Make the best of your Synchrotron Tomography Experiment - 3D Image Analysis Crash Course

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Outline

- **Part 1:** Introduction to 3D image processing software
- **Part 2:** ImageJ basic operations
- **Part 3:** 3D image processing with Dragonfly
- **Part 4:** Image segmentation
- **Part 5:** Pore analysis

Information (e.g. references) on this lecture and code samples can be found in this github repository

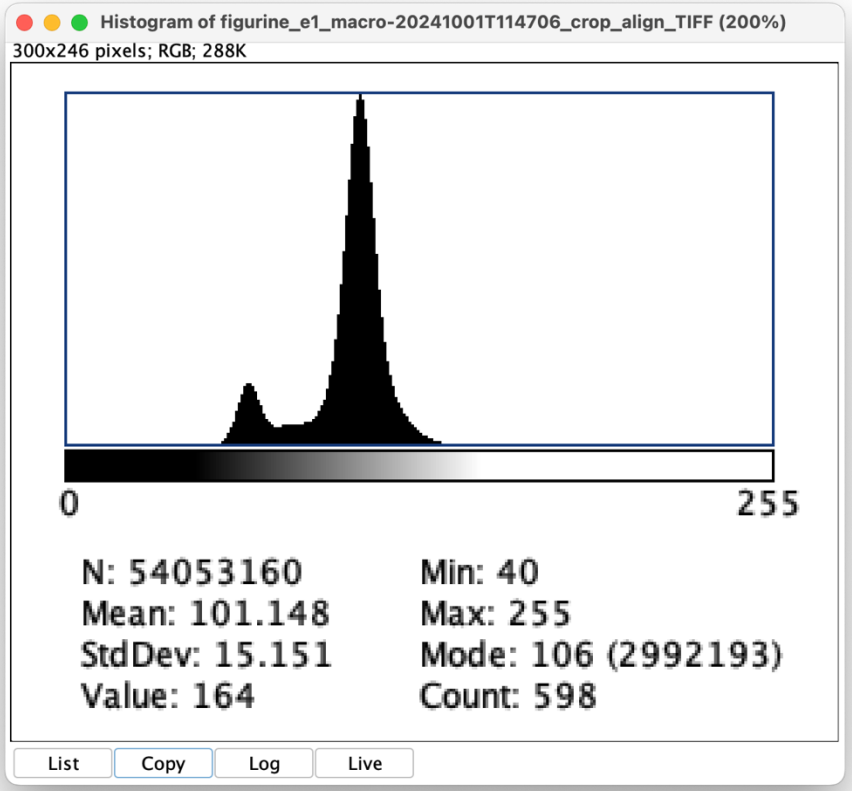
