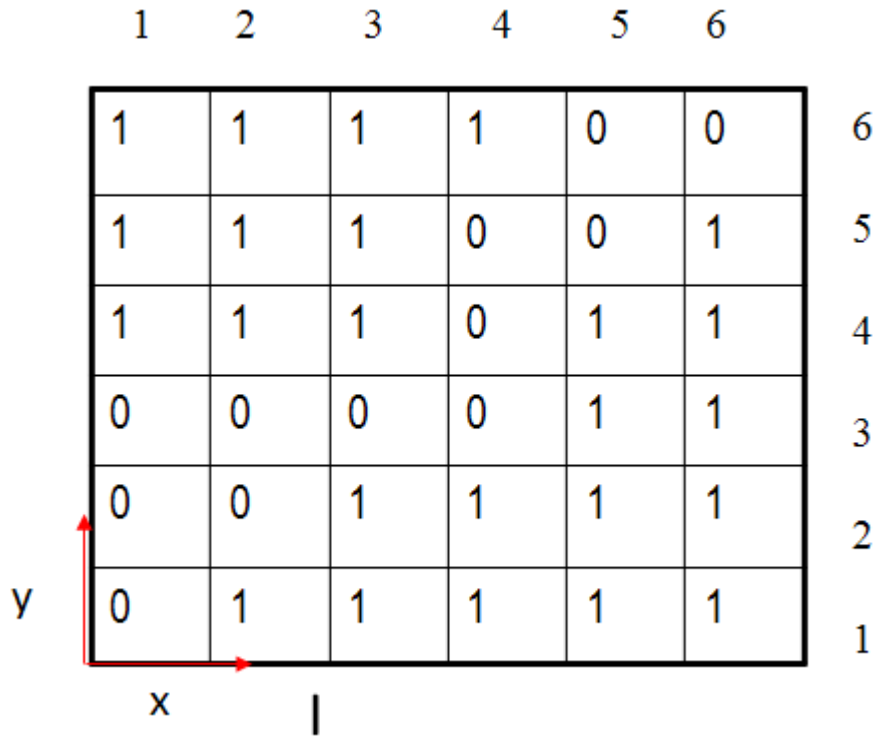
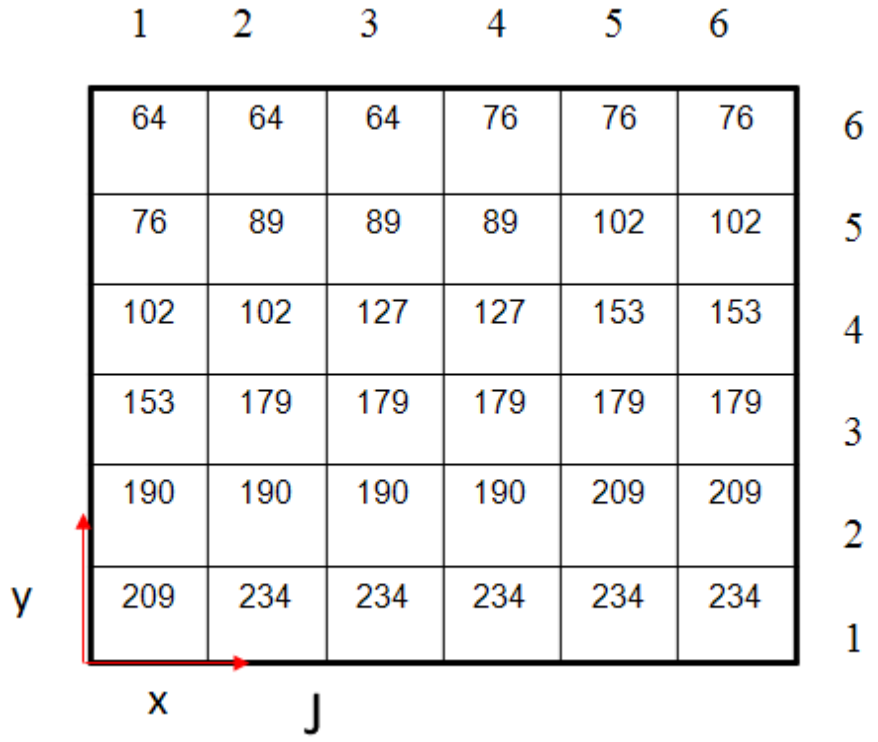
**Consider the following binary image I:**




**Consider the following greyscale image J:**



**Question 29**
Let's suppose a greyscale Image F and a linear mapping from Image F to Image G with bias **b** equal to 50 and gain **a** equal to 0.8. What is the greyscale value for G(2,3) if F(2,3) is equal to 50?

