Visualization and analysis of very large 3D images

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UM2 - Master 2 Informatics - IMAGINA

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de Montpellier

LIRMM

UNIVERSITÉ MONTPELLIER 2
SCIENCES ET TECHNIQUES

Outlines

- Background
- Main problem
- Previous work
- Contribution
  - Visualization
  - Processing
    - Processing problems
    - Proposed Solution
- Implementation
- Future Work

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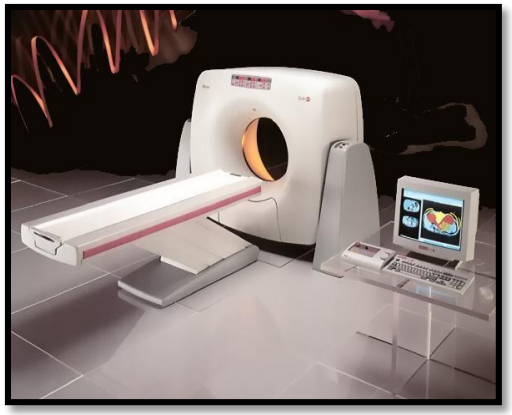
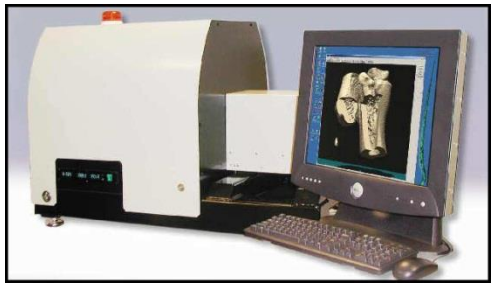
Background

* 3D Medical images
* Acquired by CT-Scan or Micro-CT
* Very large 3D images (2000*2000*2000) voxels



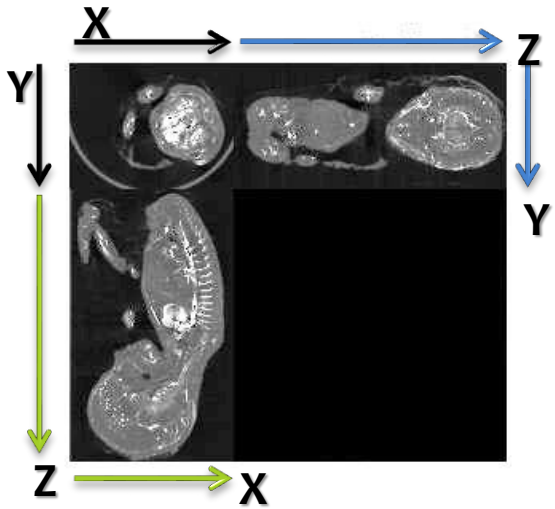
CT-Scan



Micro-CT

The 3D Image

* 3D image of foetus, (2048*2048*2740) voxels
* Intensity: each voxel is coded in two bytes ≈ 10.7 GB
* Isotropic voxel of 36 microns, Micro-CT at UM2 [*]
* MPR mode



[*] G. Captier, G. Subsol, R. Lebrun, F. Meyer, J.M. Gory, F. Canovas. "Dissection ftale virtuelle par micro tomodensitomtrie". 93e Congrs de l'Association des Morphologistes, Rouen (France), March 2011. Abstract published in Morphologie, 95, p. 102103, 2011.

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Main Problem

- Visualization
  - Very large 3D images: 2000*2000*2000 voxels
  - Problems:
    - Memory size
    - Restricted window size
- Processing
  - Restoration, Segmentation…
    - Memory size
    - Tuning interactively parameters

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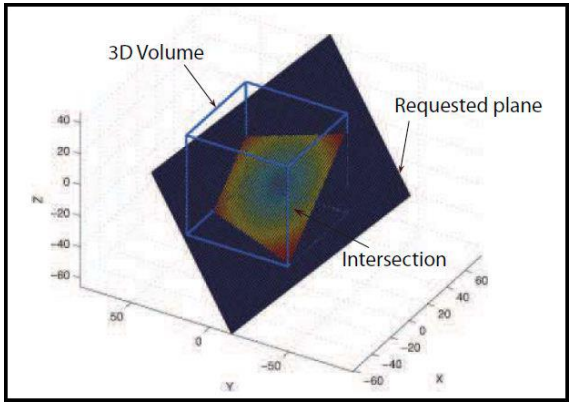
Previous Work

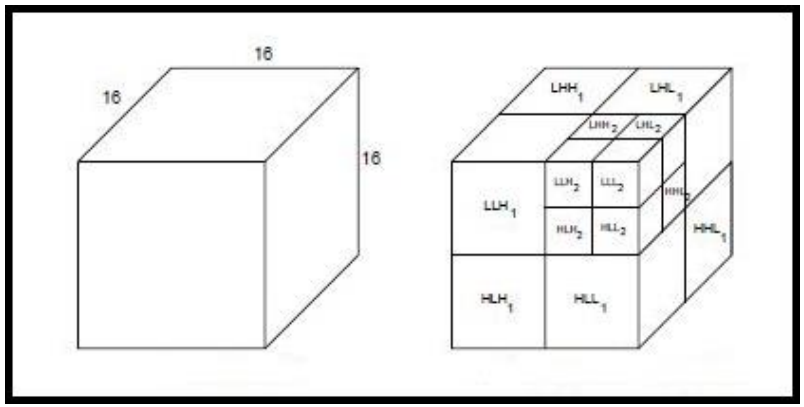
* Visualization
  * Decomposition into blocks
    * Client- server based visualization application [*]

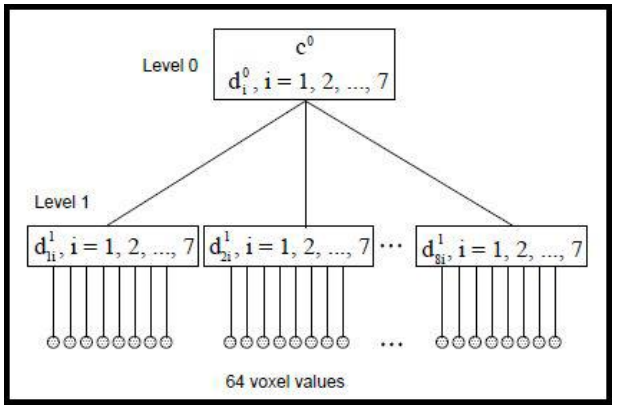


[*] Zihong Fan, Antonio Ortega, Optimization of Overlapped Tiling for Efficient 3D Image Retrieval, dcc, pp.494-503, 2010 Data Compression Conference, 2010

Previous Work

* Visualization
  * Multi-scale coding
    * Multi-level representation [*]

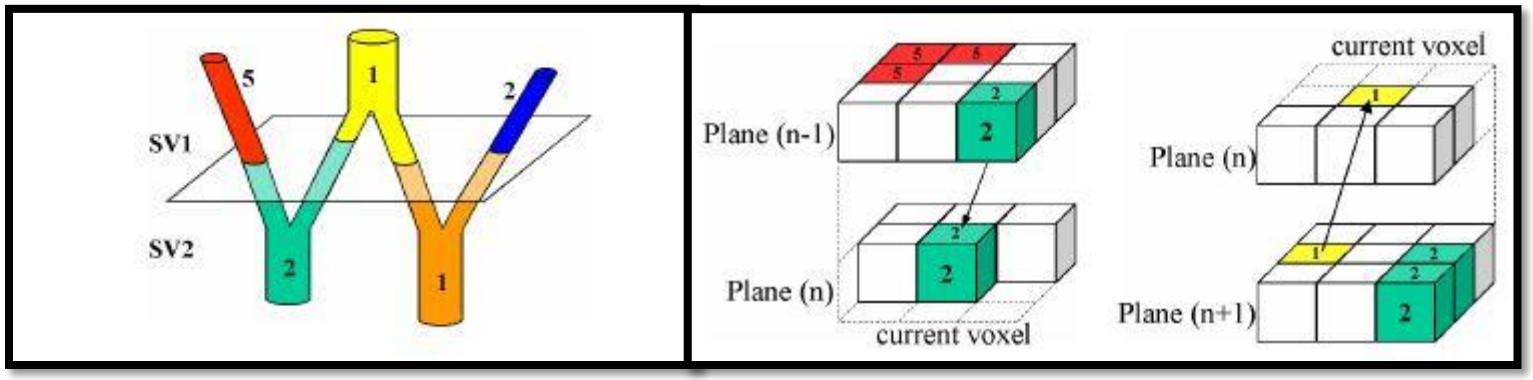




[*] Ihm, I., Park, S.: Wavelet-based 3D compression scheme for very large volume data. In: Graphics Interface .98, 107-116, 1998.