Datasets can be downloaded from Zenodo

Part 2: ImageJ basics

Image histogram

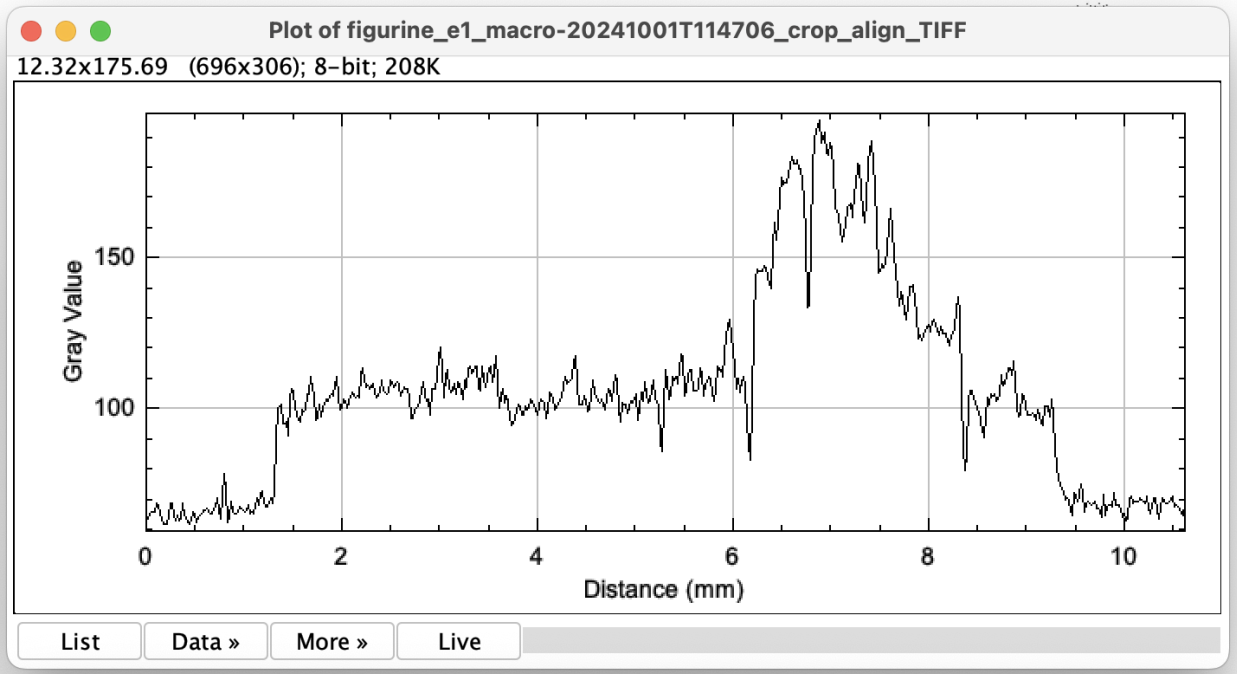
- An image histogram is a graphical representation of the intensity distribution in a digital image. It plots the number of pixels for each intensity value.

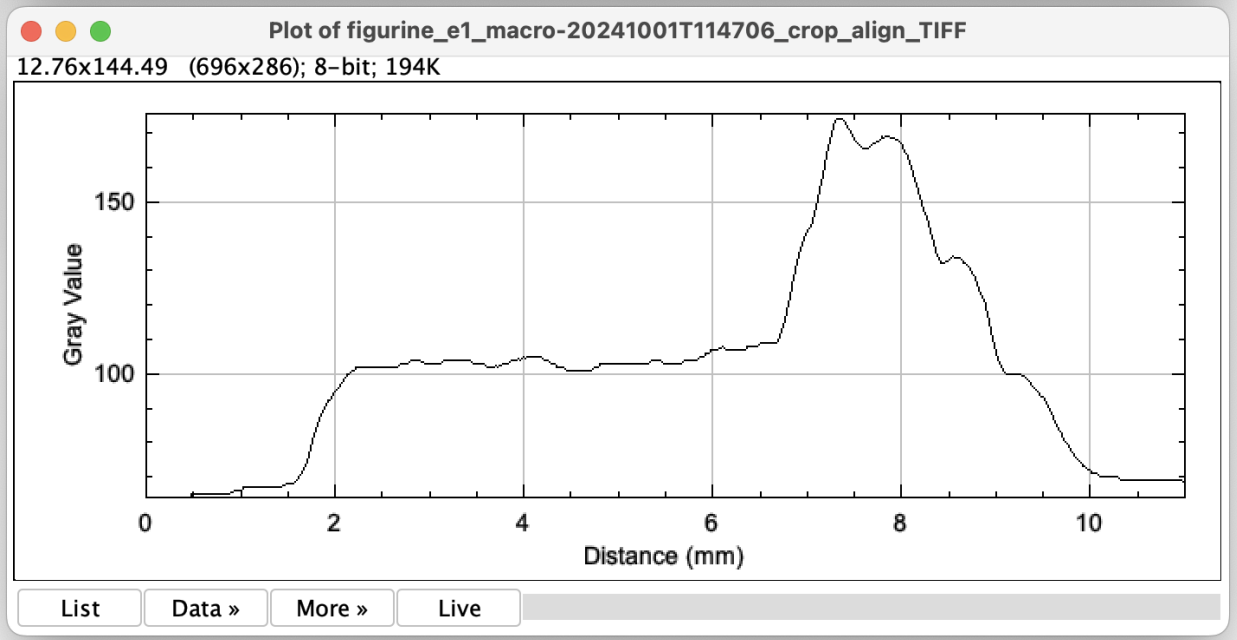
- The horizontal axis of the graph represents intensity variations, while the vertical axis represents the total number of pixels in that intensity.



