Lesion and tissue segmentation in Magnetic Resonance Imaging

Gaia Vettori & Filippo Castellani

2D spatial intensity model

3D spatial intensity model
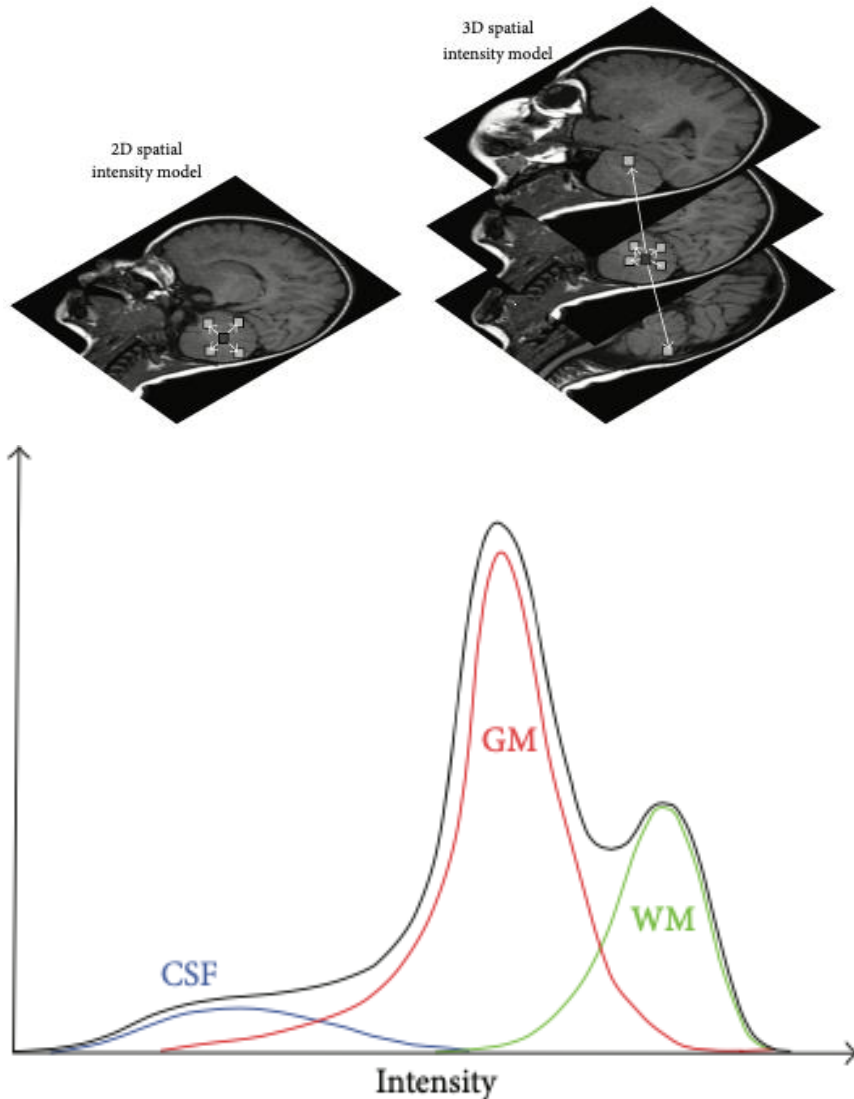
Descriptions

- Images are defined as functions in either 2 or 3 dimensions, where every point in space is associated to an **intensity value** [0, 255].

- **Nuclear magnetic resonance imaging** associates to every pixel the average magnetic resonance characteristic value.

- "**Image segmentation**" discretizes between tissues, groups together and labels homogenous ones.

- **Pre-processing**: bias field removal, non-brain tissue removal, image registration