Previous Work

* Processing
  * Extract the connected components [*]



[*] L.Apostol and F.Peyrin, Connectivity analysis in very large 3D micro tomographic images. Nuclear Science Symposium Conference Record, 2004 IEEE

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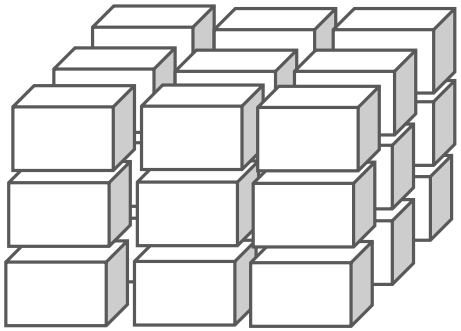
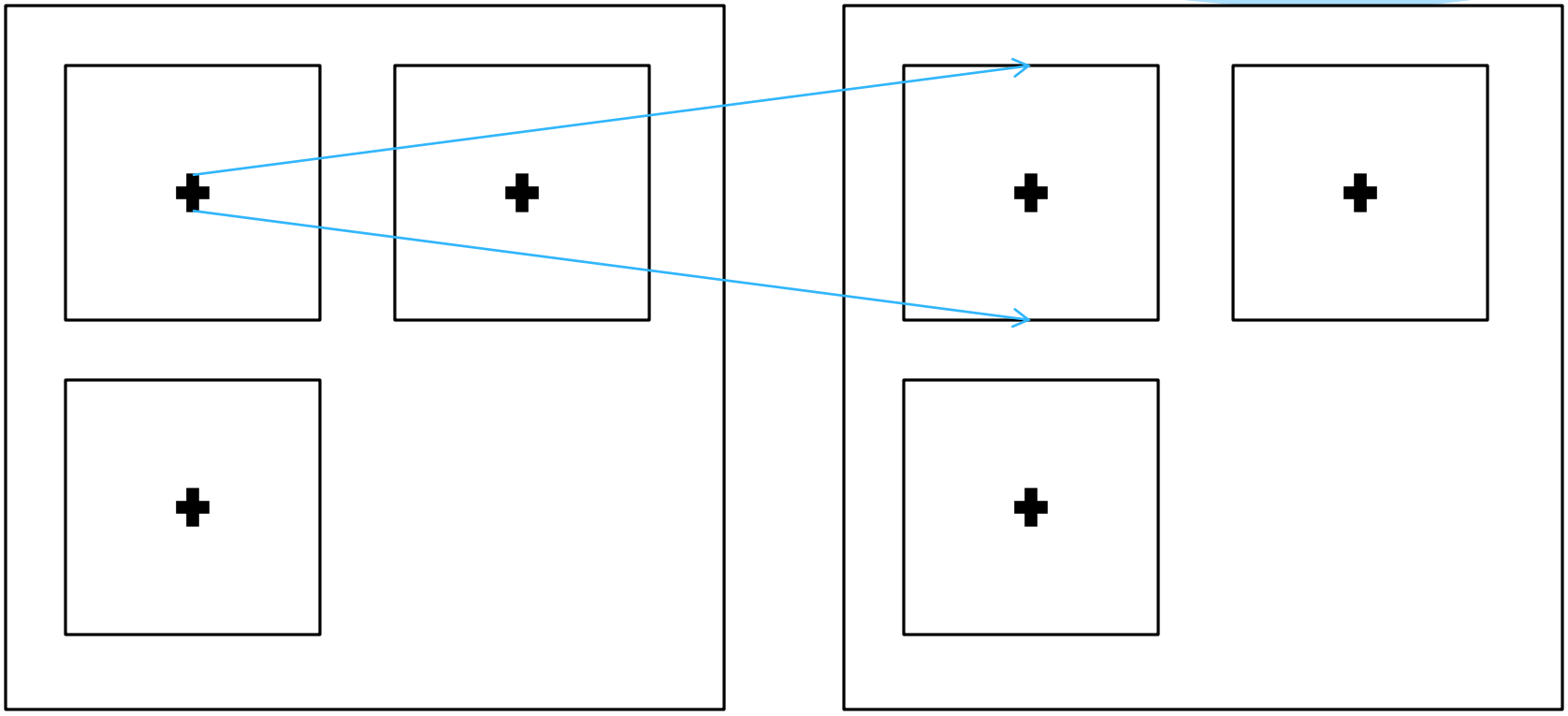
Visualization

* Decomposition into blocks



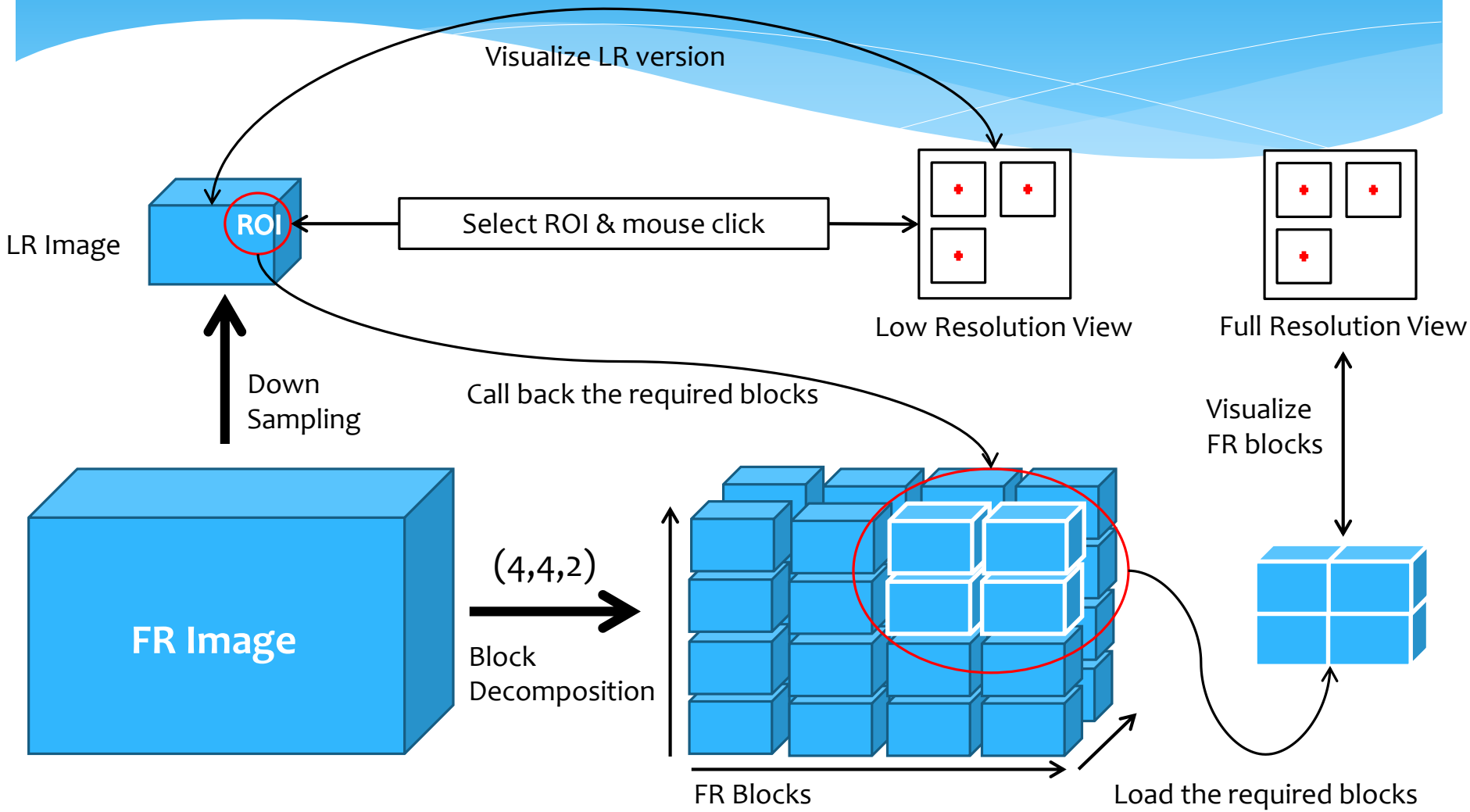
Visualization



Low Resolution View

Full Resolution View

Visualization



Visualization Parameters

* Block's decomposition parameters
  * Number of blocks along each axis
  * Configuration file (DF, BS)