Ed Sutton. "Histograms and the Zone System". Illustrated Photography. Archived from the original on 2015-02-23. Retrieved 2015-08-31.

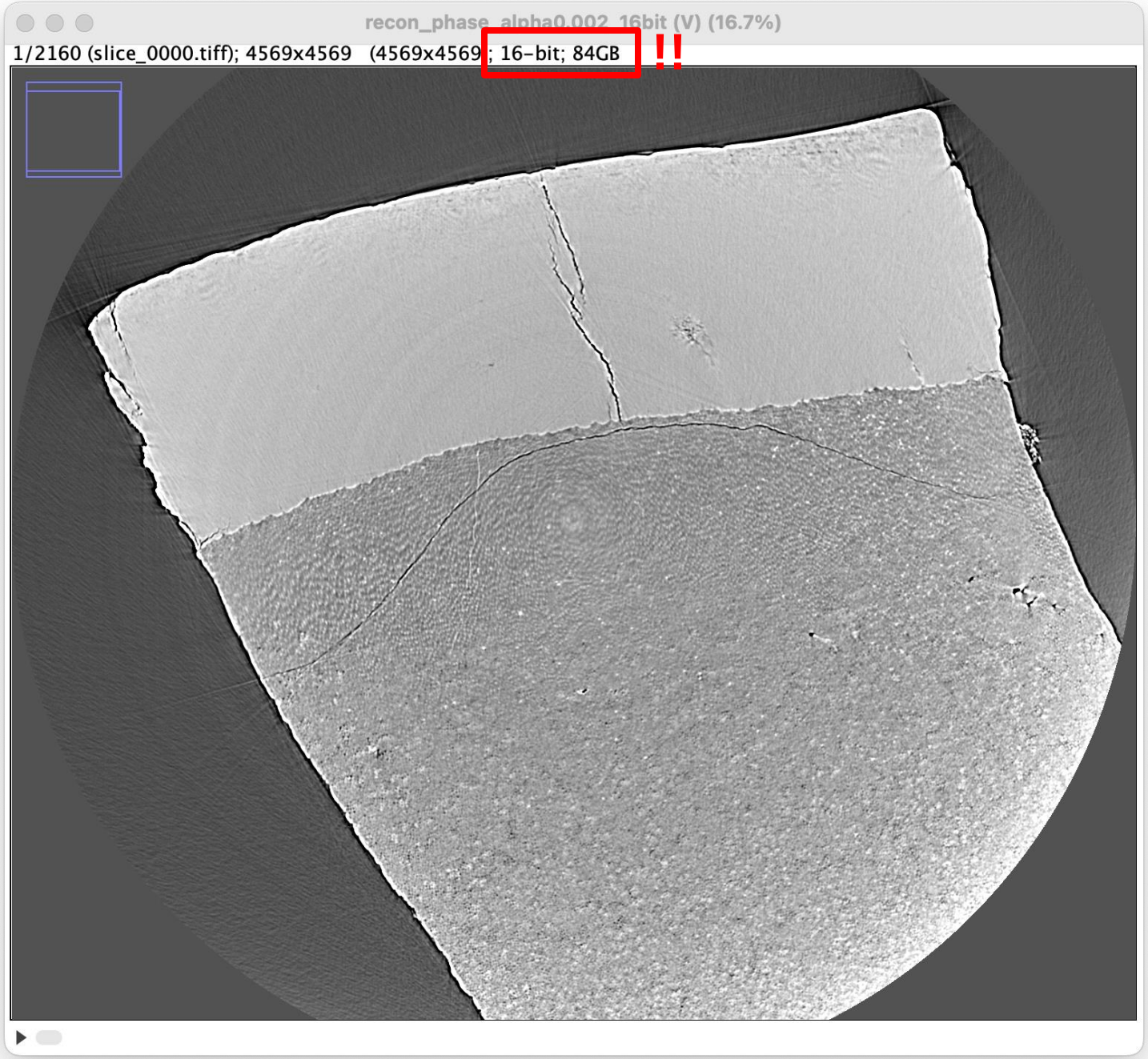