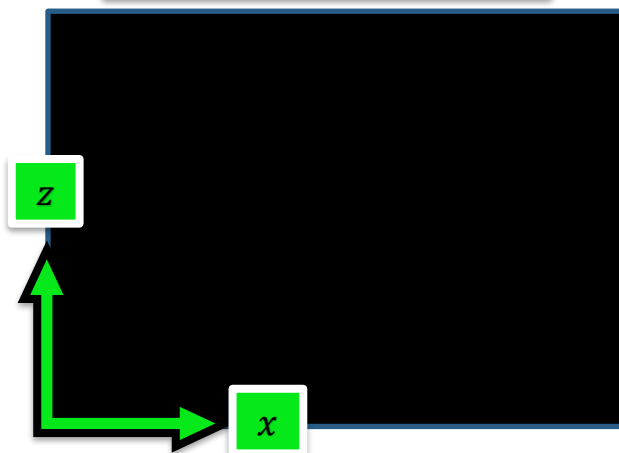# Image segmentation

Methods

- **Manual**
- **Intensity-based**
    - Threshold
    - Region growing
    - Classification
    - Clustering
- **Atlas-based**
- **Surface-based**
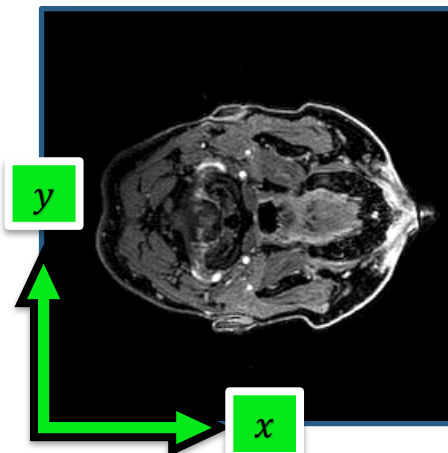- **Hybrid methods**
    - Otsu's method
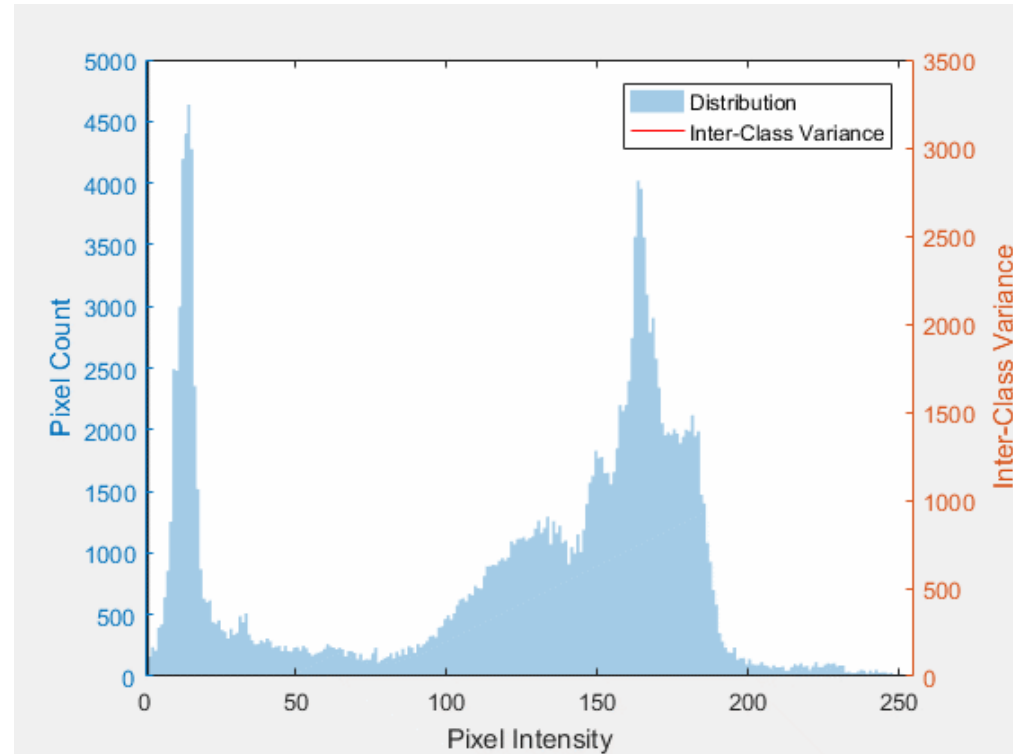
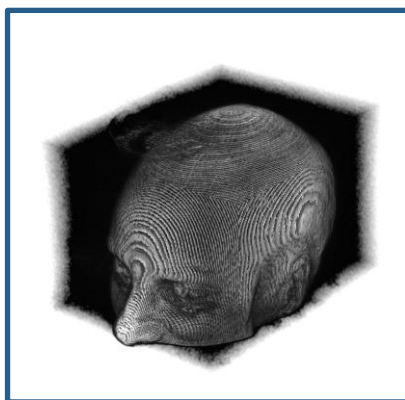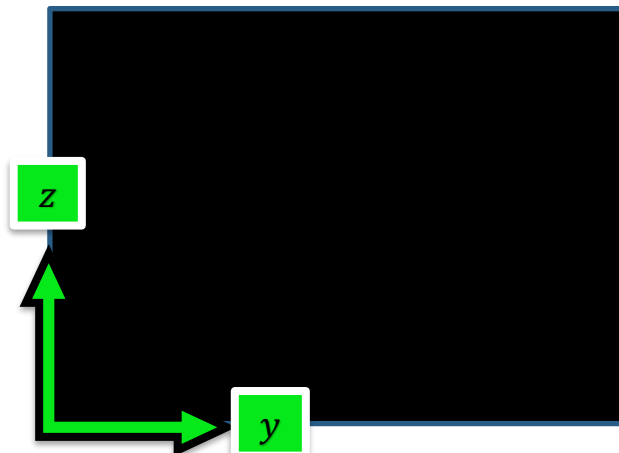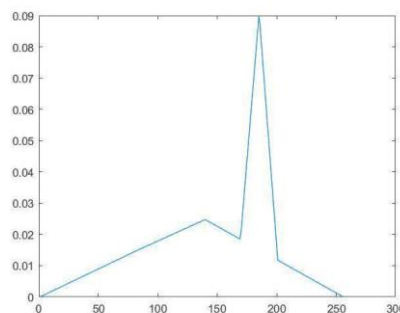# Volume Exploration (2D and 3D exploration of data)