Visualization Parameters

* Decomposition parameters: **Two matters!**
  1. Block size & Required memory
  2. Number of blocks & Required time

Visualization Parameters

1. Block size & Required memory

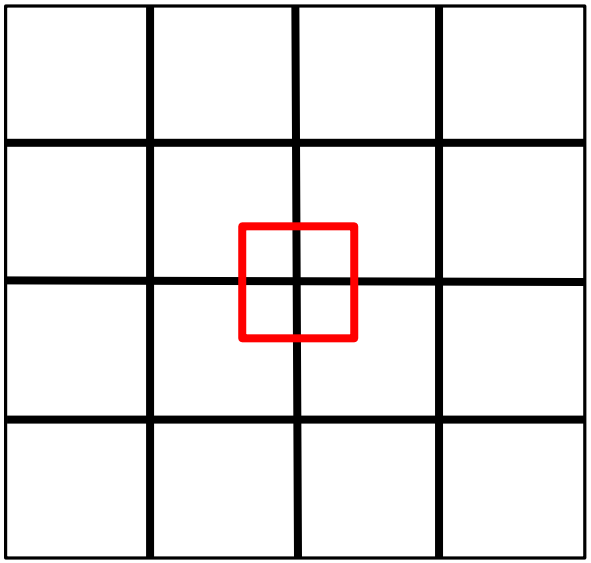
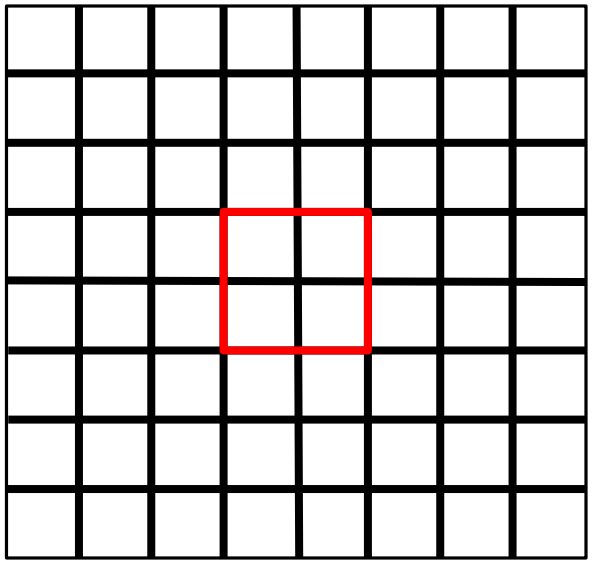


Image size

800 * 800

Window size

100 * 100

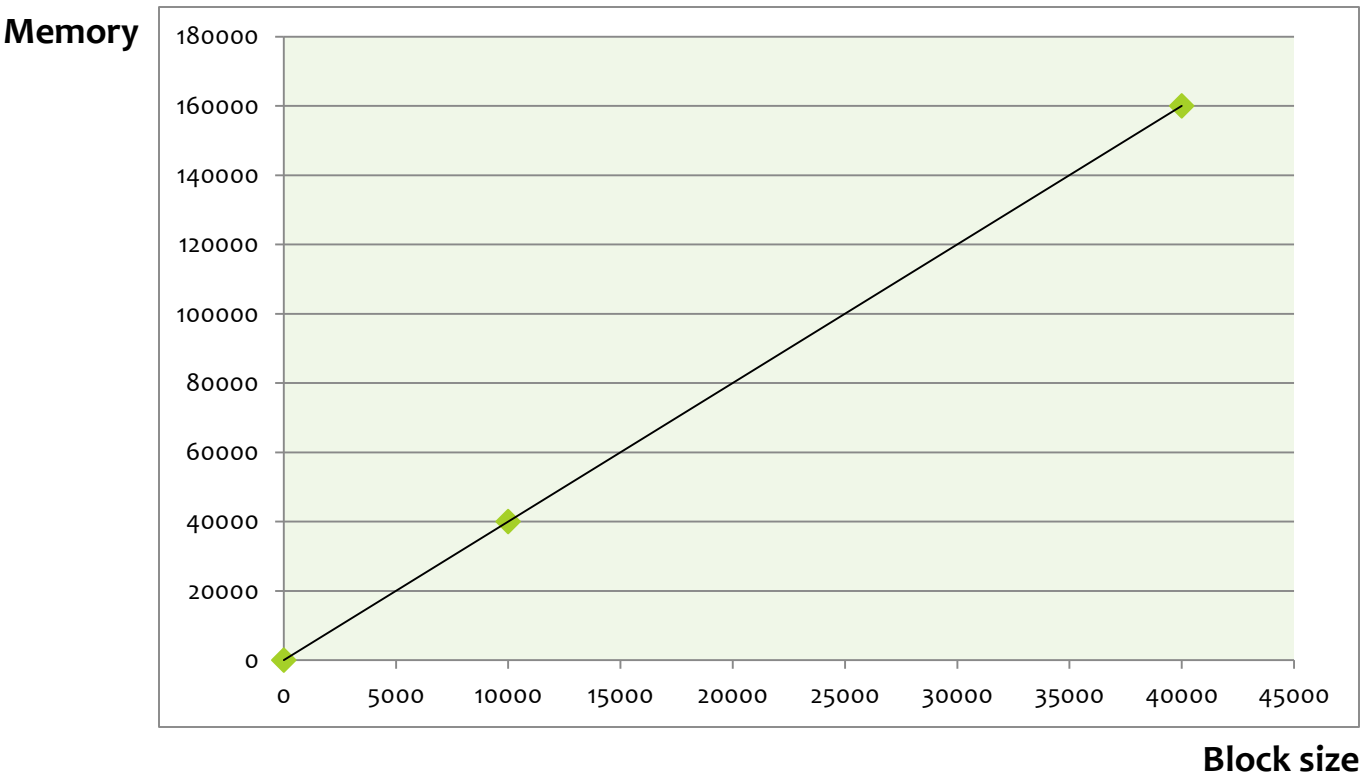


Decomposition Factor (4,4)
Block size: 200 * 200 : 40 000
Required Memory: 4 * (200*200) : 160 000

Decomposition Factor (8,8)
Block size: 100 * 100 : 10 000
Required Memory: 4 * (100*100) : 40 000