Line profile





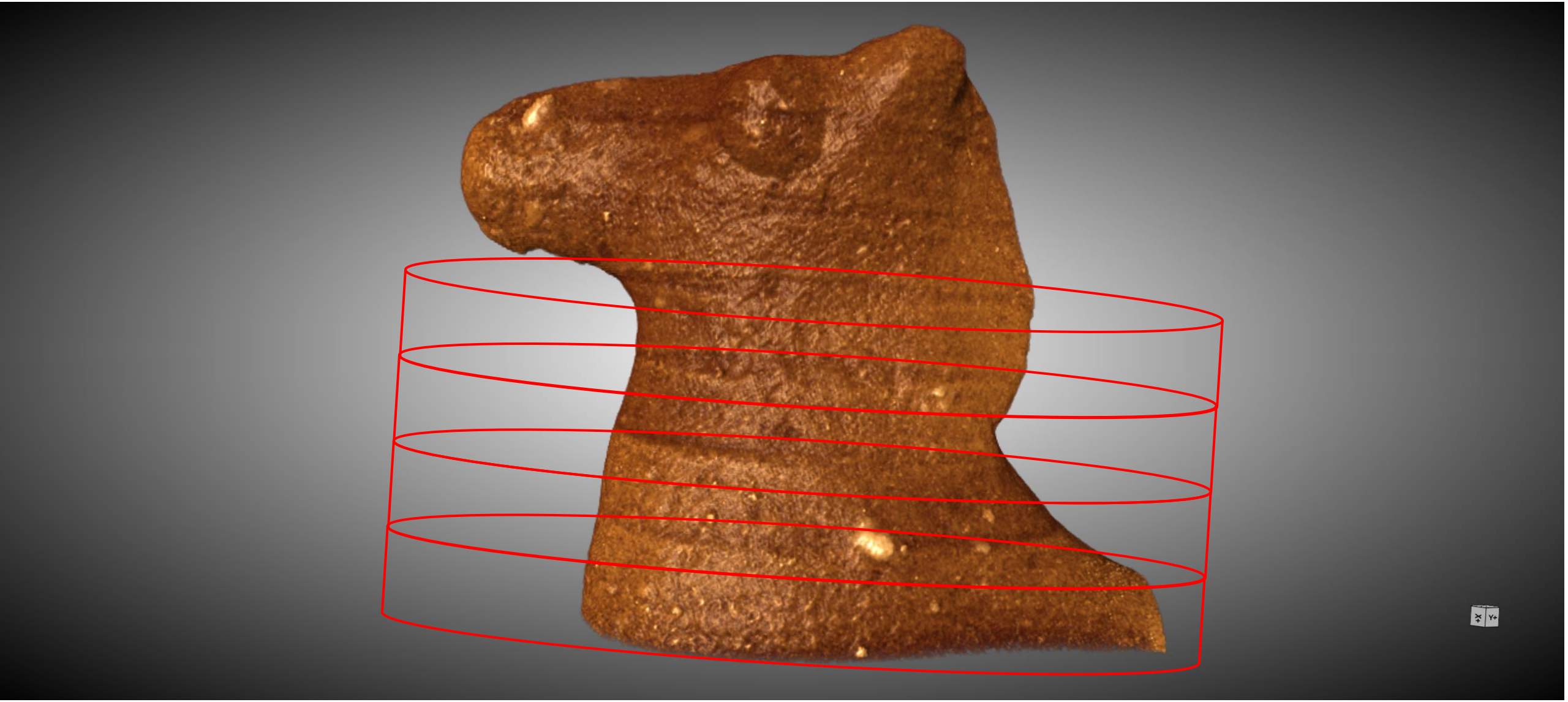
Handle large files

- Virtual stack
- Crop
- Convert to 8-bit
- Downscale
- Use server resources
- Buy workstation
- …