(a) 28
(b) 255
(c) 60
(d) 90
(e) None of the above.

**Question 30**
How many shades of grey are there in a 7-bits image?

(a) 128
(b) 256
(c) 64
(d) 63
(e) None of the above.

**Question 33**
Which statement is *true*?

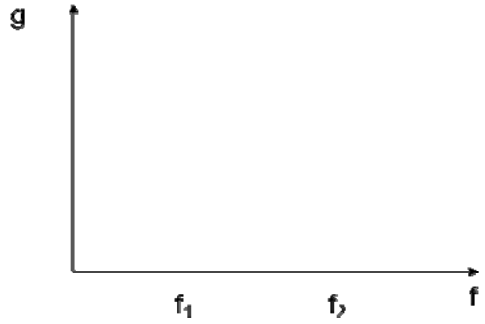
(a) The "negation" linear mapping transforms dark regions of an image into darker regions.
(b) A histogram displays the frequencies of appearance of pixel values in an image.
(c) Irrespective of the image they are applied to, the median and average filters never produce the same outcome.
(d) Linear mapping with a positive bias decreases brightness.
(e) All of the other.

**Question 31**

Let's suppose a greyscale Image K with Kmin=50 and Kmax=170. What are the values of the bias a and gain b of the stretching mapping which maps the pixel value range [Kmin, Kmax] of image K into the pixel value range [10-250]?

(a) a=1, b=45
(b) a=2, b=-90
(c) a=-1, b=45
(d) a=2, b=90
(e) None of the above.

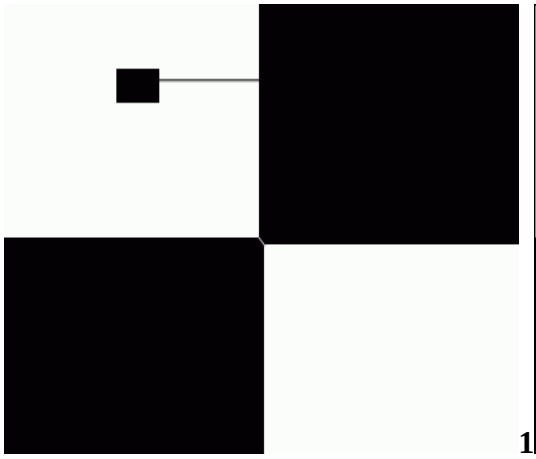
$$g_{out} = (K - K_{\min})\left(\frac{g_{\max} - g_{\min}}{K_{\max} - K_{\min}}\right) + g_{\min}$$