Visualization Parameters

1. Block size & Required memory



Visualization Parameters

2. Block size & Requires time

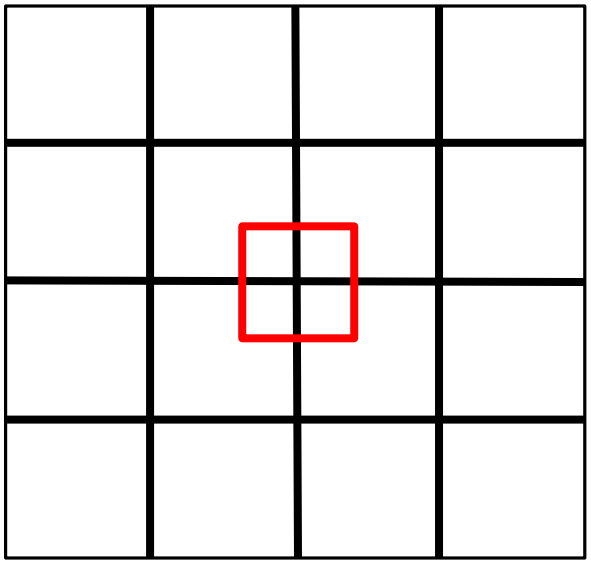


Image size

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Window size

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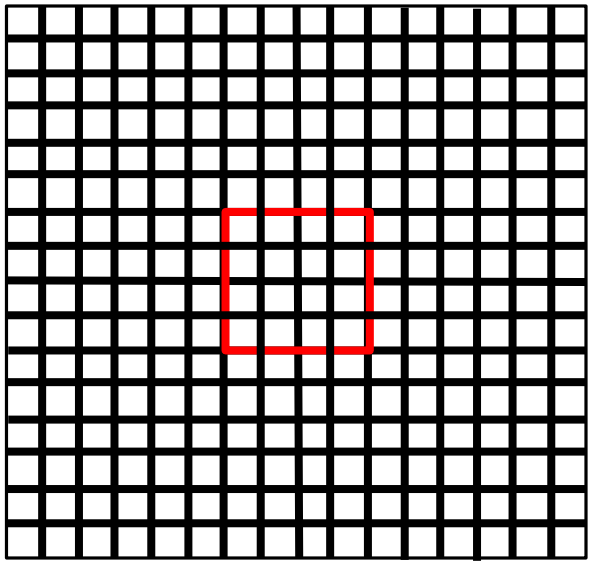
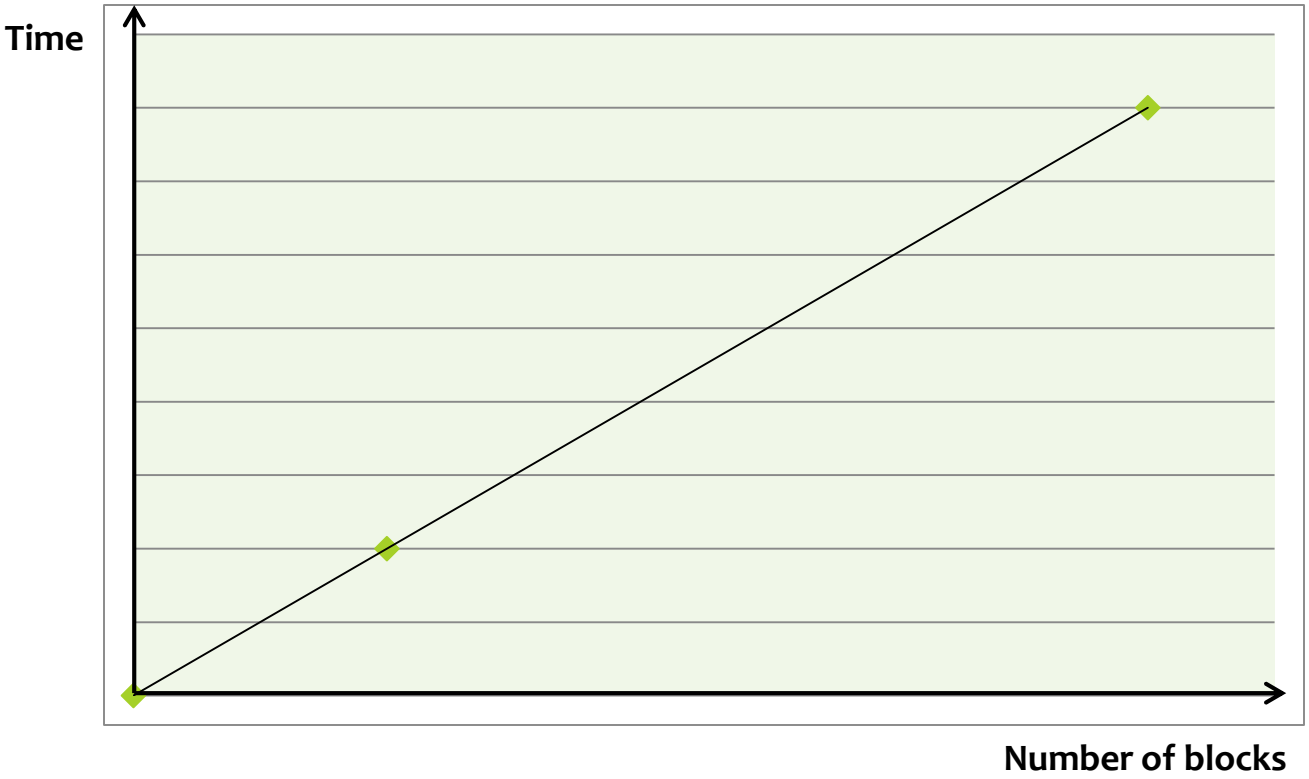


Decomposition Factor (4,4)
Required time: Time to load 4 blocks

Decomposition Factor (16,16)
Required time: Time to load 16 blocks

Visualization Parameters

2. Number of blocks & Required time



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Processing

* Processing operators [*]

1. Erosion
2. Dilation
3. Thresholding

[*] S.Wan, E. Ritman,W. Higgins, Multi-generational analysis and visualization of the vascular tree in 3D micro-CT images, Comput. Biol. Med. 32 (2002) 5571.

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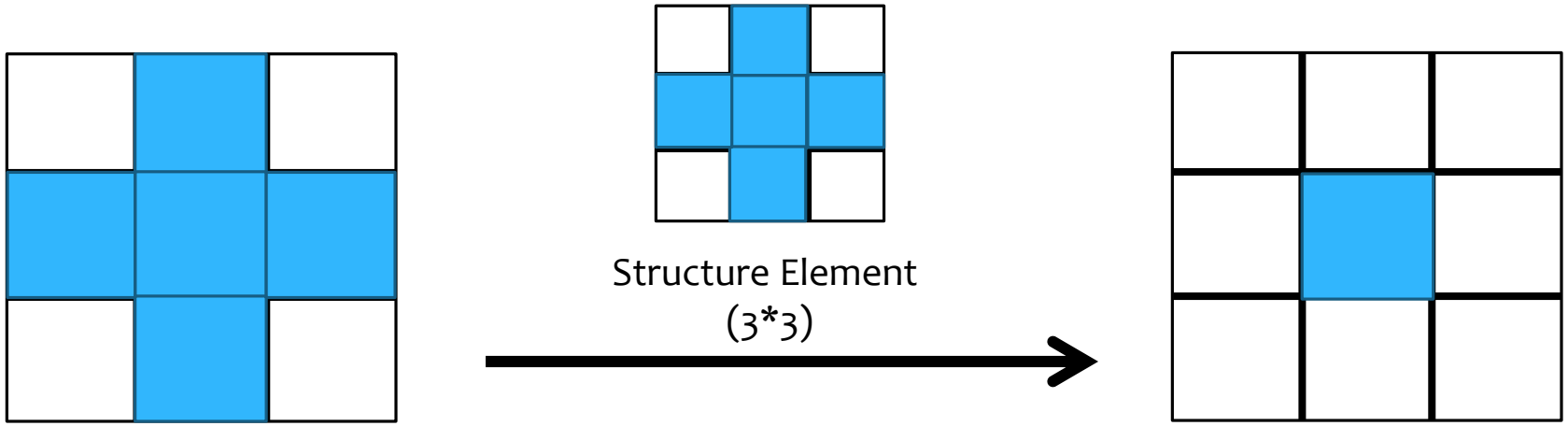
Processing Problems

- ✓ Thresholding
- ✗ Problems of applying process's operators
  1. Erosion
  2. Dilation

