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Kernel Image Processing- Sharpening

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Abstract

- **Kernel:** small matrix used in image processing for blurring, sharpening, embossing, edge detection , and more.This is accomplished by doing a *convolution* between a kernel and an image.

- **Convolution:** process of adding each element of the image to its local neighbours, weighted by the kernel.

- **Image Sharpening:**enhancement technique that highlights edges and fine details in an image

Original Image

Kernel

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Filtered Image

Math

- The general expression of a convolution is:

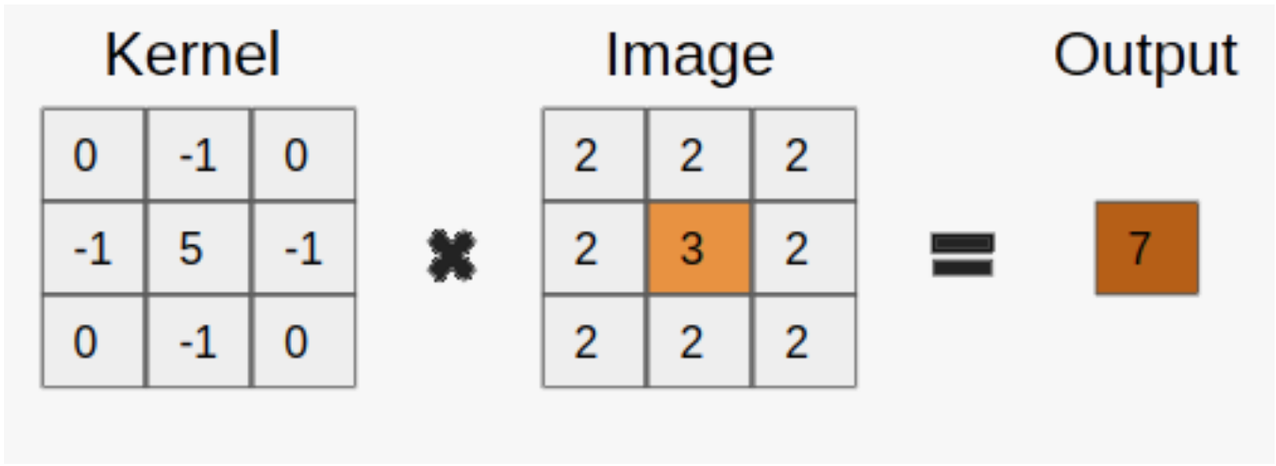
$$g(x,y) = \omega * f(x,y) = \sum_{dx=-a}^{a} \sum_{dy=-b}^{b} \omega(dx,dy) f(x+dx, y+dy),$$

Where:

f-original intensity value *g-filtered intensity value*

w-kernel value *a,b dimension of kernel matrix*

- For *Image Sharpening* we considered the following 3x3 Kernel Matrix



*g(1,1) = 0*f(0,0) + (-1)*f(0,1) + 0*f(0,2) + (-1)*f(1,0) + 5*f(1,1) + (-1)*f(1,2) + 0*f(2,0) + (-1)*f(2,1) + 0*f(2,2) = 7*

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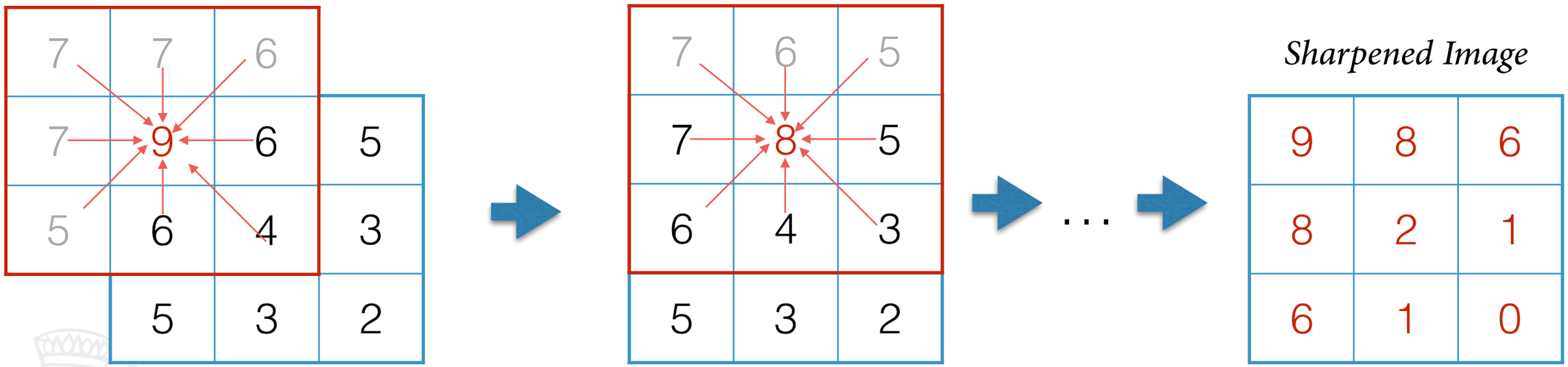
Technologies