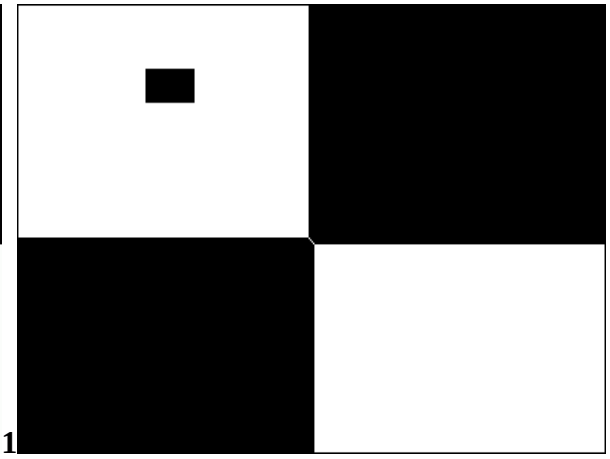
**Question 32**

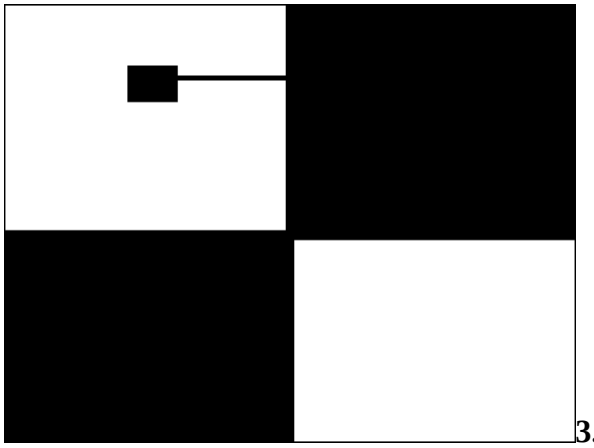
Image Z is the original binary image. Each of images 1, 2,3, 4 is the result of applying one morphological operation to image Z. A square 3x3 structuring element was used, and the foreground is white.

**Z.**

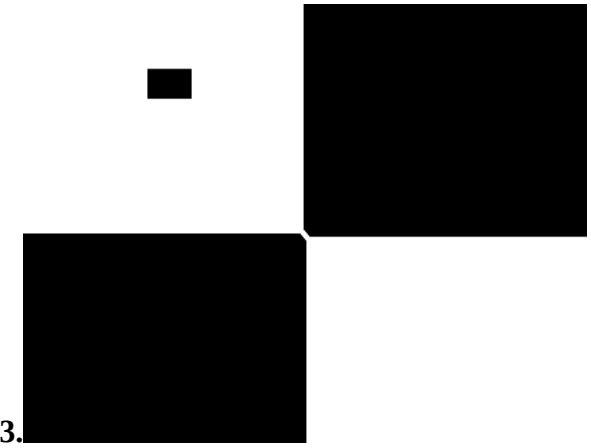


**1**





**3.**



**2.**

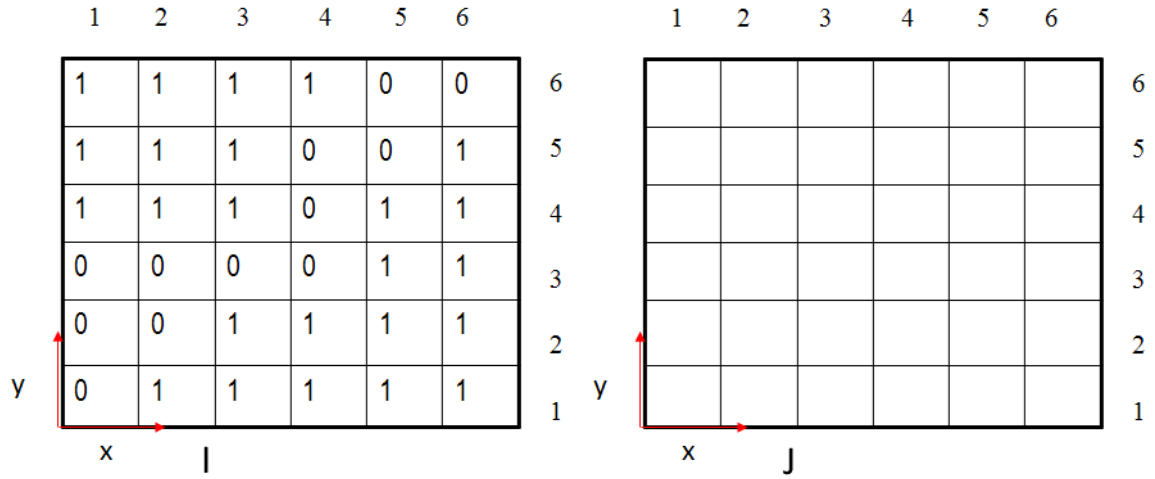
Which of the following answers gives the correct operations?

1. Close, 2. Erode, 3. Dilate.
2. Erode, 2. Close, 3. Dilate.
3. Close, 2. Erode, 3. Open.
4. Open, 2. Erode, 3. Dilate.

**Question 34**

Consider a 3 by 3 cross-like binary mask (structuring element) M. What is the Image value at pixel location (3,4) after performing an erosion on binary image I (introduced at the beginning of this script) using mask M?

