MASTER
BME


Nicolas Loménie

# 3D
# for Bio-Medical Imaging

MASTER
BME

Université de Paris

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# 3d

3D

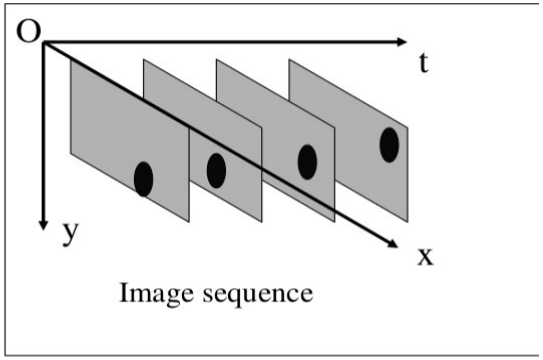
# INTRO

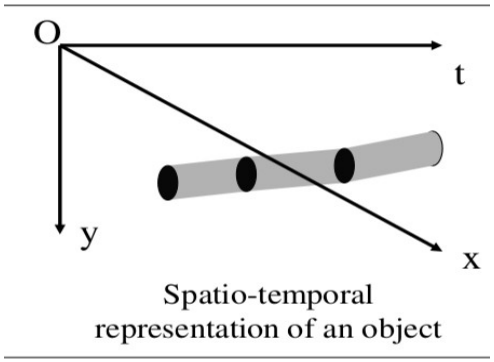
# 3D ? 2D+t, Voxels, RGB, 3D+t, 4D, 5D, RGB+Depth

## Data Structures :

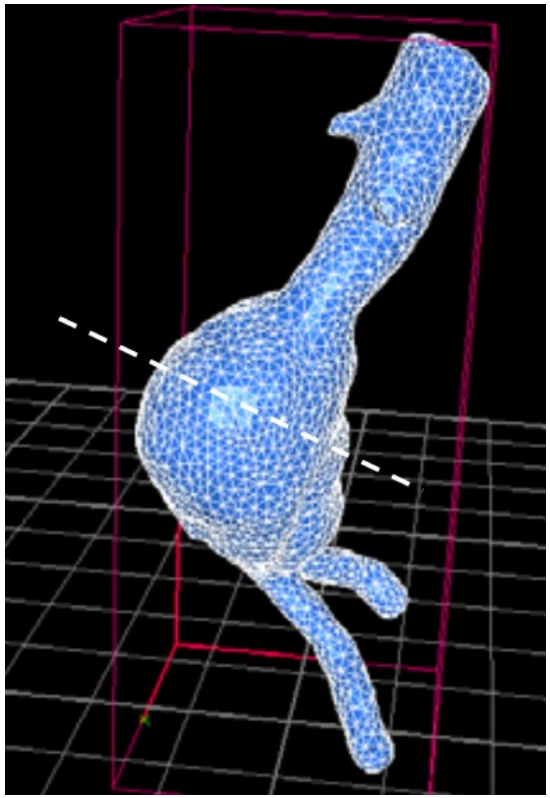
**Stacks** in a
**2D Sequence**

Volume representation of the sequence.