Sagittal Exploration (XZ)

z

x

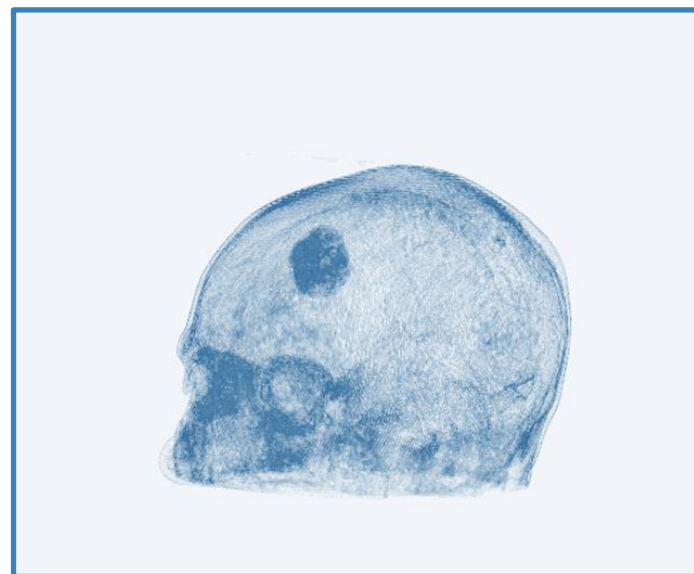**Axial Exploration (XY)**

y

x

Coronal Exploration (YZ)

z

y

Original Volume

Alphamap Tranformation
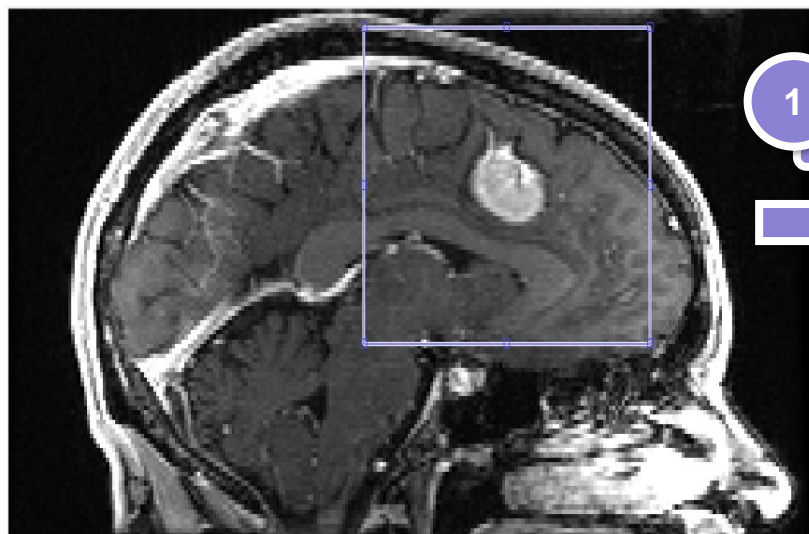*(regulates transparency level, used to highlight hard/soft tissues)*