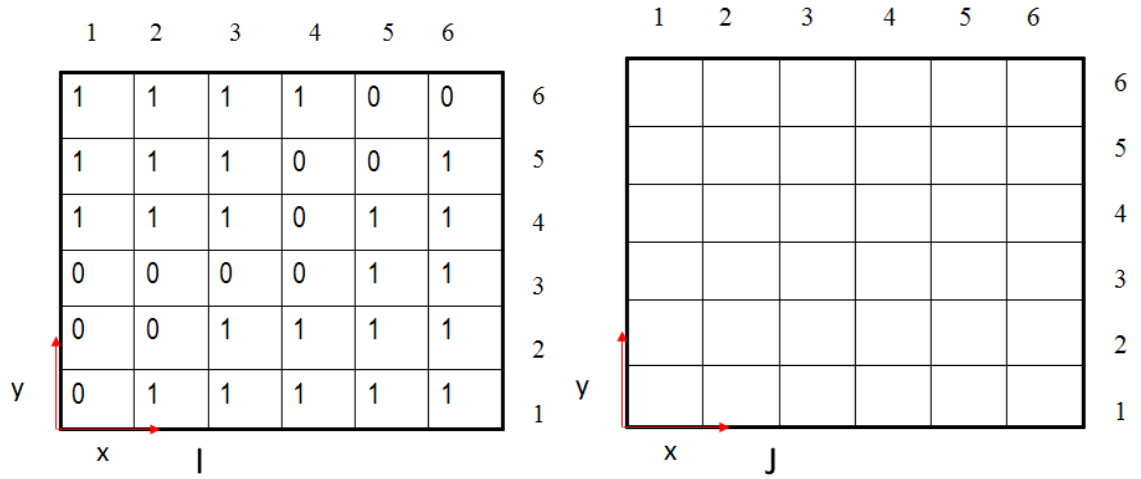
(a) 2
(b) 1
(c) undefined
(d) 0
(e) None of the above.




**Question 35**

Consider a 3 by 3 cross-like binary mask (structuring element) M. What is the Image value at pixel location (3,4) after performing a dilation on binary image I (introduced at the beginning of this script) using mask M?

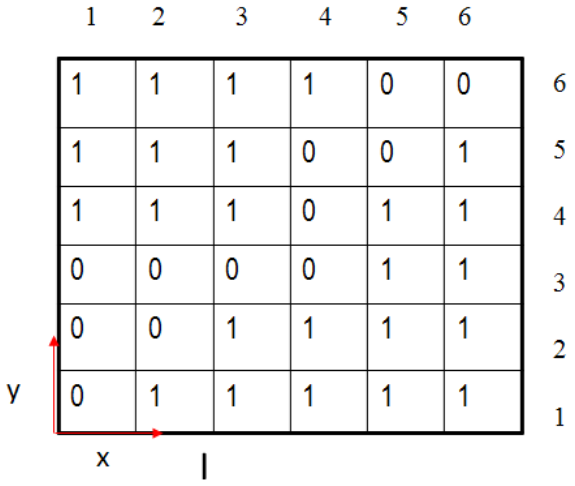
(a) undefined
(b) 0
(c) 2
(d) 1
(e) None of the above.