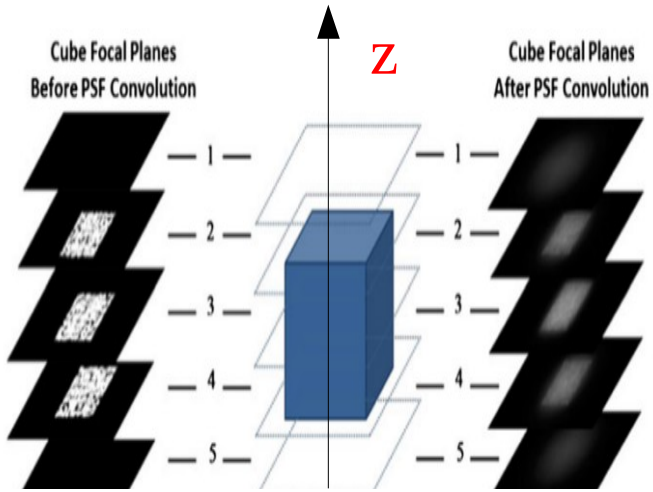


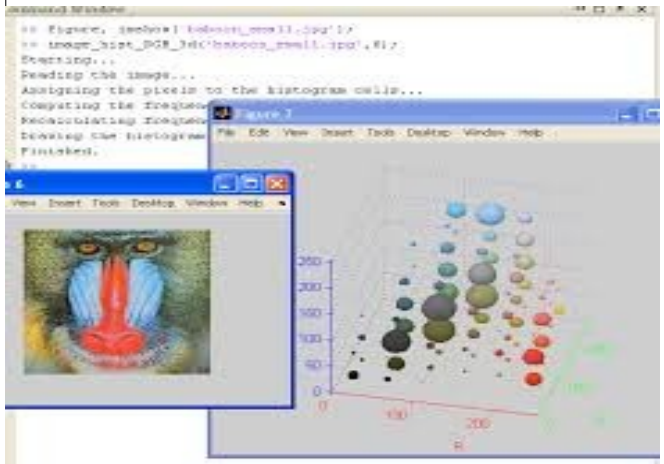




Geometric Visualization with 3D **Surface Meshes**

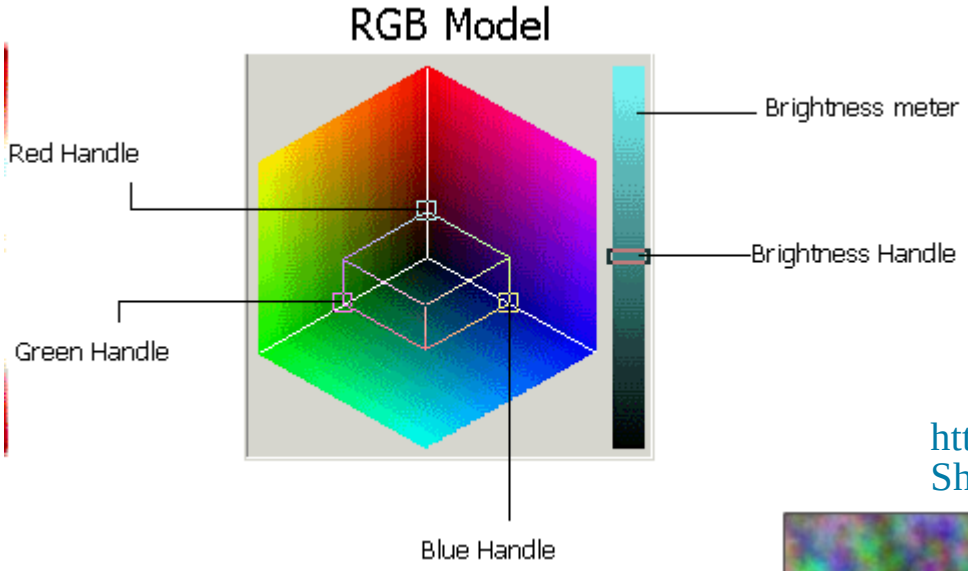


3D Visual Processing
(Stacks in z, voxels,
Color space RGB, etc.)

