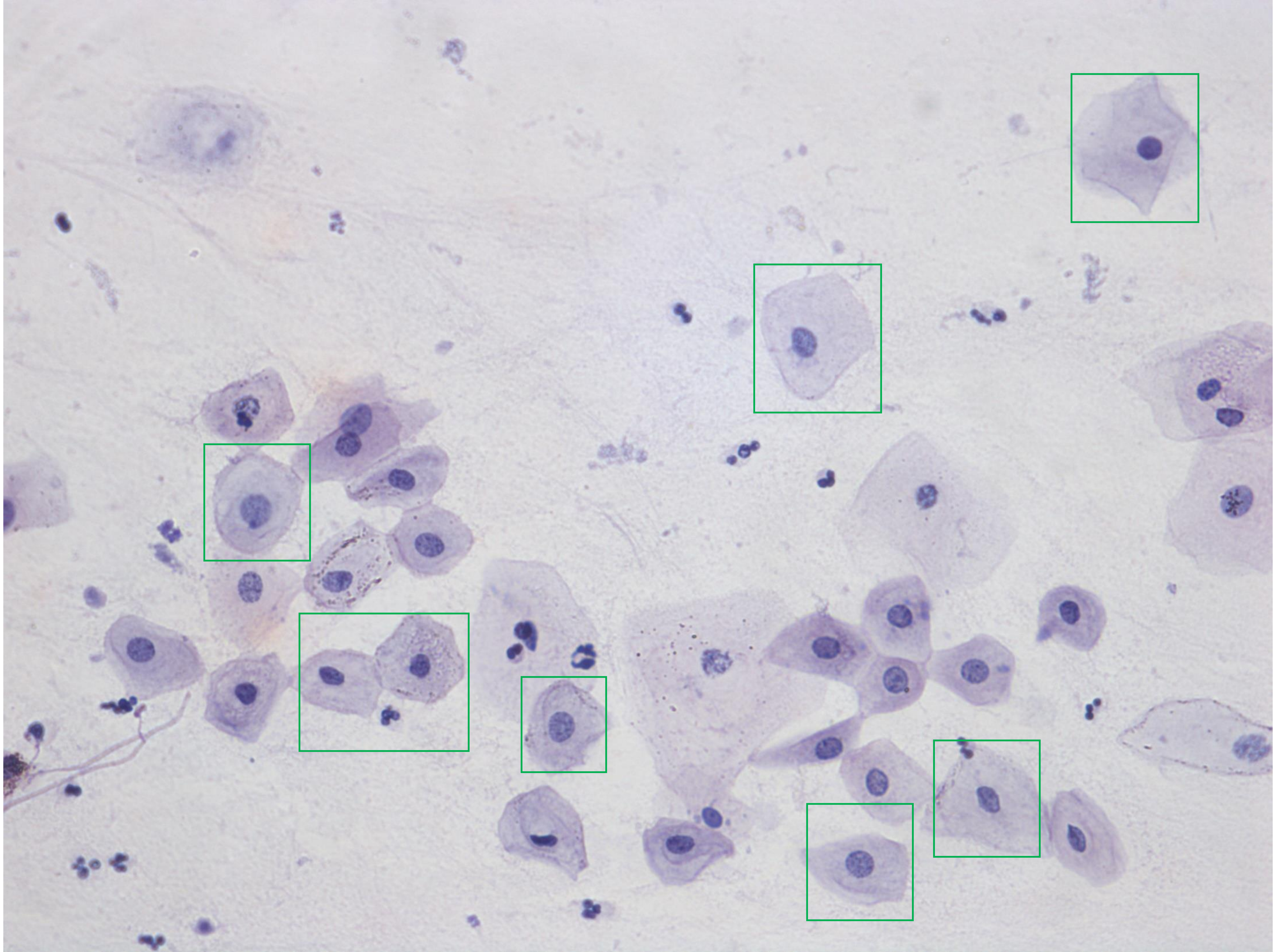
Image Entropy

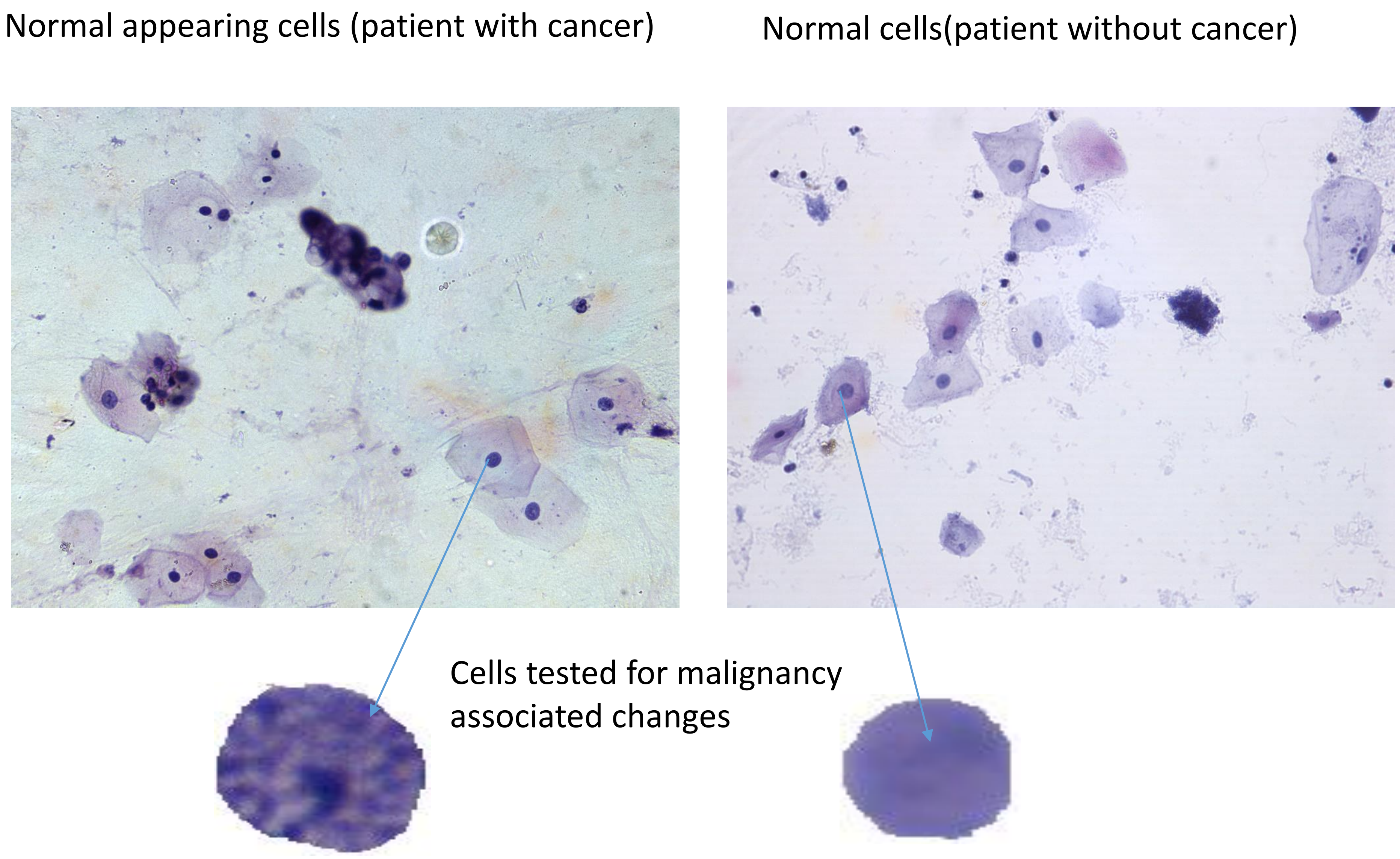
Entropy is a concept which originally arose from the study of the physics of heat engines. It can be described as a measure of the amount of disorder in a system.

In the case of an image, these states correspond to the gray levels which the individual pixels can adopt.

$$H = -\sum_{k=0}^{M-1} p_k \log_2(p_k)$$

For example, in an 8-bit pixel there are 256 such states. If all such states are equally occupied, as they are in the case of an image which has been perfectly histogram equalized, the spread of states is a maximum, as is the entropy of the image.




Normal appearing cells (patient with cancer)
Normal cells(patient without cancer)
Cells tested for malignancy associated changes

Correlation and Convolution

- ❖Correlation and Convolution are basic operations that we will perform to extract information from images.
- ❖They are simple, they can be analyzed and understood very well, and they are also easy to implement and can be computed very efficiently.
- ❖These operations have two key features: they are *shift-invariant, and they are linear.*
- ❖Shift-invariant means that we perform the same operation at every point in the image.
- ❖Linear means that this operation is linear, that is, we replace every pixel with a linear combination of its neighbors

5	4	2	3	7	4	6	5	3	6

.	.	.	*0*	*0*	5	4	2	3	7	4	6	5	3	6	*0*	*0*	.	.	.