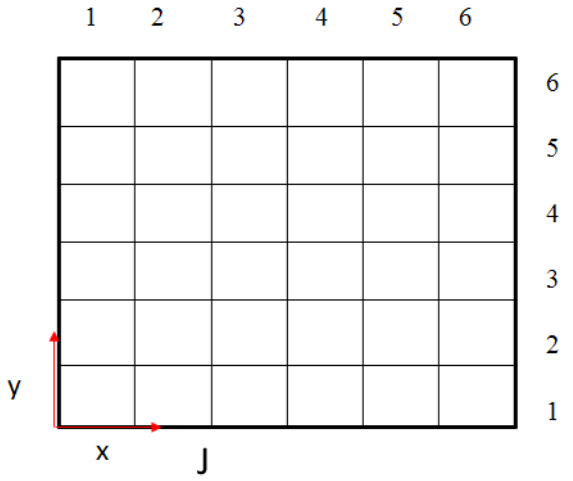


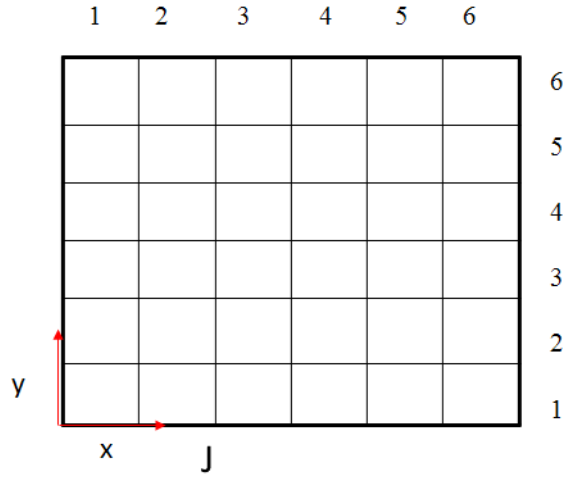
**Question 36**

Consider a 3 by 3 cross-like binary mask (structuring element) M. What is the Image value at pixel location (3,3) after performing a closing operation on binary image I (introduced at the beginning of this script) using mask M?

(a) 2
(b) 1
(c) undefined
(d) 0
(e) None of the above.



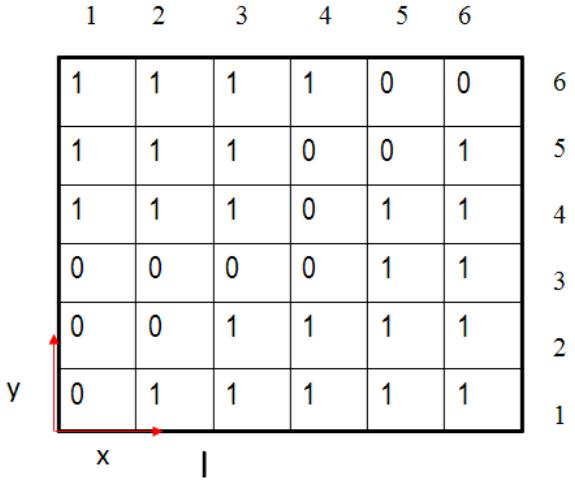



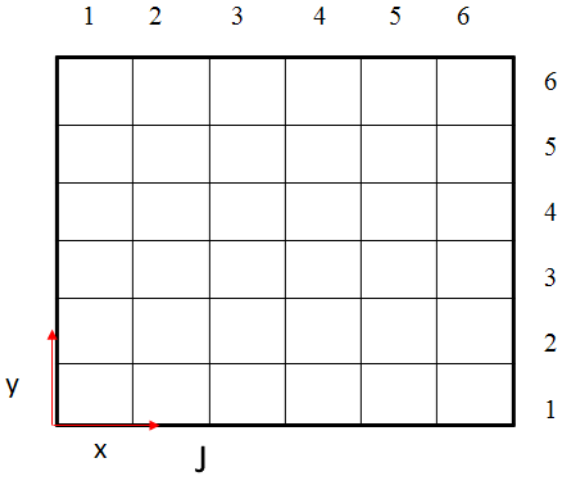



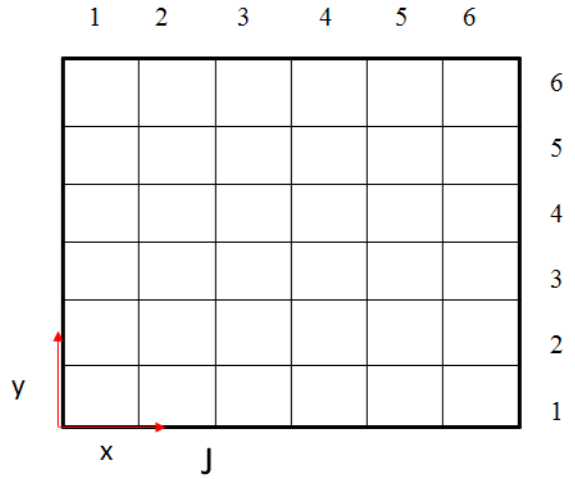
**Question 37**

Consider a 3 by 3 cross-like binary mask (structuring element) M. What is the Image value at pixel location (3,4) after performing an opening operation on binary image I using mask M?

(a) 2
(b) 0
(c) 1
(d) undefined
(e) None of the above.



**Question 40**

Consider the greyscale image J defined at the beginning of the test script. What is the histogram count for pixel value 89?

(a) 2
(b) 0
(c) 4
(d) 3
(e) None of the above.

| Value | Count |
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**Question 42**

Consider the greyscale image J defined at the beginning of the test script. What is the cumulative histogram count for pixel value 127?