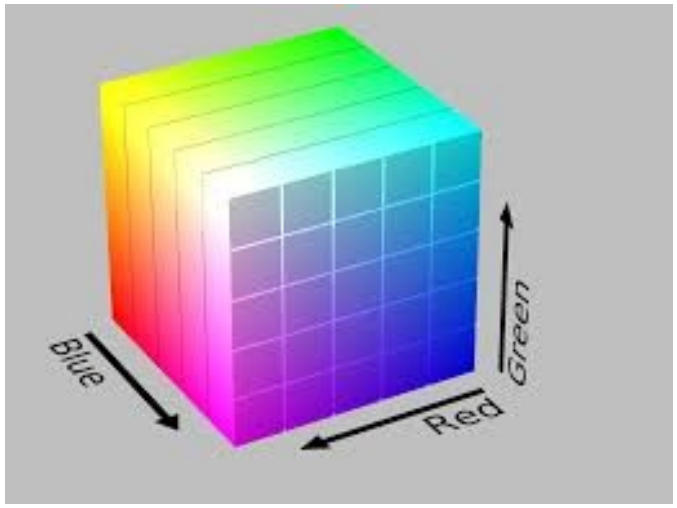


# 3D ? 2D+t, Voxels, **RGB**, 3D+t, 4D, 5D, RGB+Depth

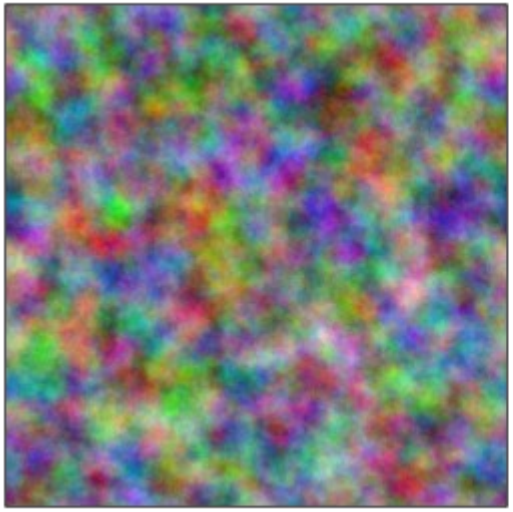


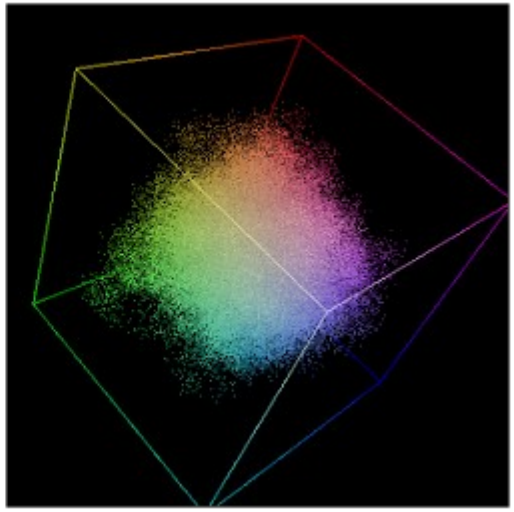

https://www.leadtools.com/help/sdk/v20/commondialog/clib/rgb-3d-additive-model.html




https://fr.m.wikibooks.org/wiki/Fichier:RGB_Cube_Show_lowgamma_cutout_a.png

https://imagej.net/Color_Inspector_3D



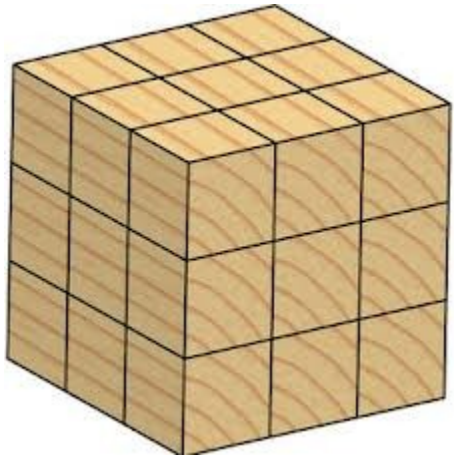


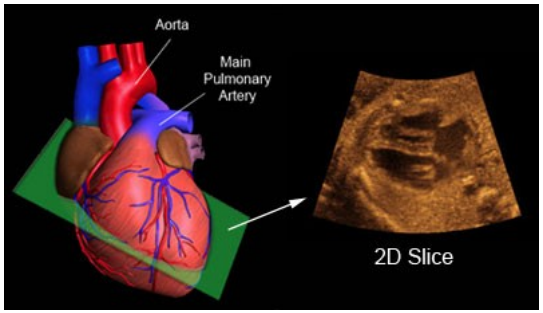
http://opensource.graphics/visualizing-the-3d-point-cloud-of-rgb-colors/

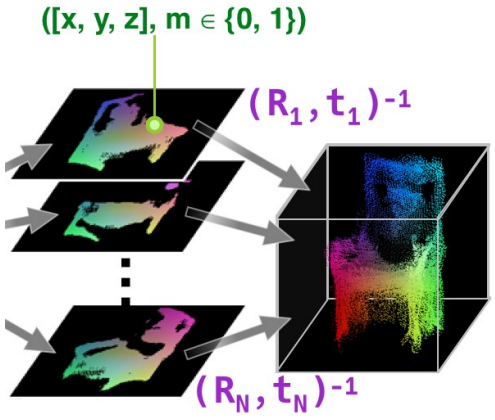
**3D ?** 2D+t, Voxels, RGB, 3D+t, 4D, 5D, RGB+Depth

## Data Processing and Analysis :

- 2D ++ : pixels → voxels (convolution, filtering etc.)






- Surface vs. Volume vs. Surface over a 3D volume :
theory differs sometimes or error rises (i.e volume calculation)

- 3D Specific (interactive segmentation, visualization etc.)