Part 3: Dragonfly tutorial

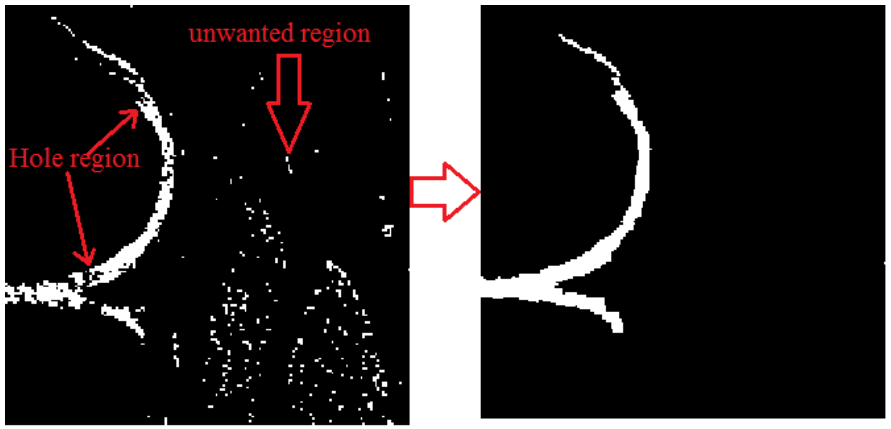
Stitching of 3D stacks



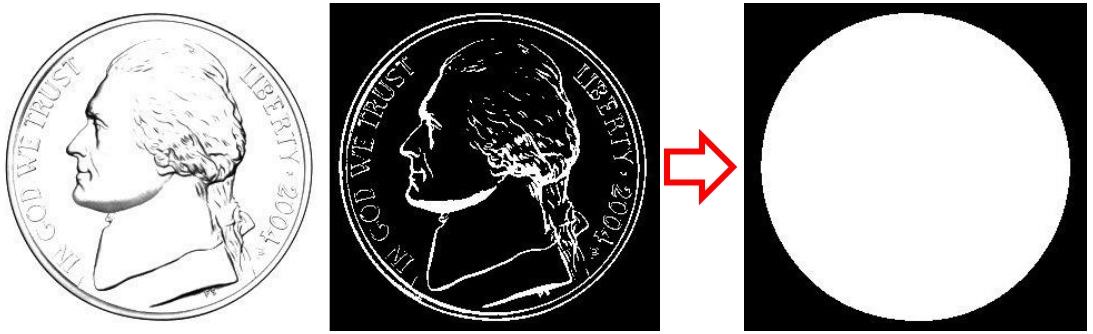
Part 4: Image segmentation

Morphological operations