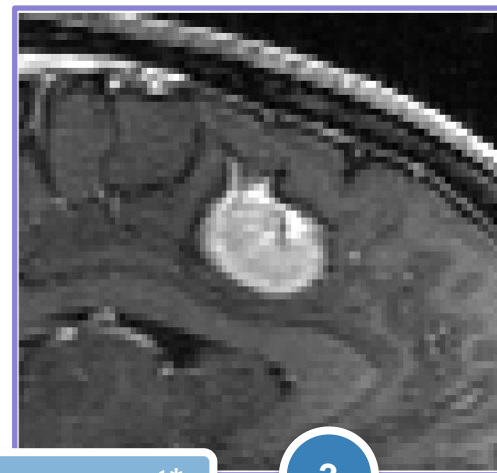# Providing a seed for segmentation Two-step seed [Crop&Click]

Initial Slice: *the choice of the initial sice is up to the expert of the field. Example: sagittal #135*
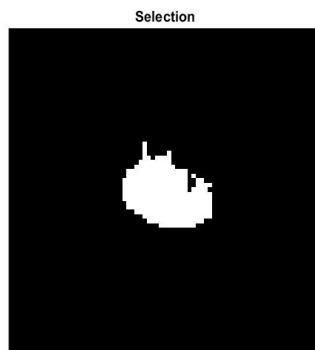
manual action

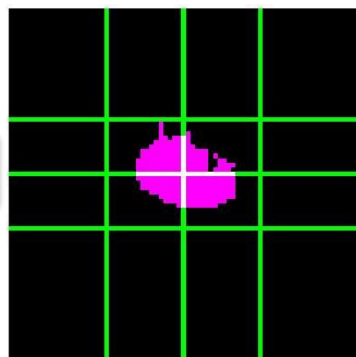**1** Crop

2 Enhancement*

3 Binarization

4 Click

Selection

$3\sigma_x$

$3\sigma_z$

z

x

After slides enhancement

Decreasing y

Increasing y

...

...

S.Slice 133

S.Slice 134

Sagittal Slice 135

S.Slice 136

S.Slice 137
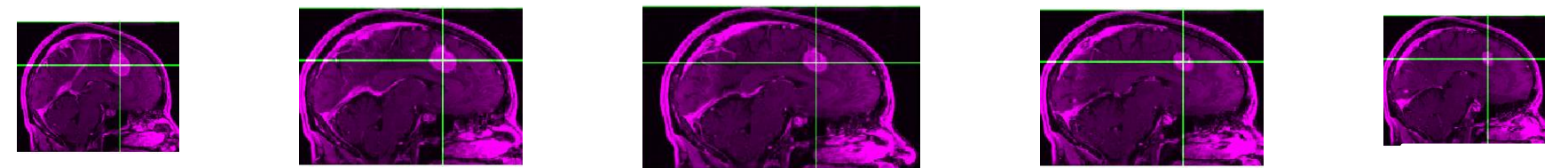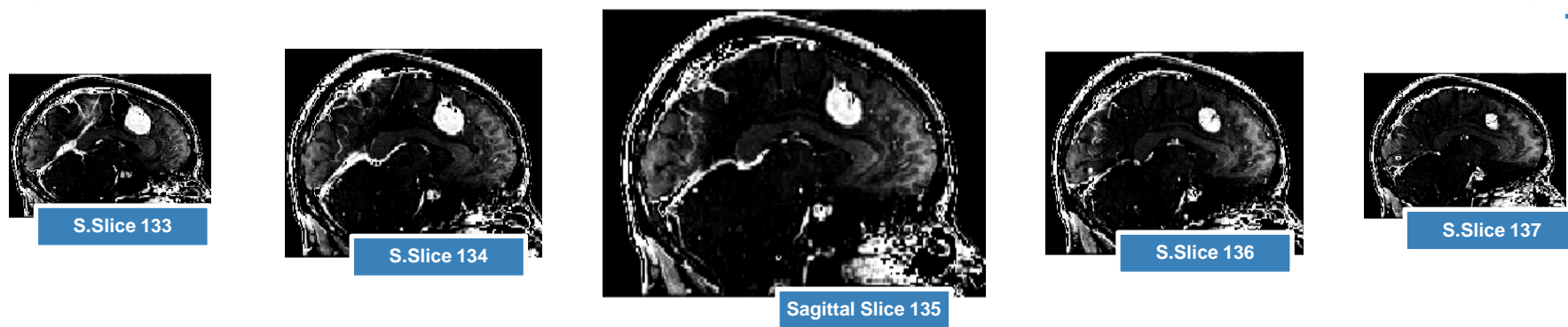
After binarization + automatic* «click»