*Create 3D model from a single 2D image in PyTorch.*
https://medium.com/vitalify-asia/create-3d-model-from-a-single-2d-image-in-pytorch-917aca00bb07
https://www.sculpteo.com/en/ https://fetalecho.com/FetalEchocardiography%20%20/07%203D.html

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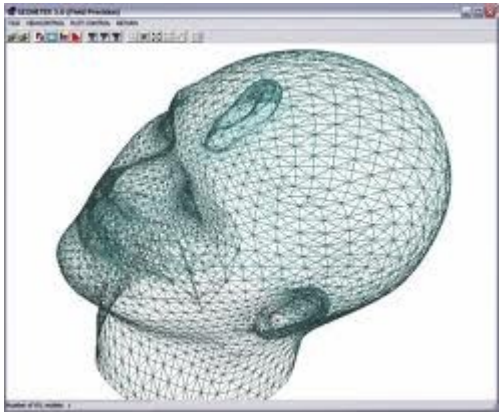
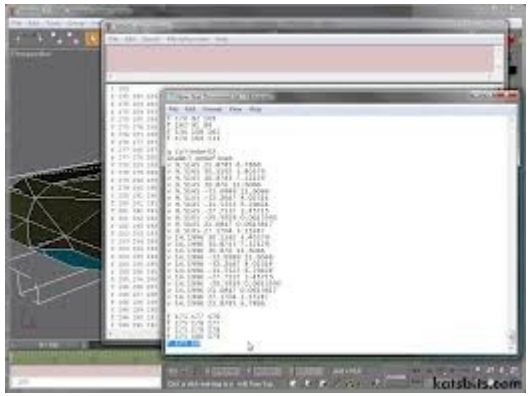


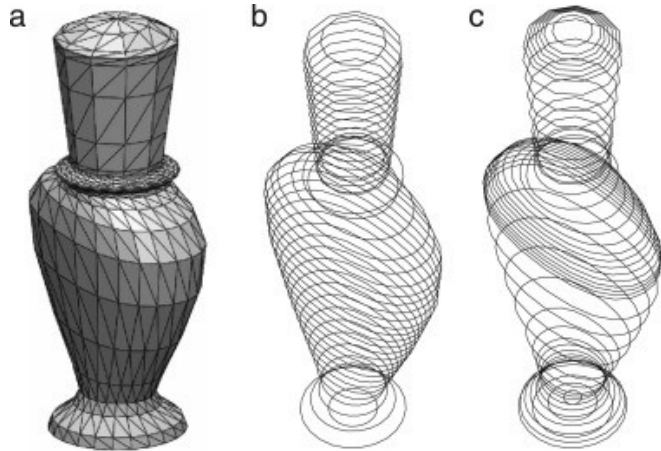


https://blog.prusaprinters.org/three-simple-methods-stylize-3d-models_7342/

## Data Formats & Specific Libraries (like VTK):

- STL : « .stl the file format STL is used in stereolithography softawres. This format was developed by the company 3D Systems »
- Wavefront (.obj)
- U3D (.u3d)