(a) 16
(b) Undefined.
(c) 4/9
(d) 2
(e) None of the above.

| Value | Count |
|---|---|
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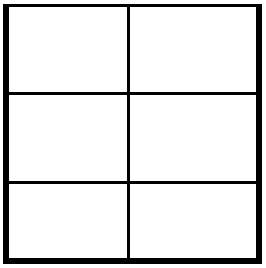

**Question 41**
Consider the greyscale image J defined at the beginning of the test script. What is the cumulative distribution function Image value at pixel value 255?

(a) 255
(b) 1
(c) 36
(d) 1/255
(e) None of the above.

| Value | Cdf |
|---|---|
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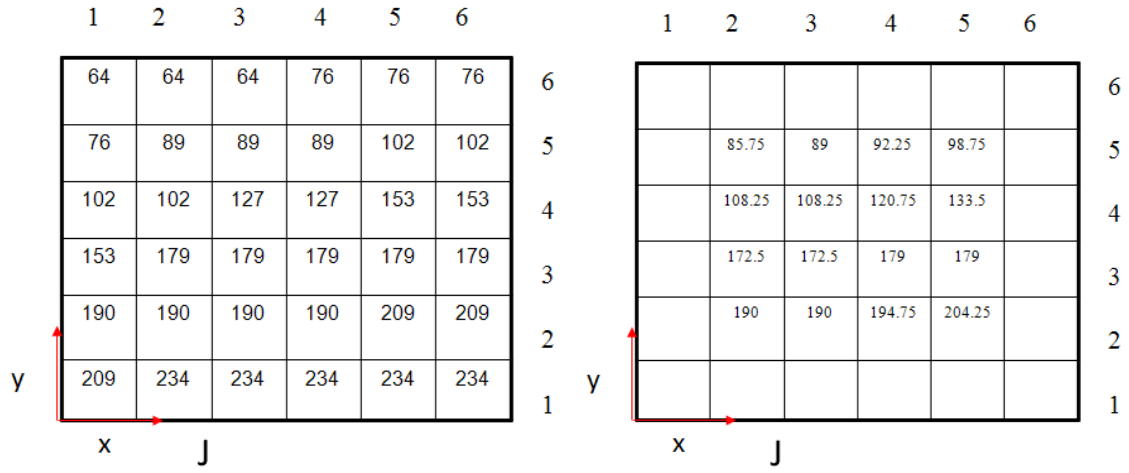
**Question 50**
Consider the greyscale image J defined at the beginning of the test script. What is the Image value at pixel location (3,3) after performing a histogram equalization?

(a) 170
(b) 127
(c) 190
(d) Undetermined.
(e) None of the above.

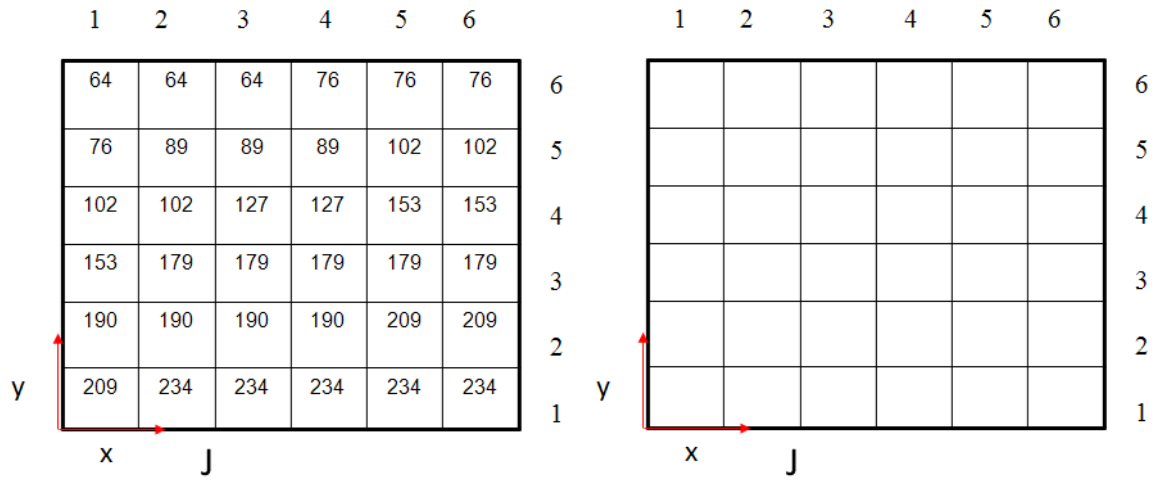
**Question 44**
Consider the greyscale image J defined at the beginning of the test script. What is the Image value at pixel location (3,3) after applying a 1 by 3 Gaussian filtering on image J?