- Sequential Implementation: Java 8
- Parallel Implementation : Java Thread

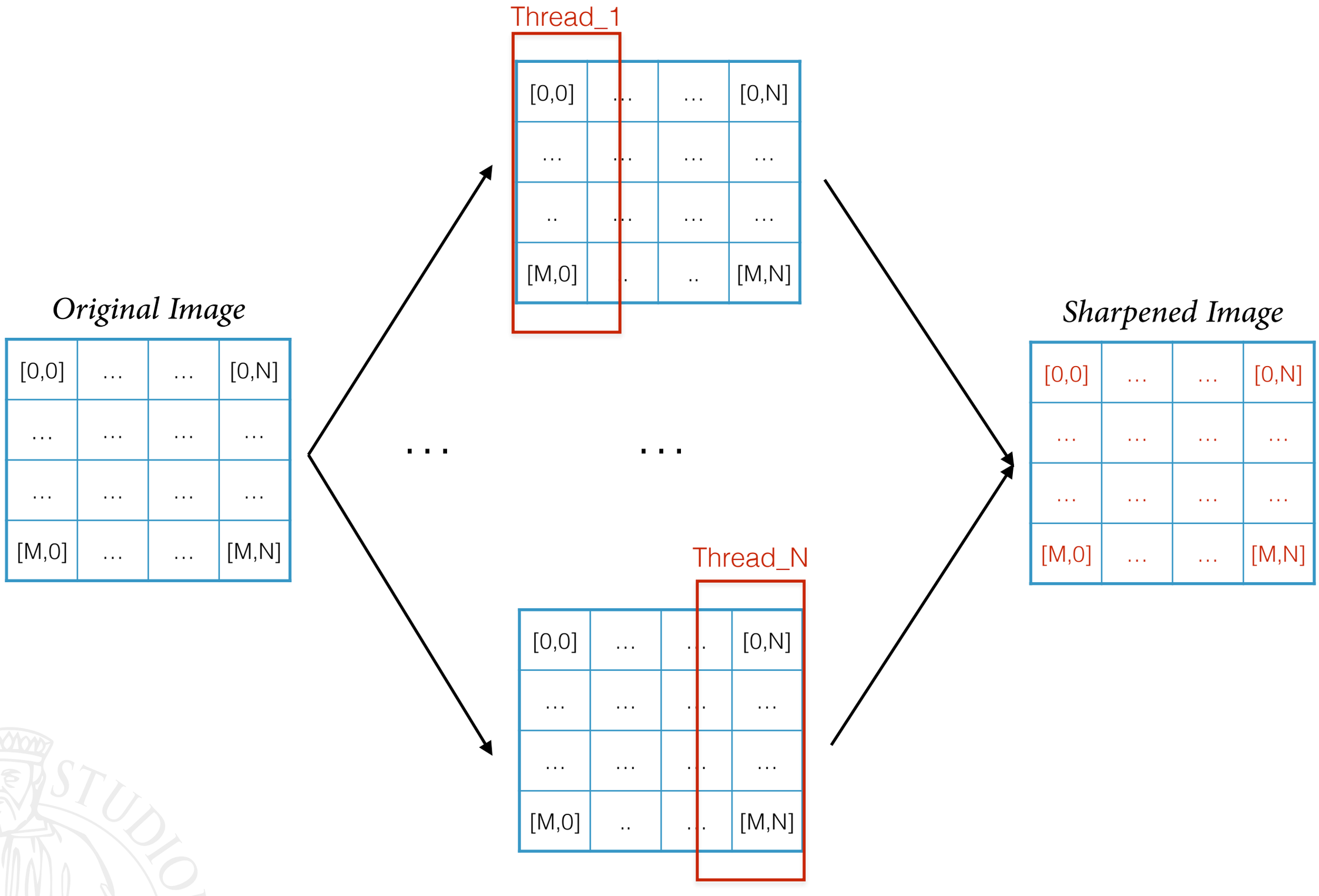
Serial

Original Image

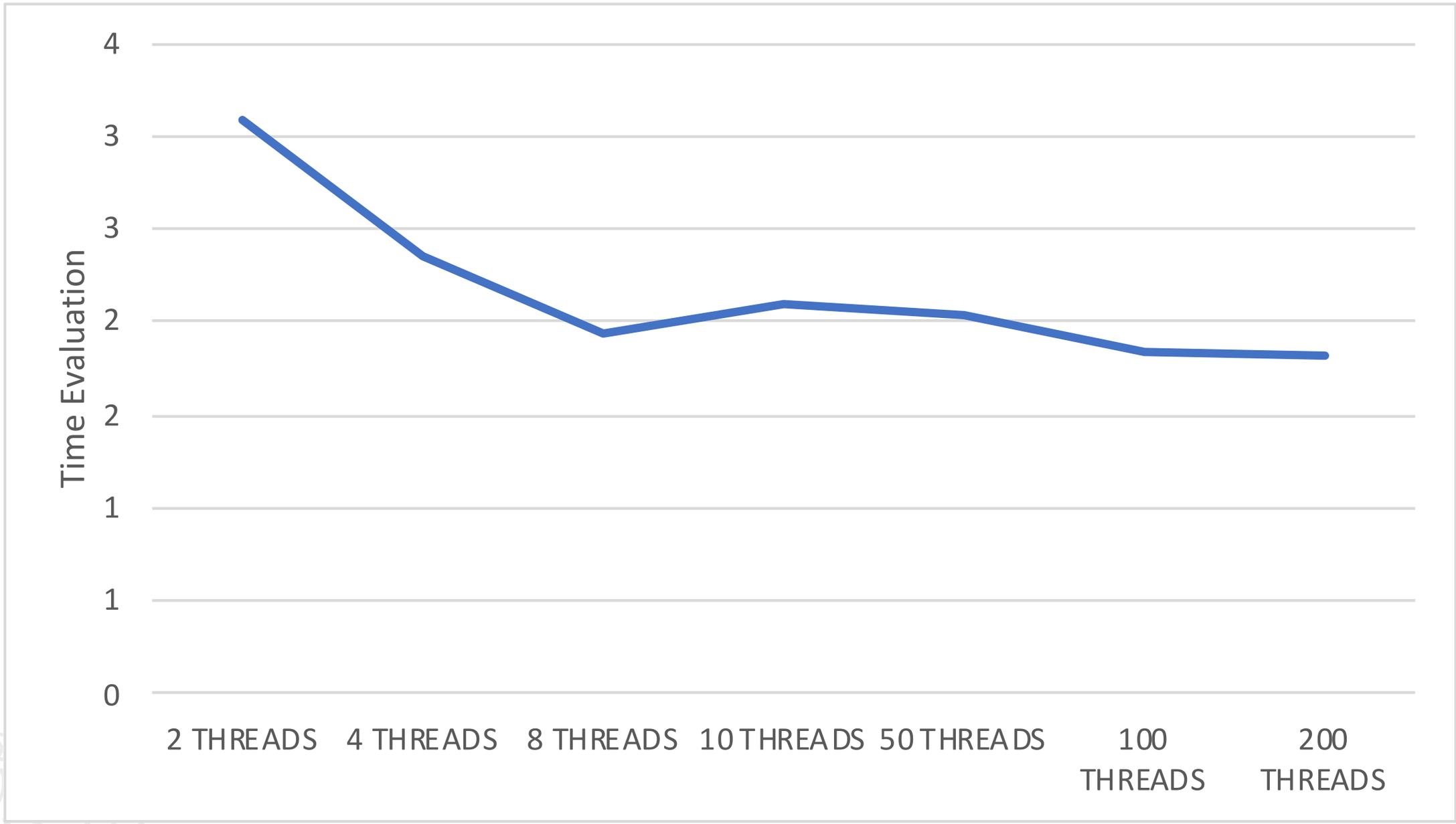
7	6	5
6	4	3