In the first method of handling boundaries, the original image is padded with zeros

.	.	.	*5*	*5*	5	4	2	3	7	4	6	5	3	6	*6*	*6*	.	.	.

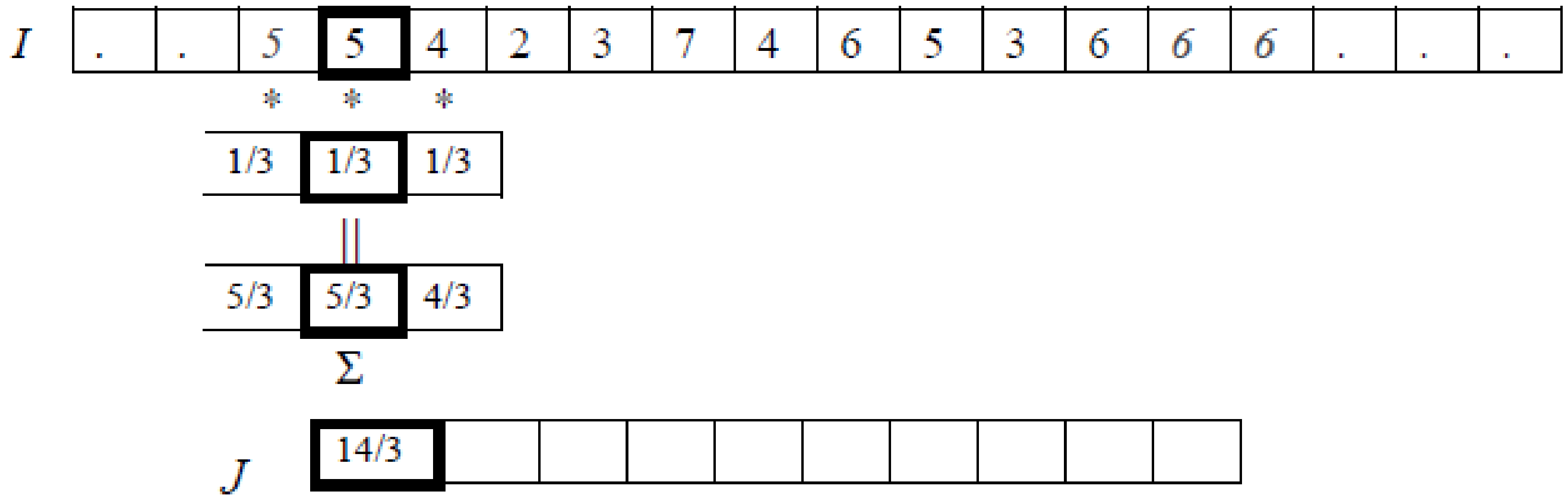
In the second method of handling boundaries, the original image is padded with the first and last values (in red italics).

.	.	.	*3*	*6*	5	4	2	3	7	4	6	5	3	6	*5*	*4*	.	.	.

In the third method of handling boundaries, the original image is repeated cyclically

One of the simplest operations that we can perform with correlation is local averaging.

5	4	2	3	7	4	6	5	3	6



Source : David Jacobs, Correlation and Convolution, http://www.cs.umd.edu/~djacobs/CMSC426/Convolution.pdf