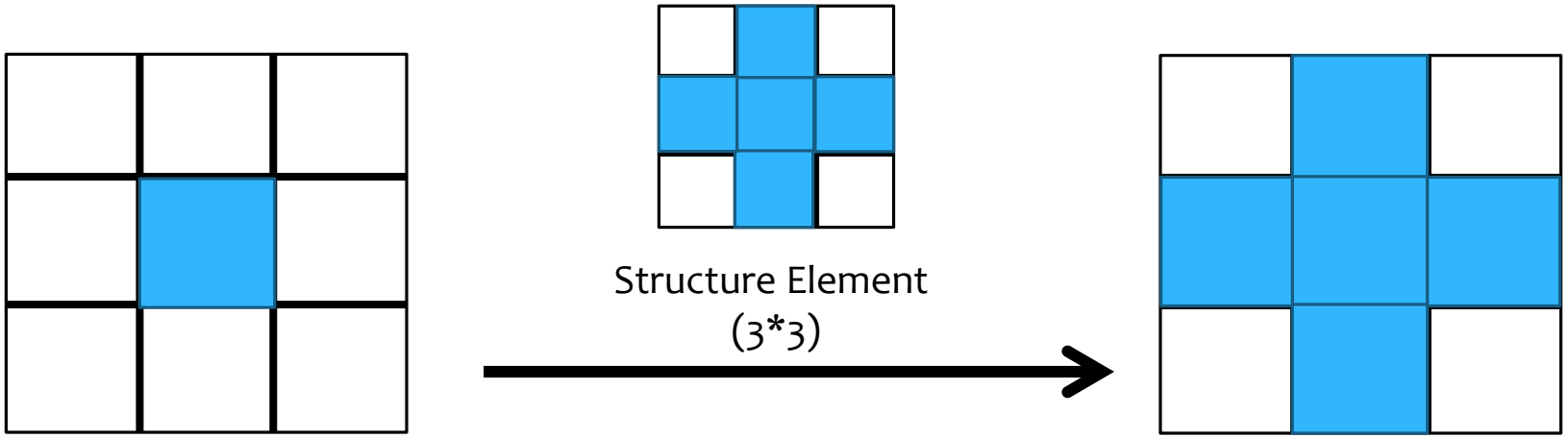
Morphological Operations

1. Erosion

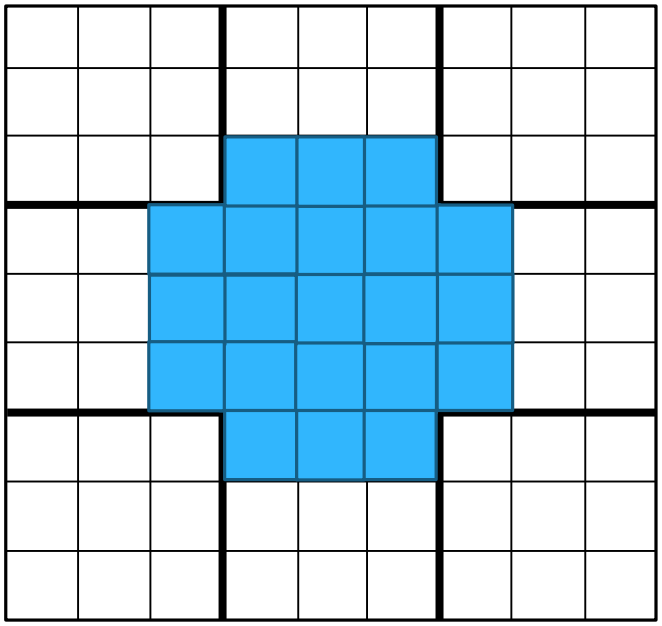


Morphological Operations

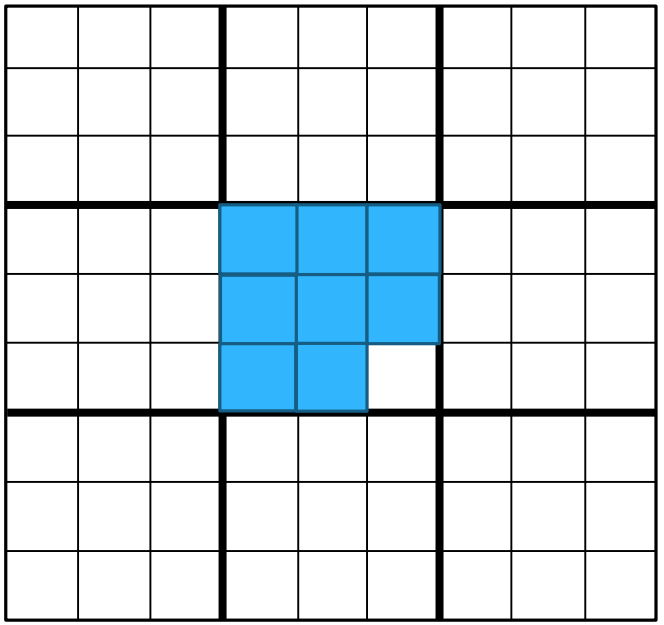
2. Dilation



Processing Problems

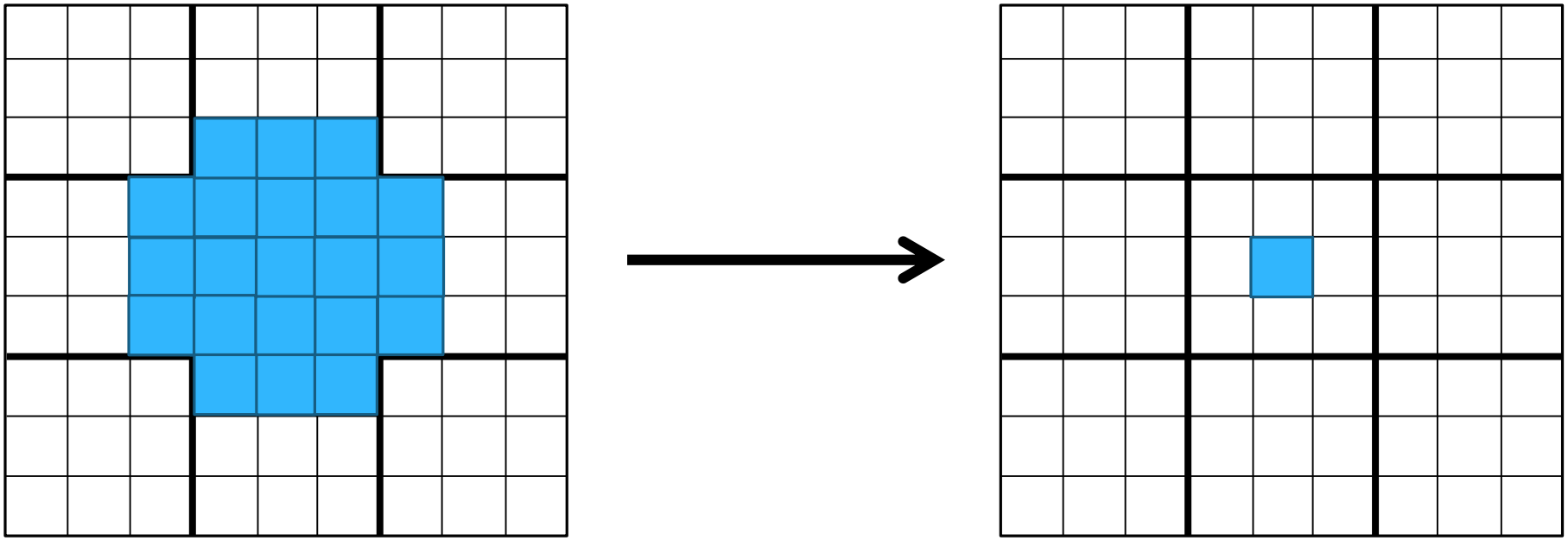