5	3	2



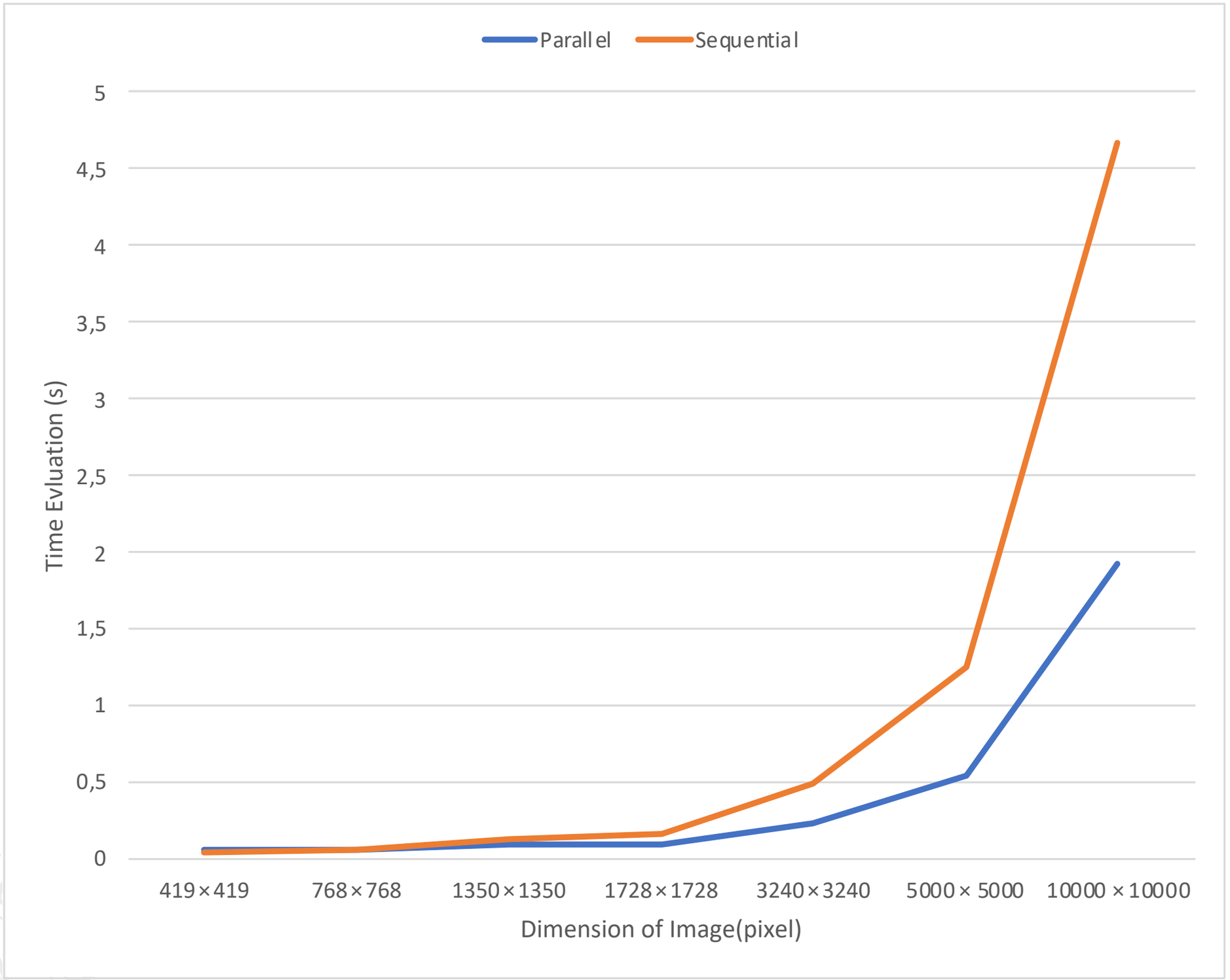
Parallel


Thread_1
[0,0] … … [0,N]
… … … …
.. … … …
[M,0] . .. [M,N]
Original Image
[0,0] … … [0,N]
… … … …
… … … …
[M,0] … … [M,N]
Sharpened Image
[0,0] … … [0,N]
… … … …
… … … …
[M,0] … … [M,N]
Thread_N
[0,0] … … [0,N]
… … … …
… … … …
[M,0] .. … [M,N]

Parallel Threads



Time Results



Speed Up

Comparison between serial and 8-Thread version