Universal 3D for pdf generation for instance

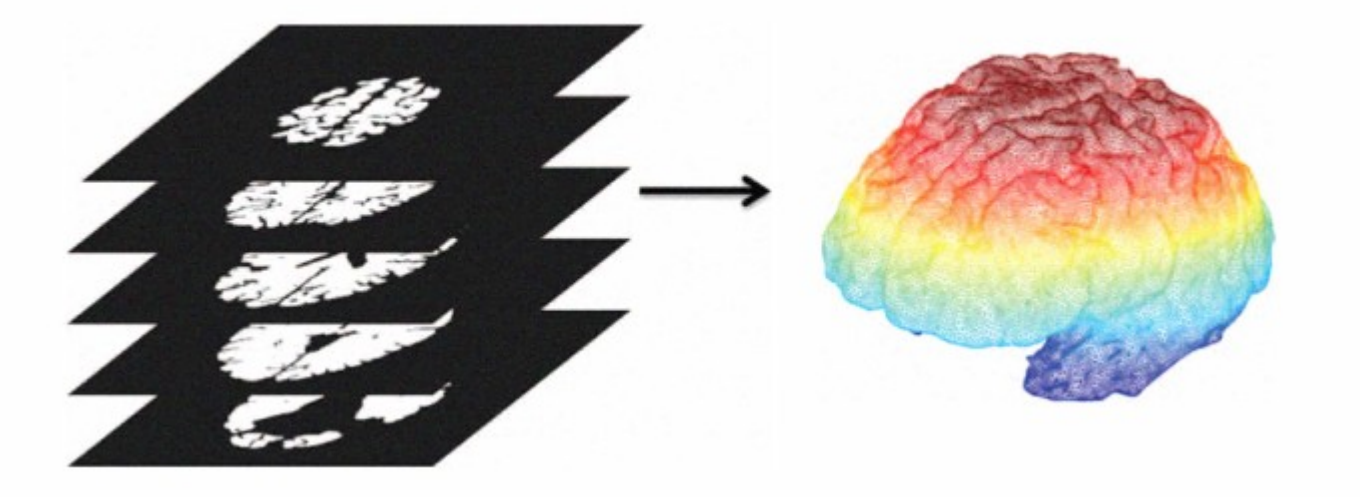


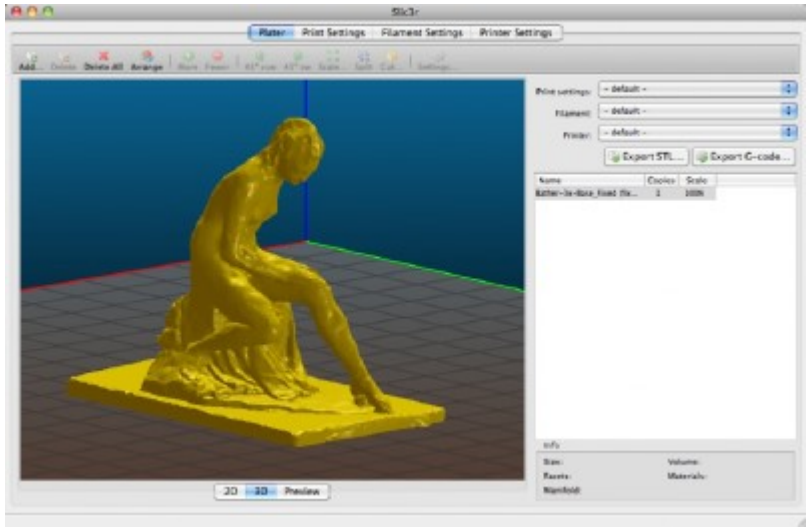

**An optimal algorithm for 3D triangle mesh slicing :**
**https://www.sciencedirect.com/science/article/abs/pii/S0010448517301215**

**https://medevel.com/invesalius-3d-dicom/**

# **3D ?** 2D+t, Voxels, RGB, 3D+t, 4D, 5D, RGB+Depth

https://www.semanticscholar.org/paper/3D-shape-analysis-of-the-brain-cortex-with-to-Nitzken-Casanova/3cfbfdf6a3cdd75541ed077d3e9d52da2dcec383