- **Remove islands:**



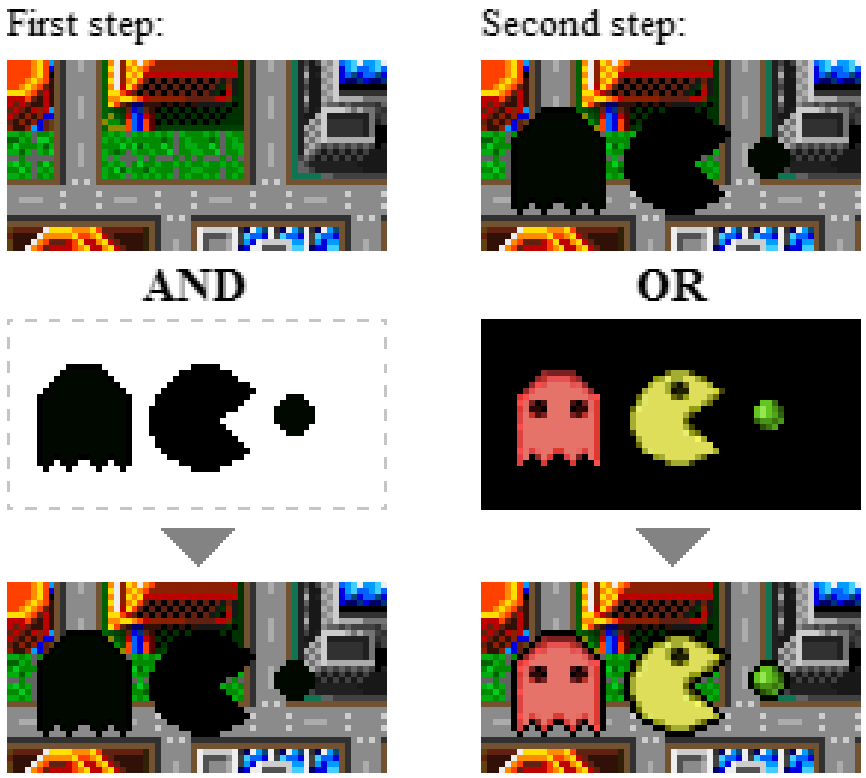
- **Fill holes:**



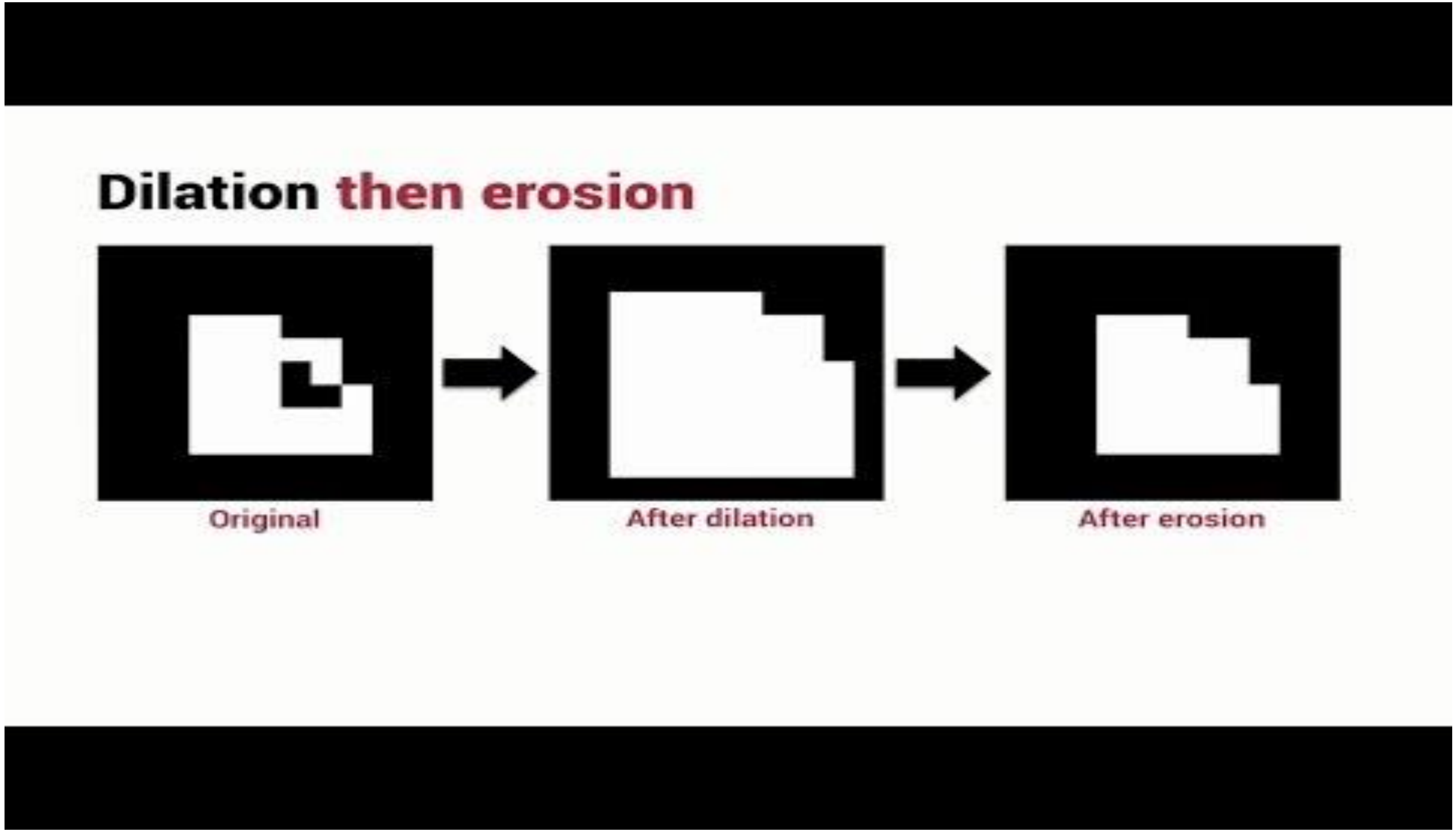
- **2D and 3D connectivity are not the same!**