Problem of Erosion



Problem of Dilation

Processing Problems



Problem of Erosion

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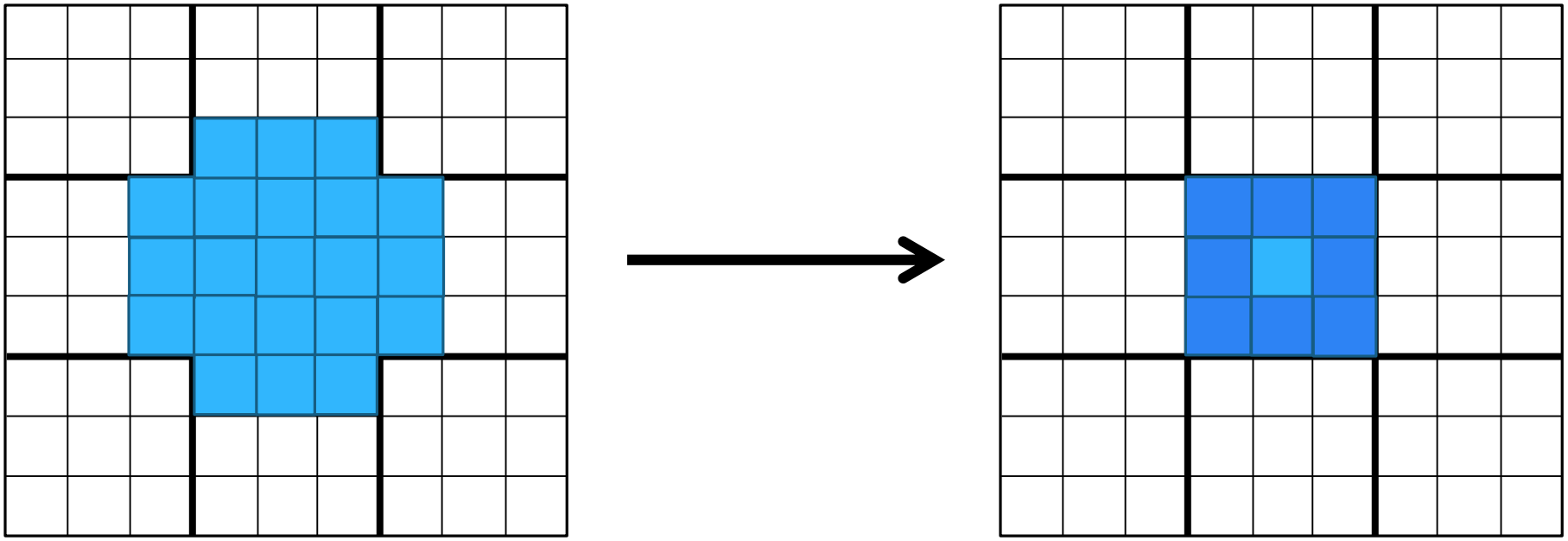
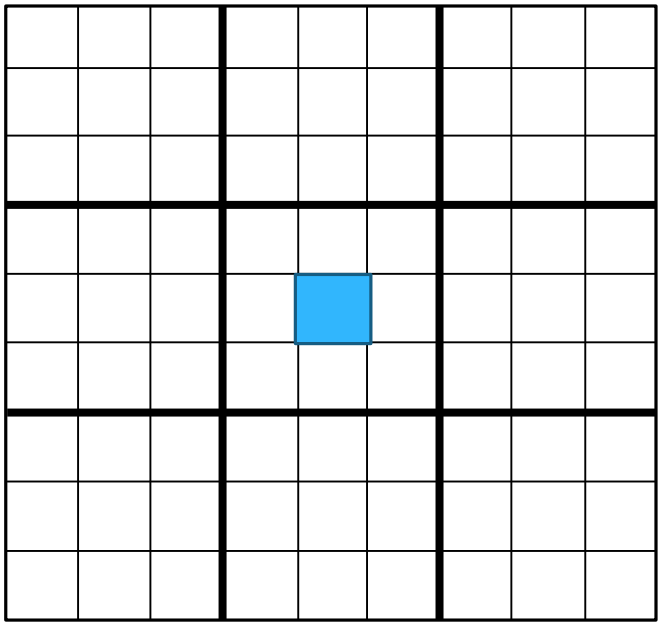
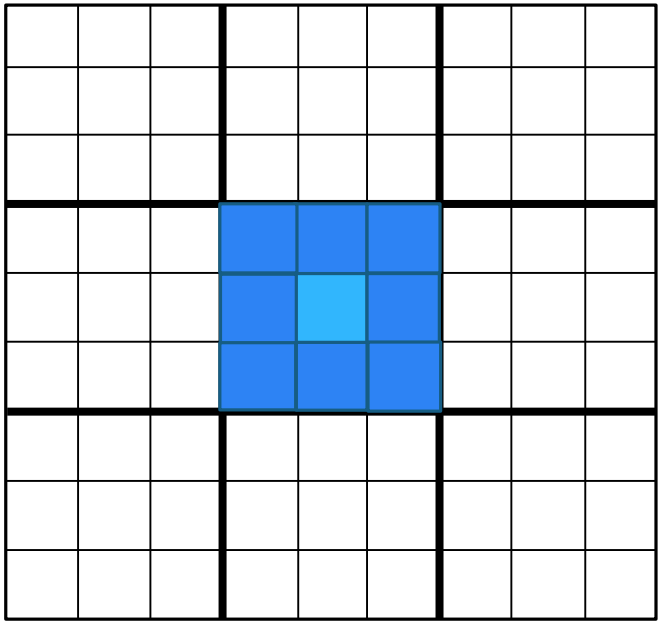