Selection

Selection

Selection

Selection

Selection

S.Slice 133

S.Slice 134

Sagittal Slice 135

S.Slice 136

S.Slice 137
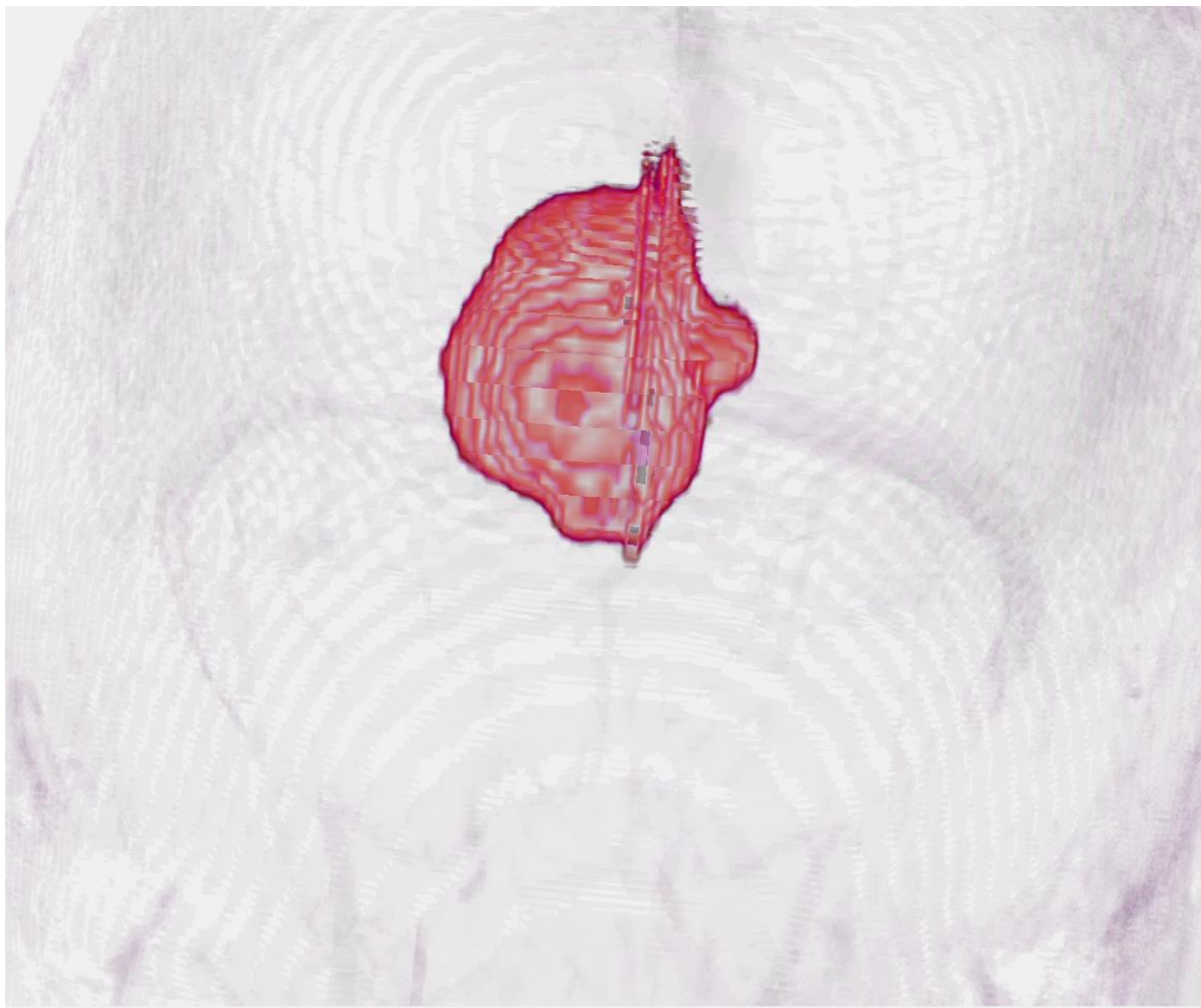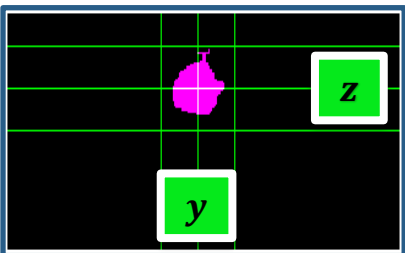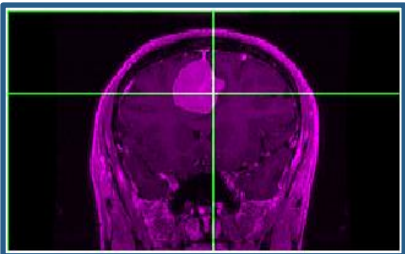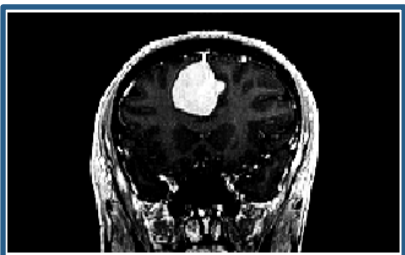
Voxels *classified as* **lesioned** 14427