Logical operators and masking

- **Logical operators: AND, OR, NOT, NAND, NOR, XOR, XNOR**
- **A binary image or mask is a set of zeros and ones (Falses and Trues)**
- **Masking:**



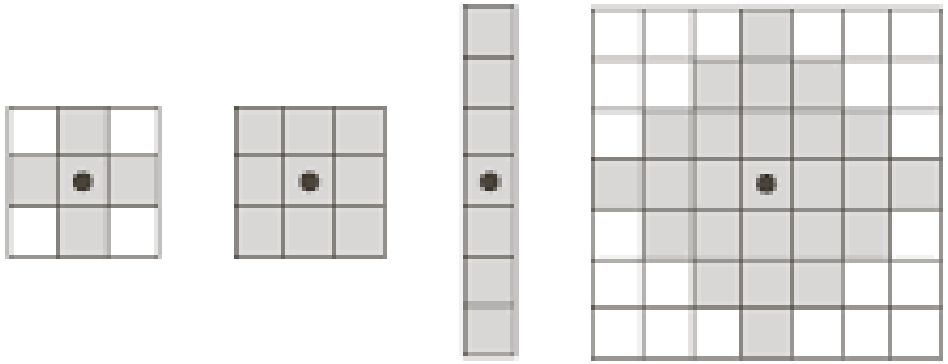
A	B	A AND B	A OR B	NOT A
False	False	False	False	True
False	True	False	True	True
True	False	False	True	False
True	True	True	True	False



https://robotacademy.net.au/masterclass/image-processing/?lesson=655
https://slideplayer.com/slide/13105232/

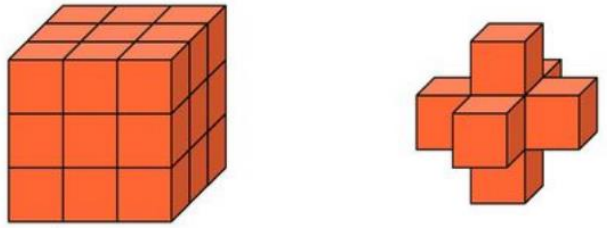
Morphological operations: image erode, dilate, open, close