Correct Erosion

Processing Problems

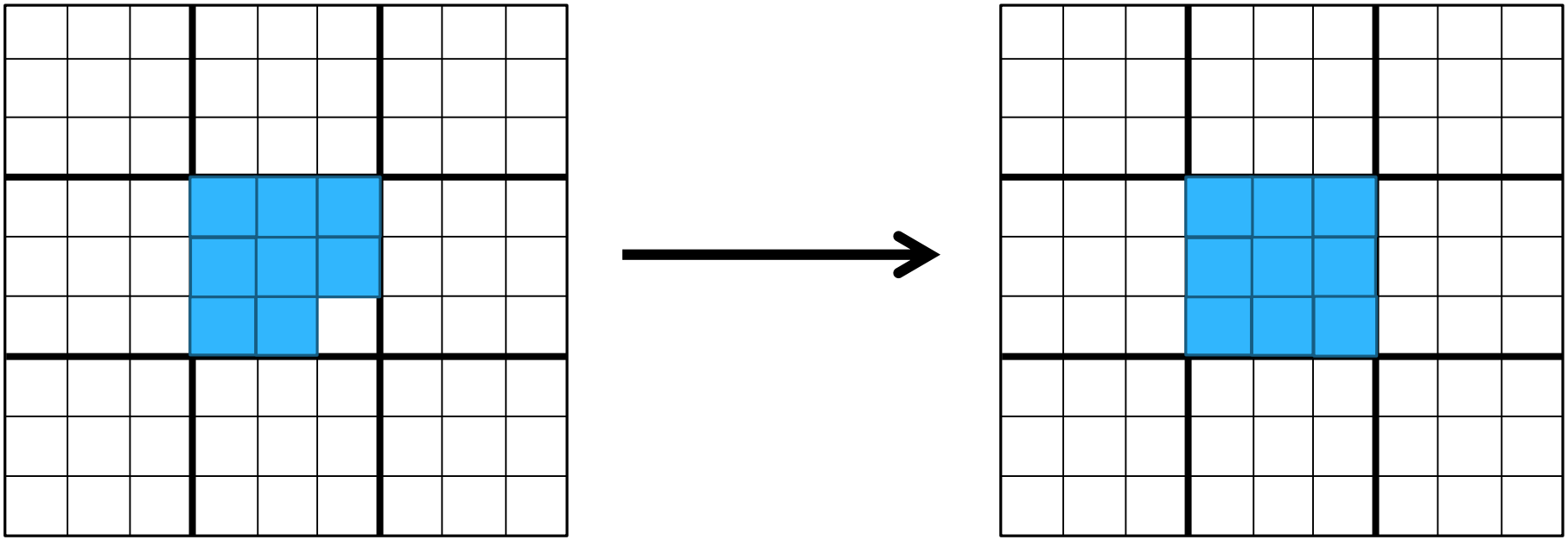


Erosion on the blocks



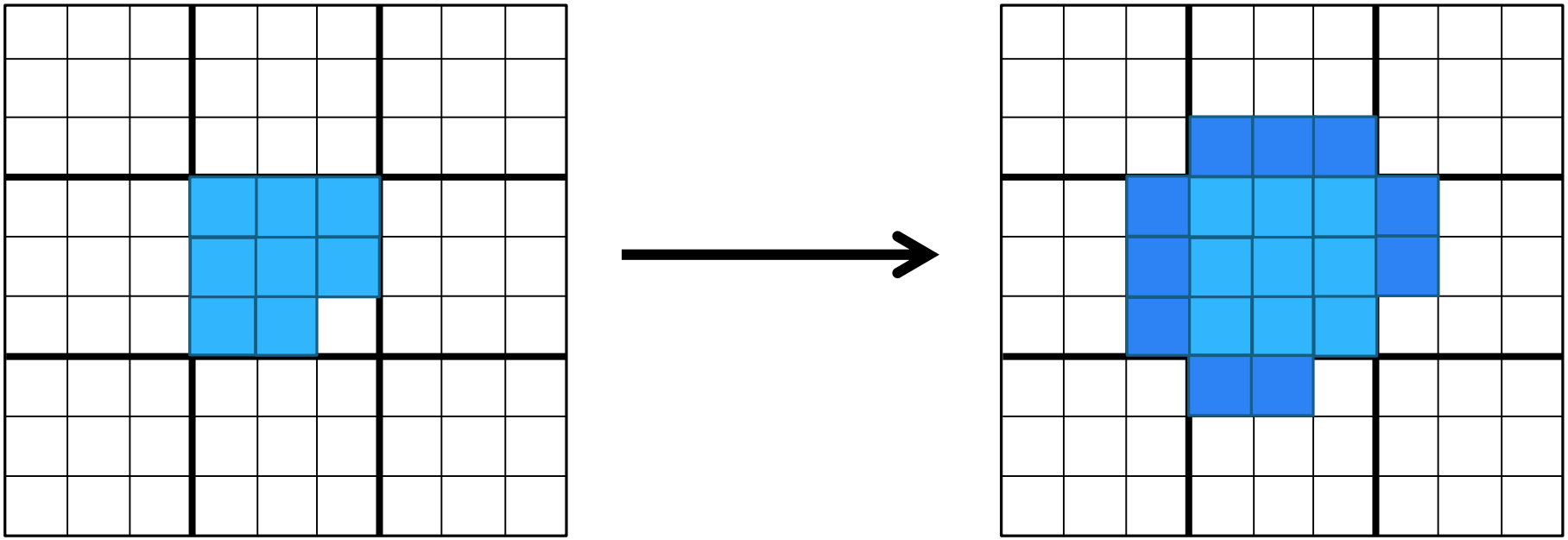
Correct Erosion

Processing Problems



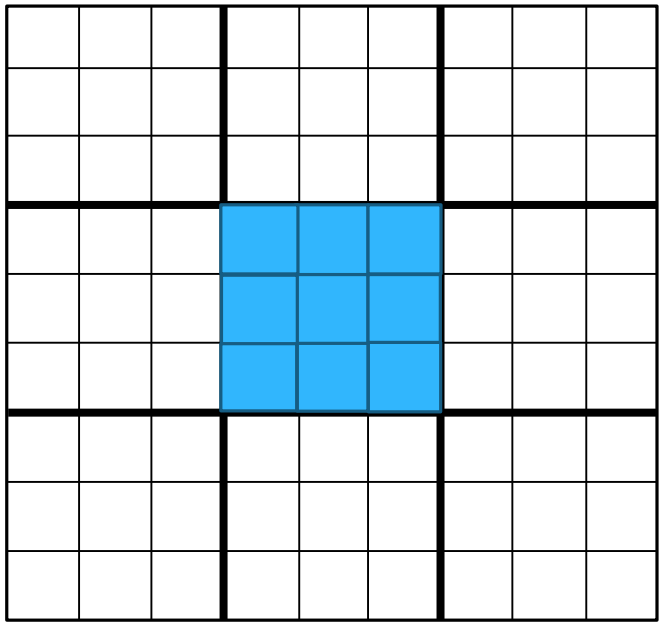
Problem of Dilation

Processing Problems

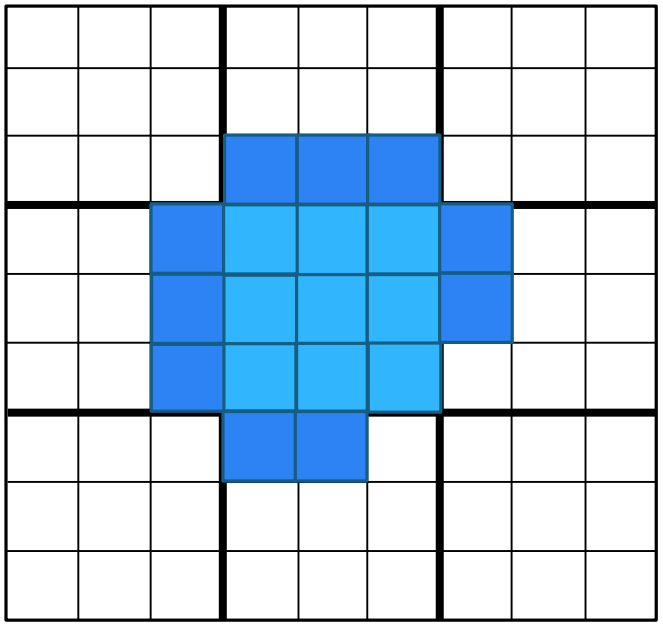


Problem of Dilation

Processing Problems



Dilation on the blocks



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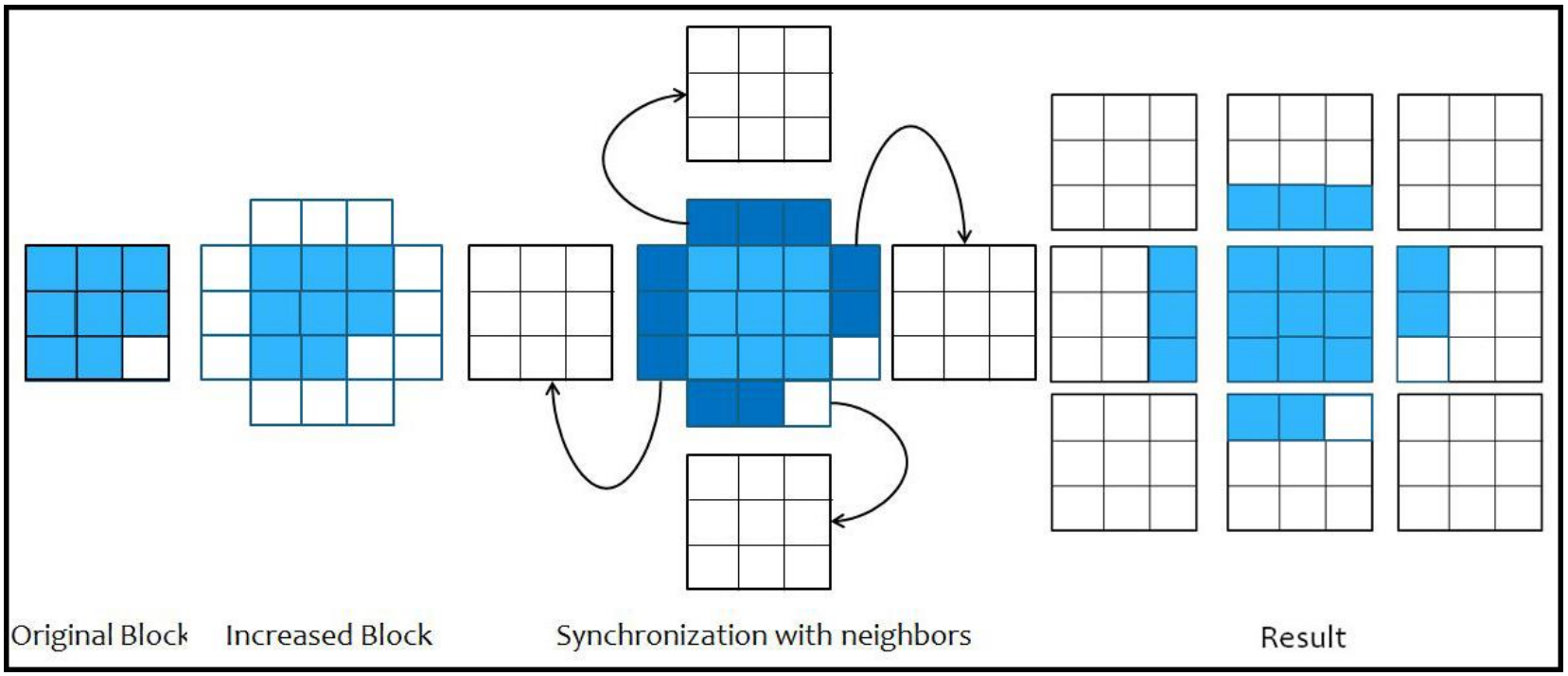
Proposed Solution