Volume estimate $17.8\ cm^3$

Performances after noise
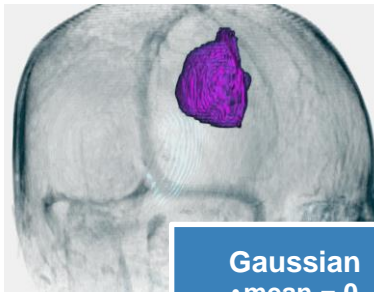
Increasing noise
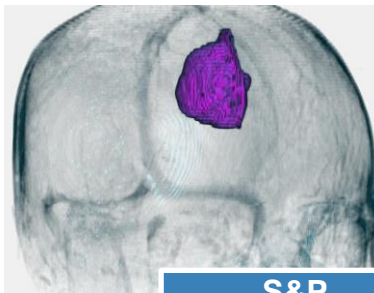
S&P
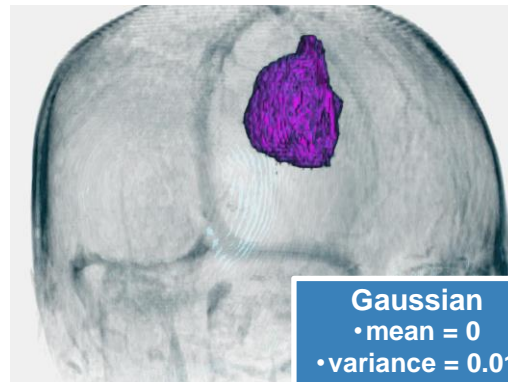- m=0.01
- Voxels = 14391
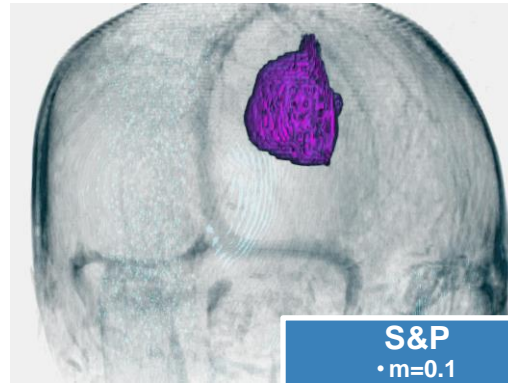
S&P
- m=0.1
- Voxels = 13949
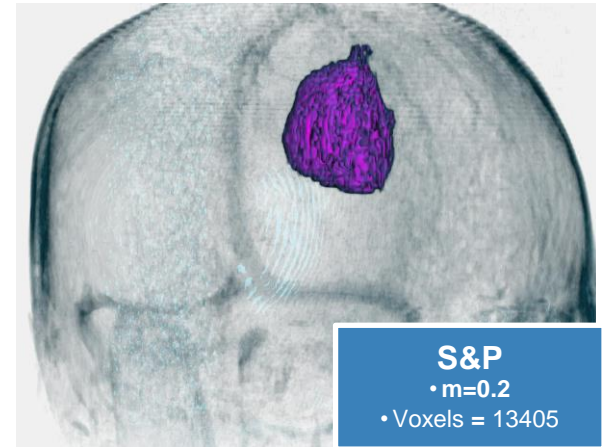
S&P
- m=0.2
- Voxels = 13405