(a) Undefined.
(b) 179
(c) 125
(d) 173
(e) None of the above.



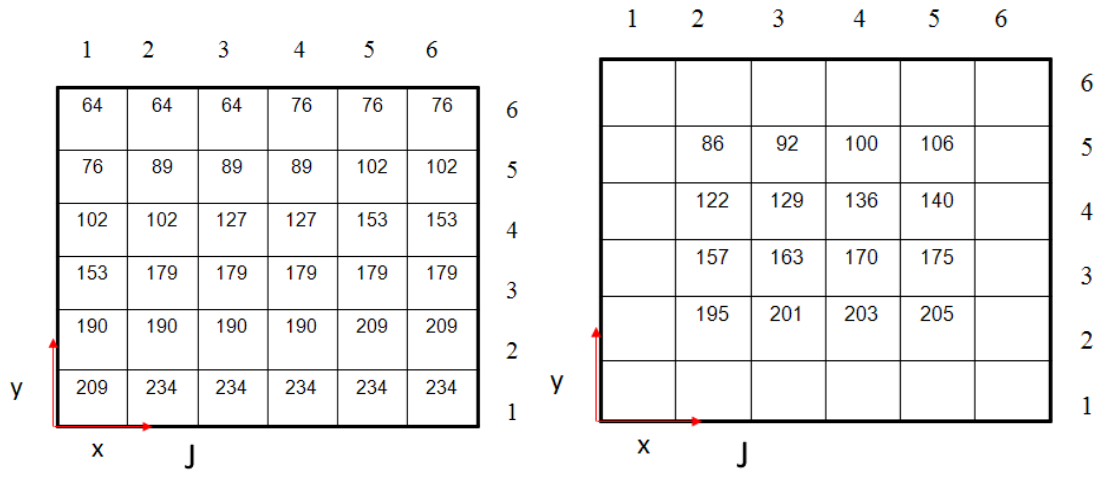

**Question 46**
Consider the greyscale image J defined at the beginning of the test script. What is the Image value at pixel location (3,4) after applying a 3 by 3 Median filter on image J?

(a) 89
(b) 127
(c) 179
(d) 102
(e) None of the above.




**Question 47**
Consider the greyscale image J defined at the beginning of the test script. What is the Image value at pixel location (3,4) after applying a 3 by 3 Average filter on image J?

(a) 127
(b) 89
(c) 132
(d) 179
(e) None of the above

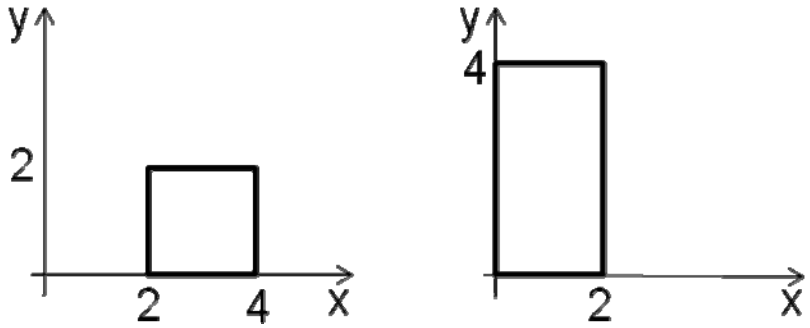


**Question 43**
Considering an 8 bits image, what is the cumulative histogram count for pixel value 127 if an image has an evenly distributed histogram pixel count for all pixel values?

(a) 1/127
(b) 127
(c) 1
(d) 1/2
(e) None of the above.

## Question 7:

Which homogeneous 2D matrix transforms the figure on the left side to the figure on the right?