I	5	4	2	3	7	4	6	5	3	6

h	1/3	1/3	1/3

	0	1	2	3	4 …					
I	5	4	2	3	7	4	6	5	3	6

	-1	0	1
h	1/3	1/3	1/3

J		3.6								

$$J(1) = I(0) \times h(-1) + I(1) \times h(0) + I(2) \times h(1)$$

$$J(1) = 5 \times \frac{1}{3} + 4 \times \frac{1}{3} + 2 \times \frac{1}{3}$$

J		3.6								

$$J(1) = I(0) \times h(-1) + I(1) \times h(0) + I(2) \times h(1)$$

$$J(1) = 5 \times \frac{1}{3} + 4 \times \frac{1}{3} + 2 \times \frac{1}{3}$$

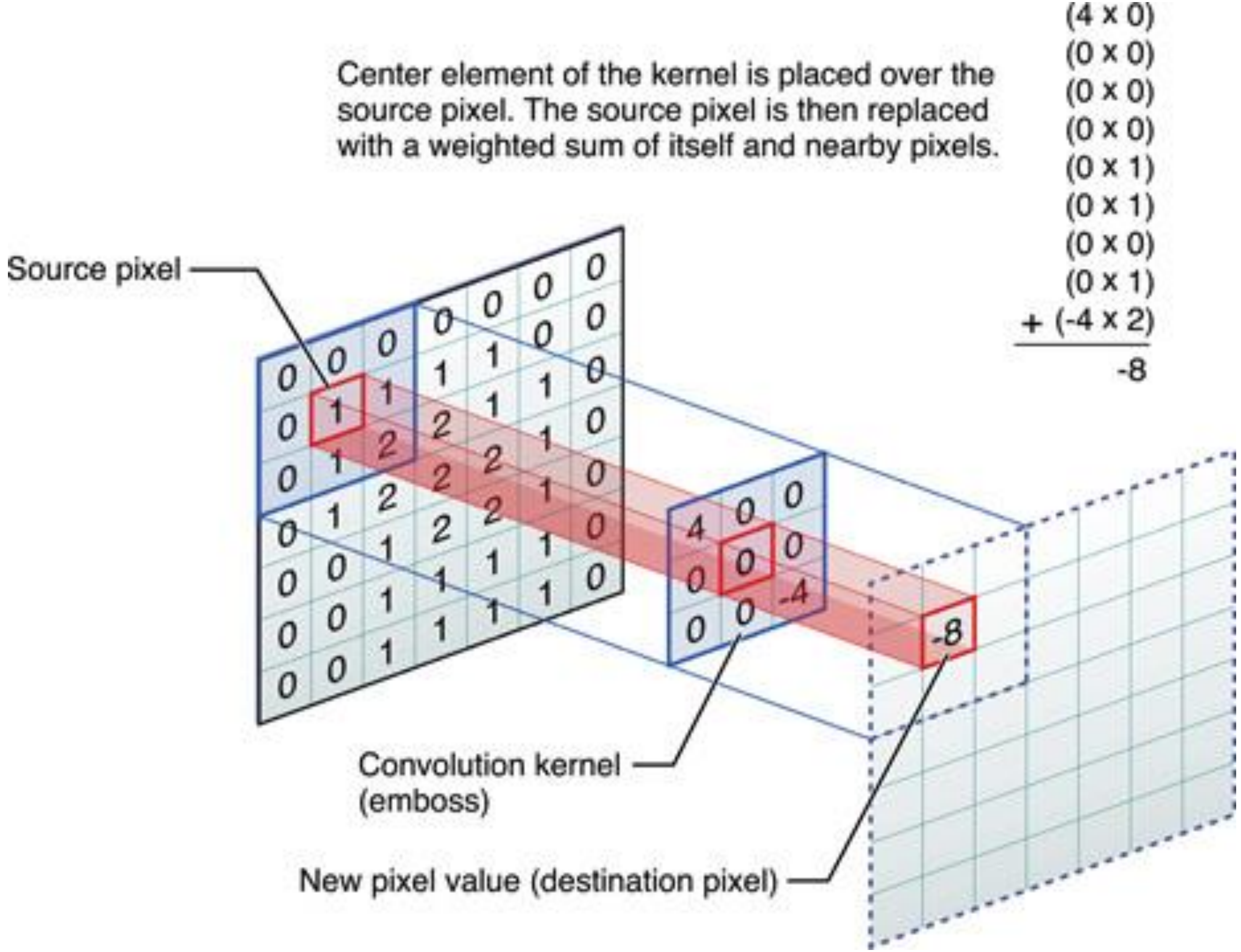
	0	1	2	3	4					
I	5	4	2	3	7	4	6	5	3	6

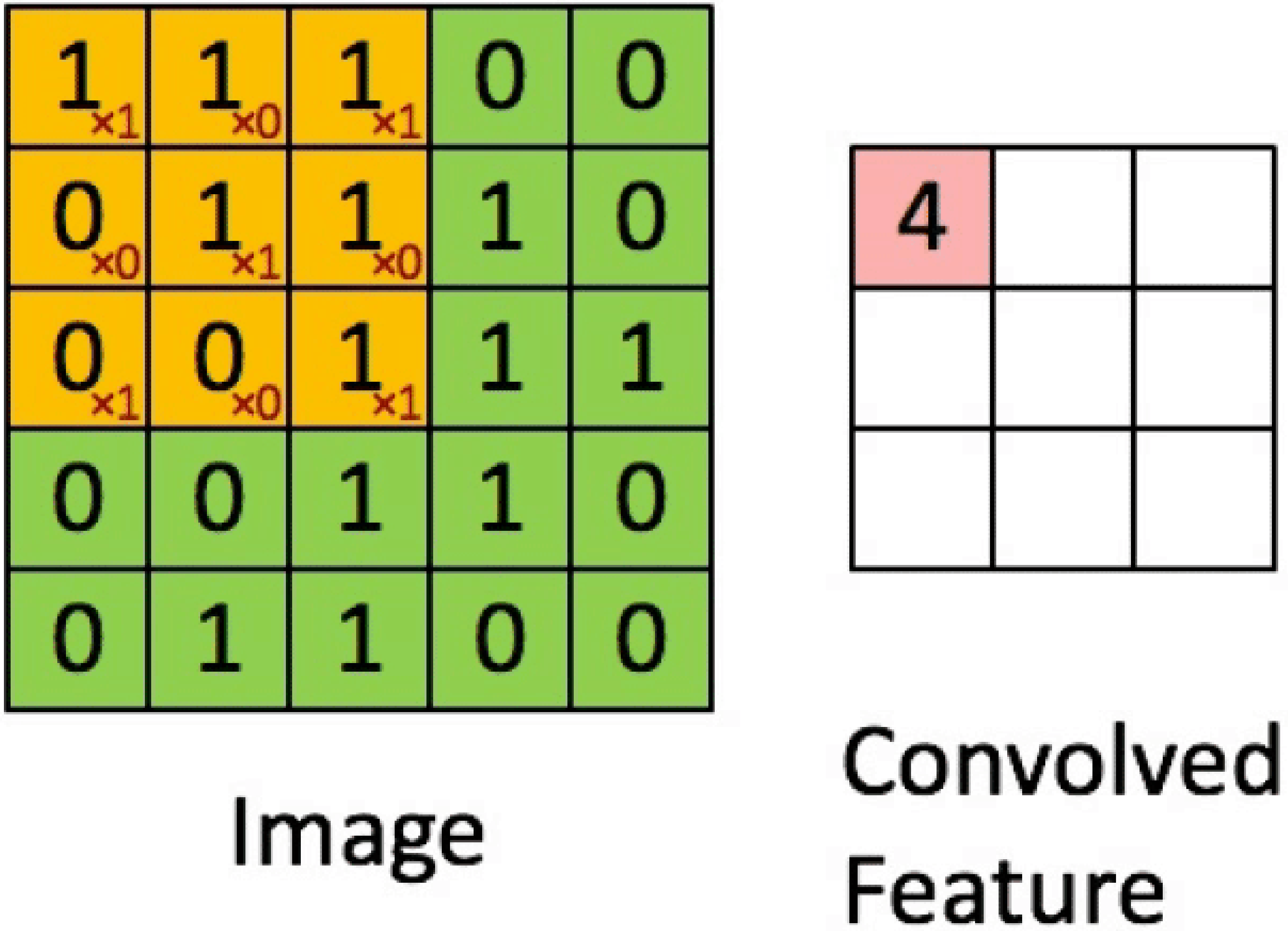
	-1	0	1
h	1/3	1/3	1/3

$$J(x) = \sum_{i=-1}^{1} h(i) \times I(x+i)$$

$$J = I \circ h = \sum_{i=-N}^{N} h(i) \times I(x+i)$$

$$J = I \circ h = \sum_{i=-N}^{N} \sum_{j=-N}^{N} h(i,j) \times I(x+i,,y+j)$$


Center element of the kernel is placed over the source pixel. The source pixel is then replaced with a weighted sum of itself and nearby pixels.
(4 x 0)
(0 x 0)
(0 x 0)
(0 x 0)
(0 x 1)
(0 x 1)
(0 x 0)
(0 x 1)
+ (-4 x 2)
-8
Source pixel
Convolution kernel (emboss)
New pixel value (destination pixel)


4
Image
Convolved
Feature

Mean Filters: Effect of Filter Size

Original

7×7

15×15

41×41