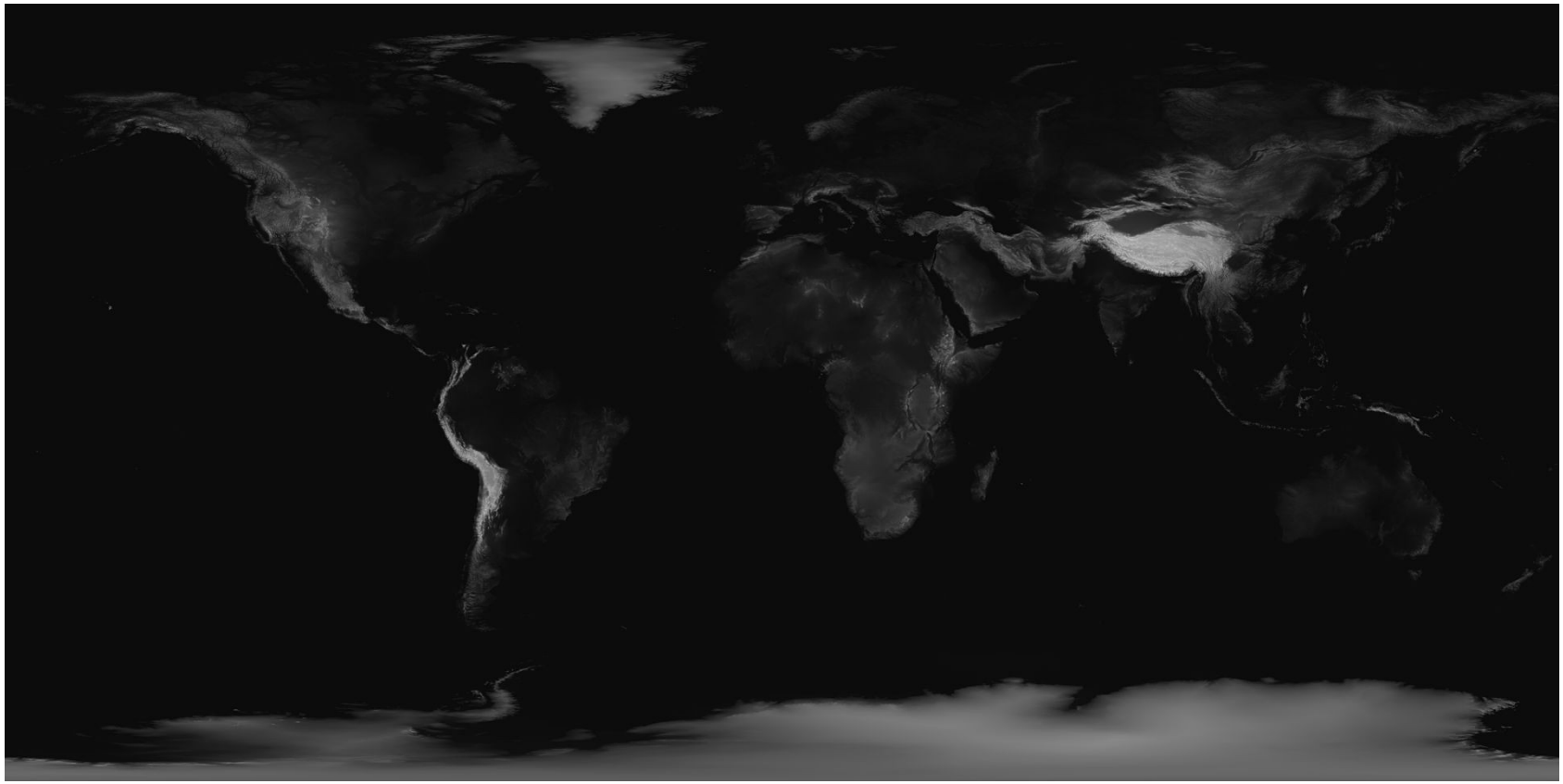
https://slic3r.org/

https://www.3dnatives.com/en/bioprinting-projects-3d-printed-organs-070420205/

https://www.voxel-man.com/segmented-inner-organs-of-the-visible-human/faq/

**3D ?** 2D+t, Voxels, RGB, 3D+t, 4D, 5D, RGB+Depth

**3D ? 2.5D ?  that exists :-) like in DEM applications**



Heightmap of Earth's surface

https://en.wikipedia.org/wiki/Digital_elevation_model

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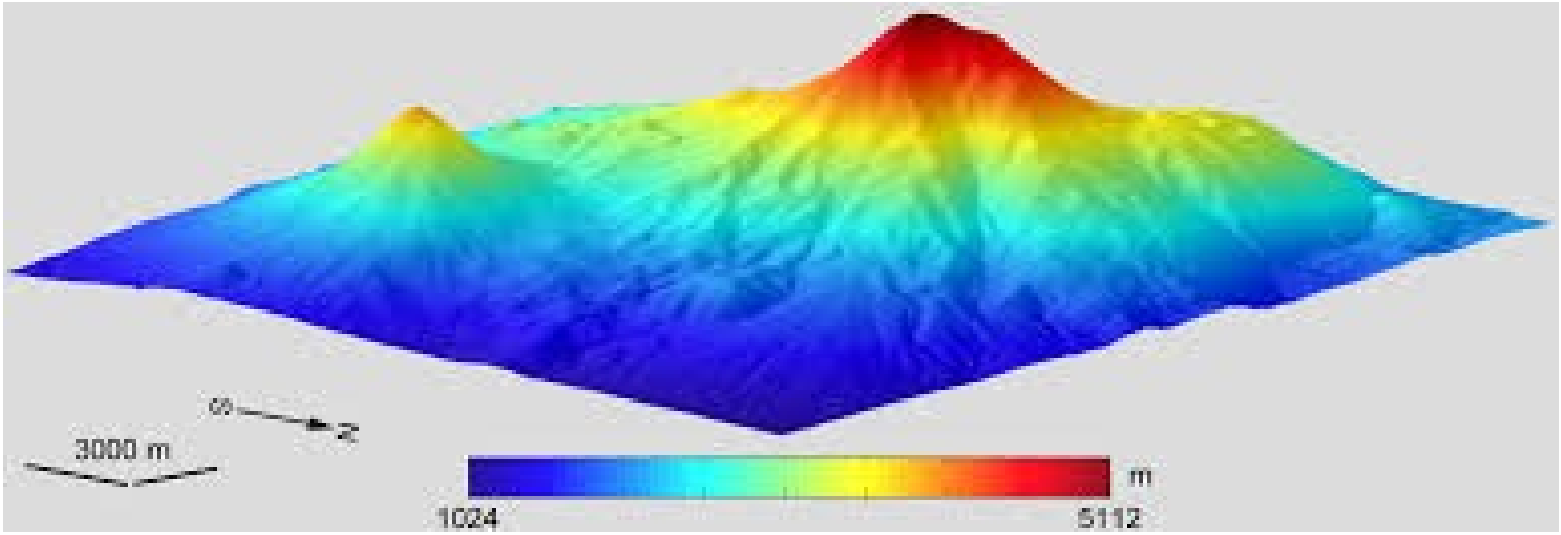
**3D ? 2.5D exists :-) like in DEM applications**