- Open: erode followed by dilate
- Close: dilate followed by erode



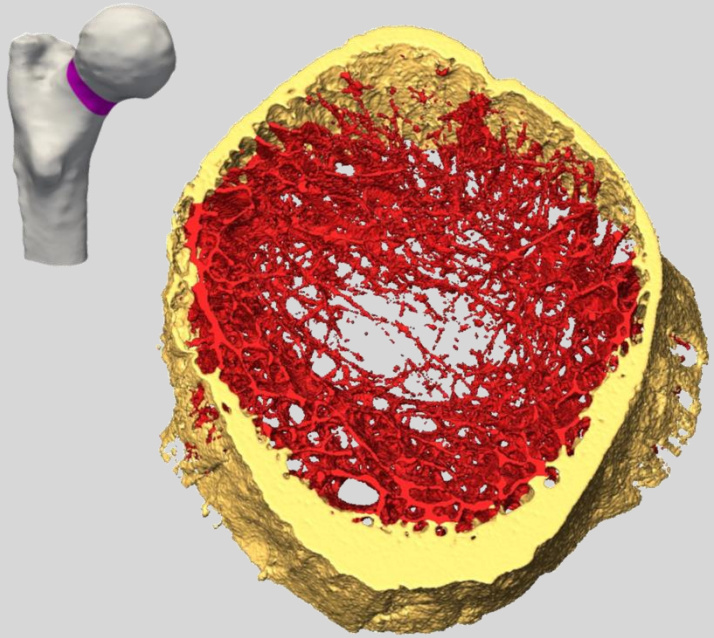
- Different structuring elements can be applied

- 2D and 3D morphological operations are not the same!



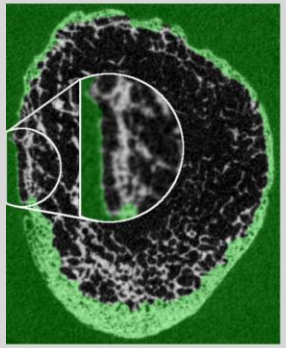
https://robotacademy.net.au/
https://slideplayer.com/slide/13105232/

Morphological operations: image **erode**, **dilate**, **open**, **close**, **AND**, **OR**...

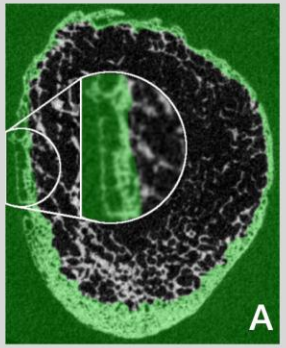


Human femoral neck

(1) Manual correction of endosteum mask



Cortex mask
[Burghardt et al. 2010]



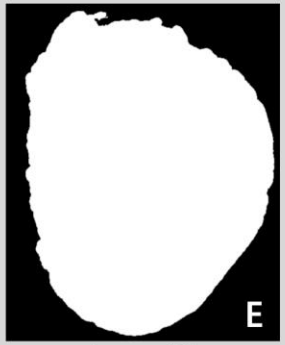
Manual correction

(2) Periosteum mask

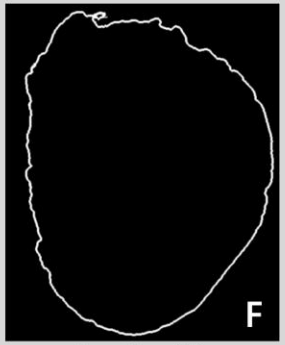
Bone tissue mask

B OR NOT(**A**)

fill pores (**C**)



imopen (**D**)



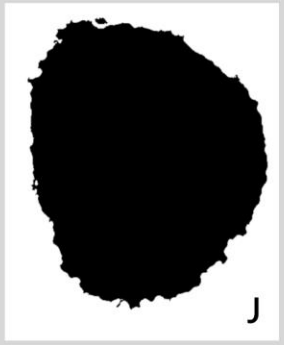
boundary (**E**)

(3) Endosteum and final cortex mask

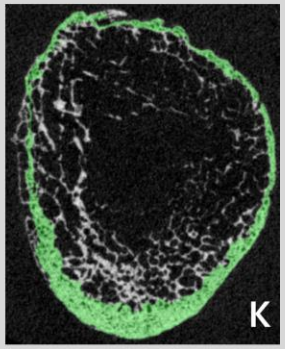
A AND **B** OR **F**

fill pores (**G**)

remove background (**H**)



imopen (**I**)



E AND **J**

Part 5: Pore analysis

Porosity analysis