To get deal with such kind of problems: Three points of view

1. Increase the block size
2. Increase the block size from its neighbors
3. Apply the process on the block and its neighbors

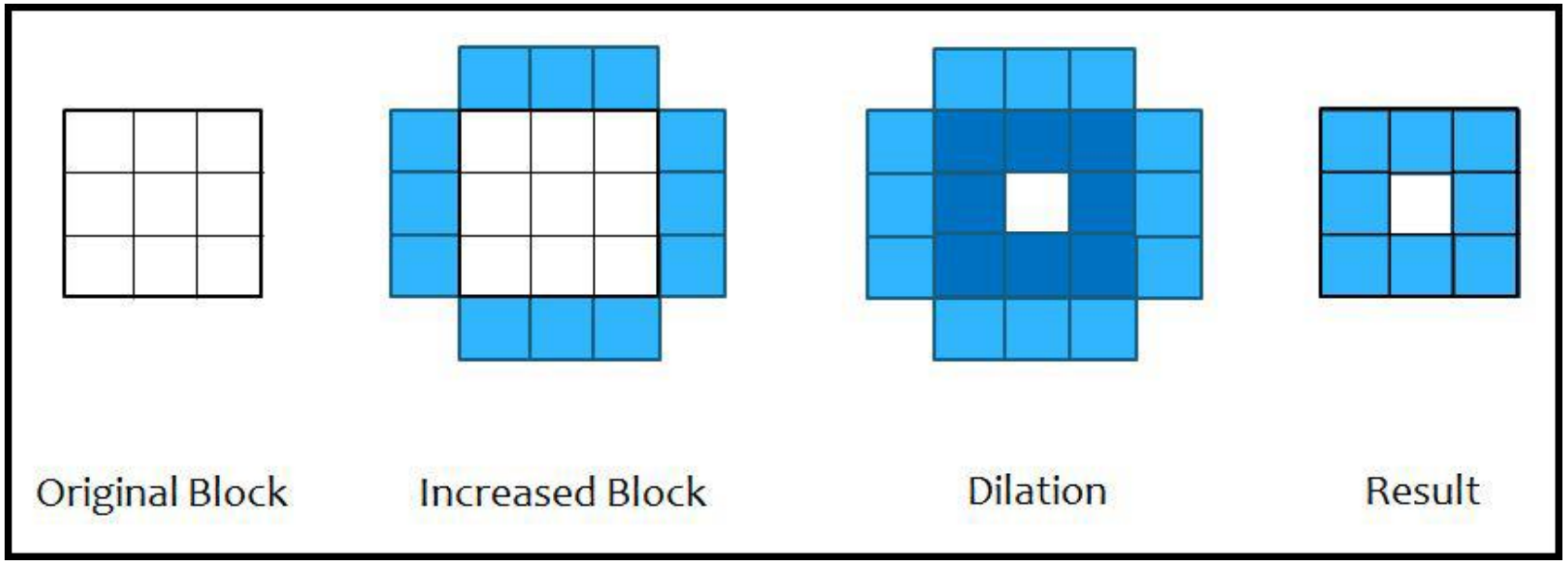
Proposed Solution

1. Increase the block size



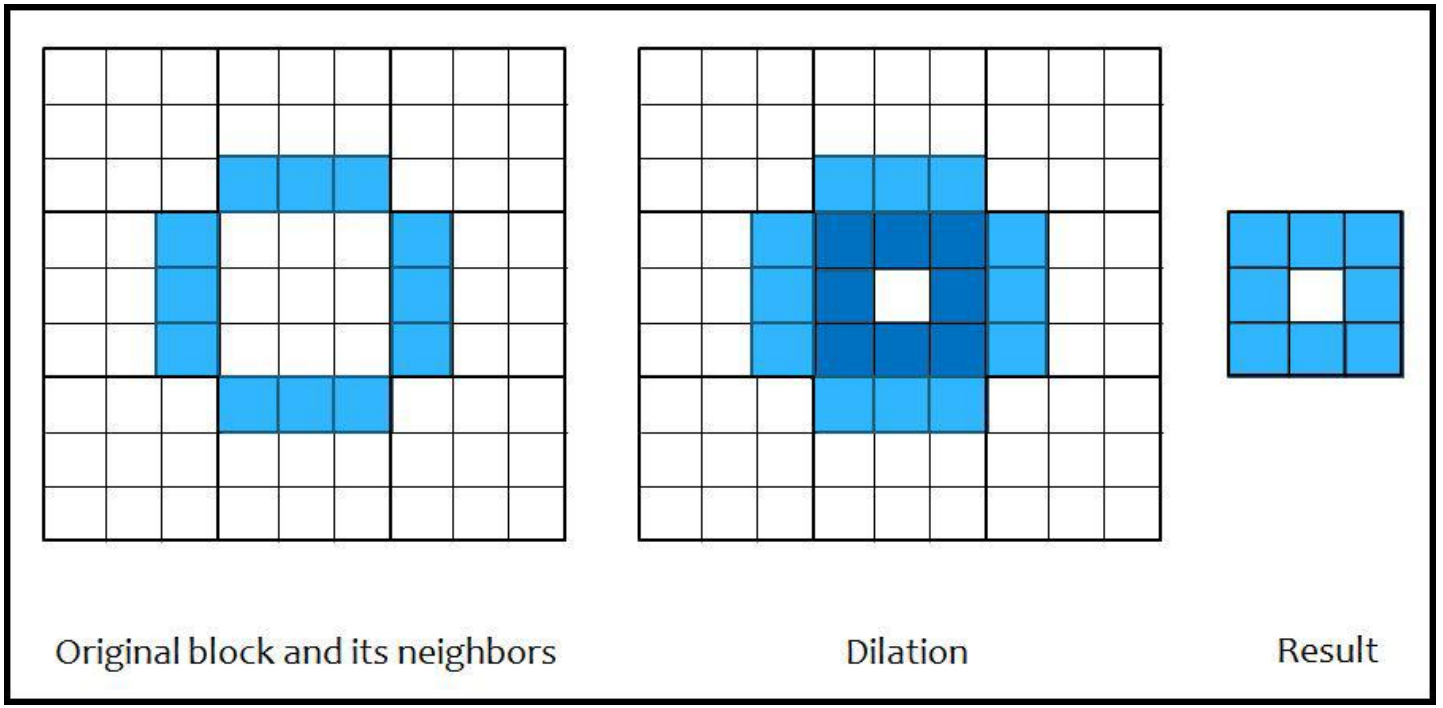
Proposed Solution

2. Increase the block size from its neighbors



Proposed Solution

3. Apply the process on the block and its neighbors



Solutions Comparison

	First Solution	Second Solution	Third Solution
Memory	+	+	+
Data access complexity	+	+	-
Synchronization complexity	+	+	-

Processing Sections

1. Preview the process list
2. Select a process and provide the parameters
3. Apply on LR version and show the result
4. Select ROI to apply this process and show the result
5. Add this process to the process list
6. (Creating a process list file and load an existing one)
7. Apply the process list on the full resolution image

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Implementation Tools

* C++
* Cimg library [*]
  - ✓ Simplicity
  - ✓ Portability
  - ✓ Not a heavy library
* Compiler of visual studio 2008

[*] www.cimg.sourceforge.net

Demonstration

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Future Work

- ✓ Optimize the parameters
- ✓ Develop the processing
- ✓ To be used in a practical application

Merci de votre attention

Citadelle d'Alep

Questions..?!