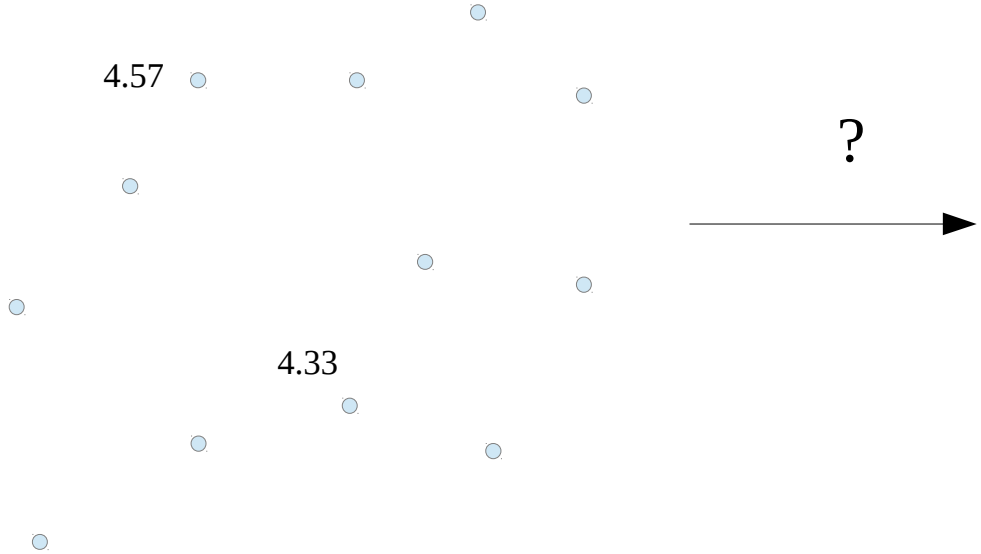


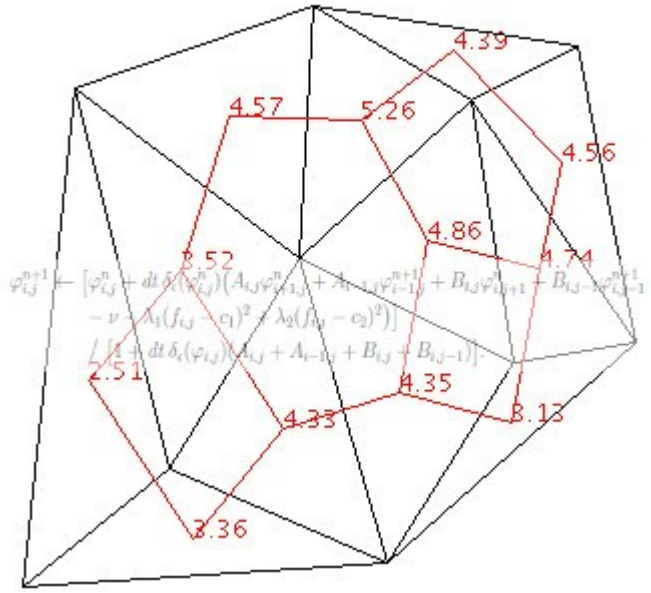

Digital Surface Model
(MNE in French IGN dictionary)

http://iflorinsky.impb.ru/z.htm

**3D ?** 2D+t, Voxels, RGB, 3D+t, 4D, 5D, RGB+Depth

**3D ? 2.5D exists :-) like in DEM applications : Algorithmic Geometry**




https://en.wikipedia.org/wiki/Delaunay_triangulation

http://openalea.gforge.inria.fr/doc/vplants/tissue/doc/_build/html/user/reconstruction/delaunay2D/index.html#tissue-delaunay2d

http://openalea.gforge.inria.fr/doc/vplants/tissue/doc/_build/html/user/reconstruction/delaunay3D/index.html