(a) $\begin{pmatrix} 1 & 0 & -2 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(b) $\begin{pmatrix} 1 & 0 & 2 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(c) $\begin{pmatrix} -2 & 0 & -2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(d) $\begin{pmatrix} -2 & 0 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(e) None of the others

**Question 20**
Which statement about affine transformations is *false*?

(a) After being transformed by an affine transformation, a straight line is still straight
(b) With homogeneous coordinates, affine transformations can be expressed using only a matrix multiplication

CONTINUED

(c) The order in which affine transformations are performed does not matter
(d) An affine transformation consists of a linear transformation and a translation
(e) None of the above

**Question 21**
Which of the following statements about Phong illumination is *false*?

(a) Ambient light is scattered everywhere, even in dark corners
(b) Specular reflection is largest if light is reflected directly into the eye
(c) Diffuse reflection creates highlights on a surface
(d) There is generally more diffuse reflection on a rough surface than on a smooth surface
(e) None of the above

**Question 28**
Which statement is *true*?

(a) Two different images cannot have the same histogram.
(b) For an N by M 8-bit greyscale image the cumulative histogram value for the greyscale value 255 is 255.
(c) Two different images cannot have the same cumulative histogram.
(d) For an N by M pixels 8-bit greyscale image the cumulative histogram count at pixel value 255 is N*M.
(e) None of the above.

**Question 49**
Which of the following statement is *true*?

(a) A Sobel filter is a first order edge detector operator.
(b) Median filtering acts as a noise reduction operation.
(c) An average filter performs the weighted sum of a group of pixels.
(d) Gaussian filtering is also referred as a low-pass filter.
(e) All of the above.

## Question 4:

The dot product of $\mathbf{u} = \begin{pmatrix} 1 \\ -5 \\ 2 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} 0 \\ 4 \\ -1 \end{pmatrix}$ equals

(a) -22
(b) 5
(c) -23
(d) 22
(e) None of the others

## Question 5:

The vector product **u**×**v** where $\mathbf{u} = \begin{pmatrix} -1 \\ -1 \\ 3 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} 2 \\ -1 \\ 2 \end{pmatrix}$ equals

$\begin{pmatrix} 1 \\ 8 \\ 3 \end{pmatrix}$

$\begin{pmatrix} -1 \\ 3 \\ 3 \end{pmatrix}$

$\begin{pmatrix} -2 \\ 1 \\ 6 \end{pmatrix}$

$\begin{pmatrix} -1 \\ 8 \\ 4 \end{pmatrix}$

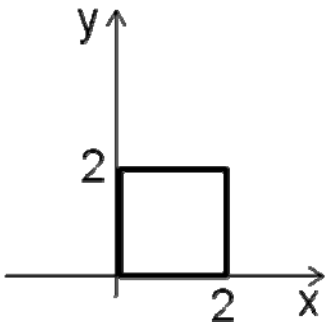
None of the others

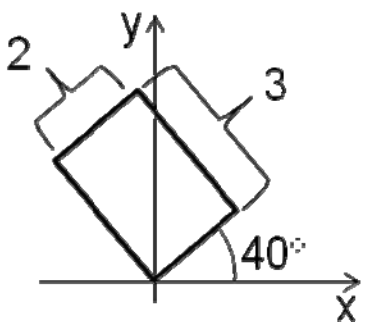
## Question 6:

A plane with the following plane equation is given: x + 2 y – 2 z = 4
How far is the point (5,4,2) away from the plane?

(a) 0
(b) 3
(c) 9
(d) 5/3
(e) None of the others

**Question 18**
Which homogeneous 2D matrix transforms the figure on the left side to the figure on the right?



(a) $\begin{pmatrix} \cos(40^\circ) & -1.5\sin(40^\circ) & 0 \\ \sin(40^\circ) & 1.5\cos(40^\circ) & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(b) $\begin{pmatrix} 1.5\sin(40^\circ) & \cos(40^\circ) & 0 \\ -1.5\cos(40^\circ) & \sin(40^\circ) & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(c) $\begin{pmatrix} \cos(40^\circ) & 1.5\sin(40^\circ) & 0 \\ -\sin(40^\circ) & 1.5\cos(40^\circ) & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(d) $\begin{pmatrix} \sin(40^\circ) & 1.5\cos(40^\circ) & 0 \\ -\cos(40^\circ) & 1.5\sin(40^\circ) & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(e) None of the above

**Rough Working – This page will not be marked**