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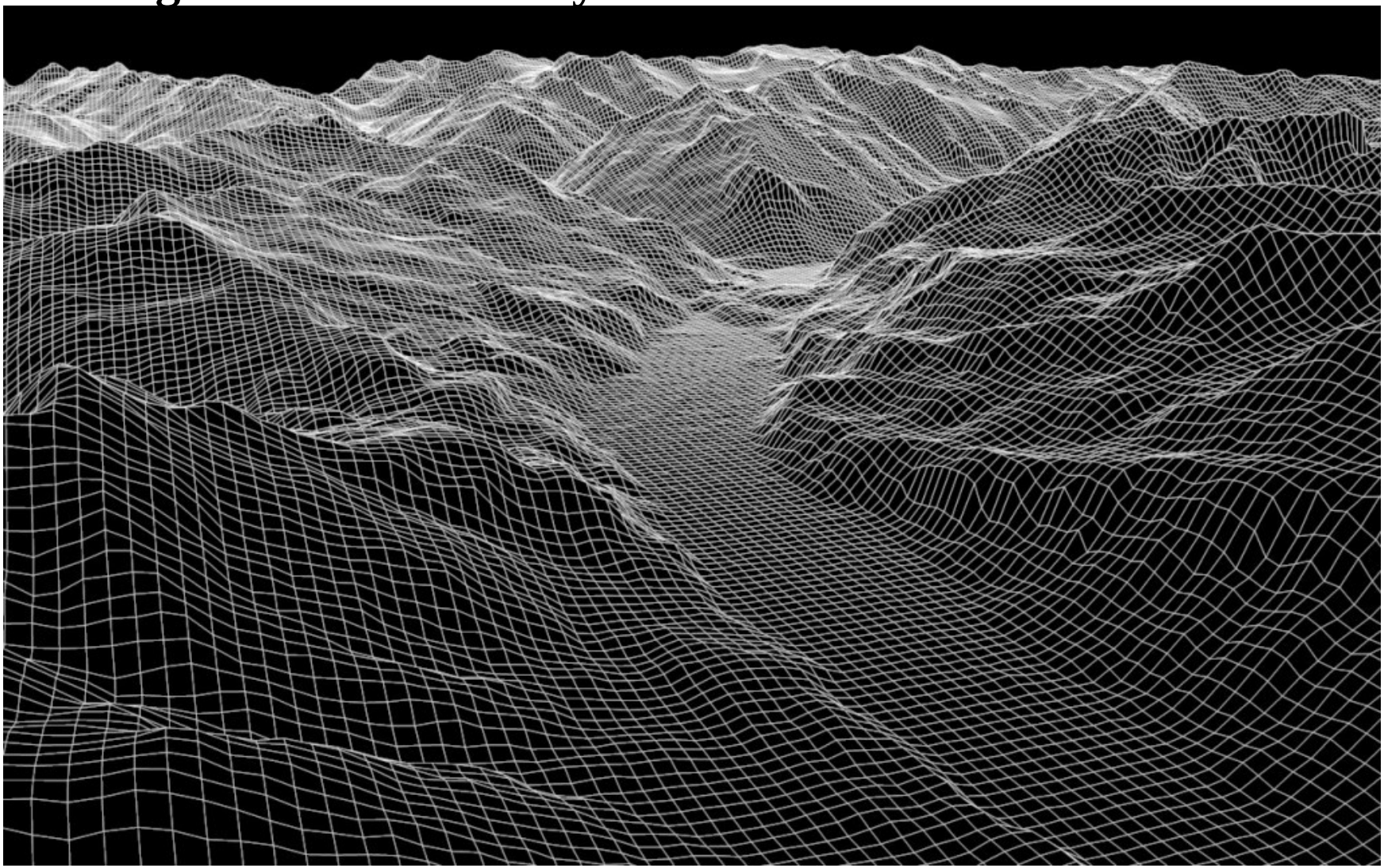

# 3D ? 2.5D exists :-) like in stereovision systems

Intensity Image vs. Range Image

Passive Optical vs. Active Device

LASER, LIDAR, RADAR : see TESLA car :
https://towardsdatascience.com/why-tesla-wont-use-lidar-57c325ae2ed5

# Bibliography


• “Three-dimensional computer vision : A geometric Viewpoint”, O.D. Faugeras, MIT Press, Cambridge (MA), 1993

• “Introductory techniques for 3D computer vision”, E. Trucco et Alessandro Verri, Prentice Hall, 1998

• Bashar MK, Komatsu K, Fujimori T, Kobayashi TJ (2012) Automatic Extraction of Nuclei Centroids of Mouse Embryonic Cells from Fluorescence, Microscopy Images. PLoS ONE 7(5): e35550. doi:10.1371/journal.pone.0035550, May 2012

• Real-time segmentation of 3D echocardiograms using a state estimation approach with deformable models, PhD 2009, Fredrik Orderud

• Evaluation of the effectiveness of simple nuclei-segmentation methods on Caenorhabditis elegans embryogenesis images, Azuma and Onami, BMC Bioinformatics 2013, 14:295

Fiji: Image 3D Viewer, Volume Viewer, NeuronJ EPFL, Object Counter 3D,etc.