Gaussian
- mean = 0
- variance = 0.001
- Voxels = 14593

Gaussian
- mean = 0
- variance = 0.01
- Voxels = 14622

Not working

Gaussian
- mean = 0
- variance = 0.1

Thank you for your attention

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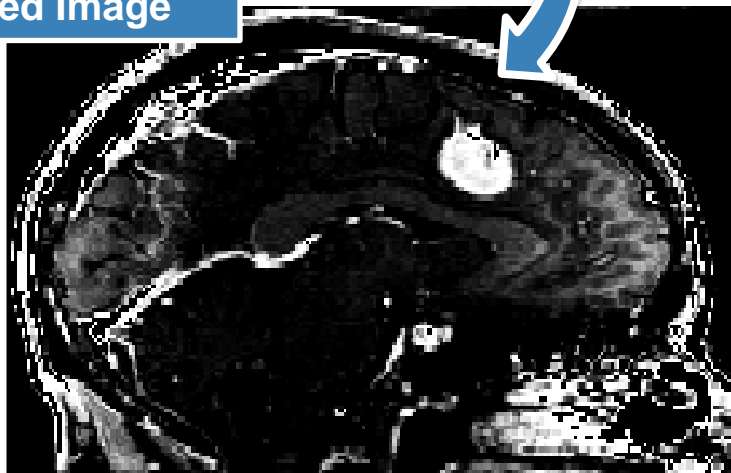
Original Image
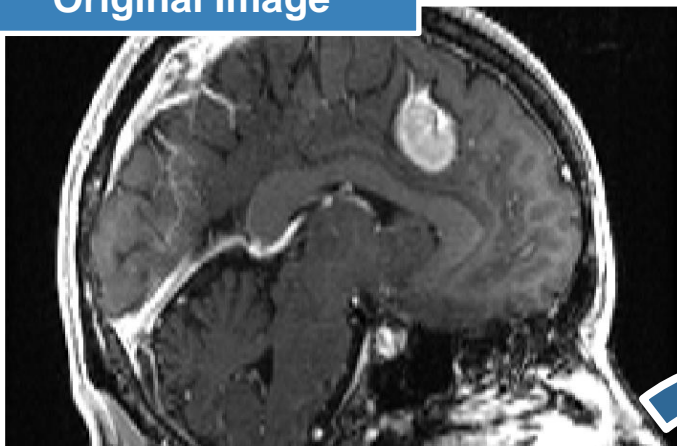
Transformation
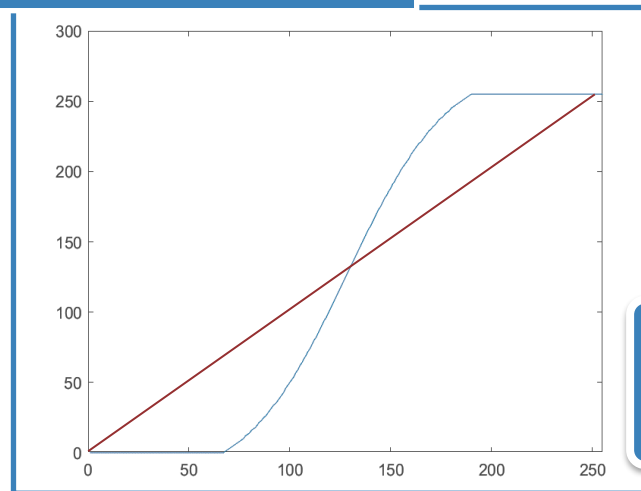
$$k = 10$$
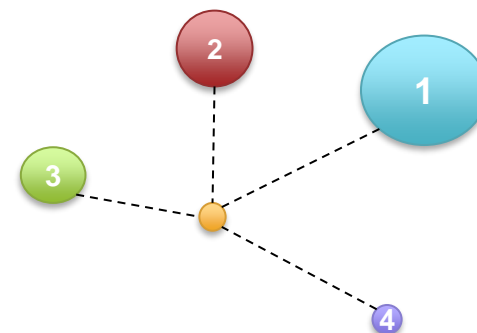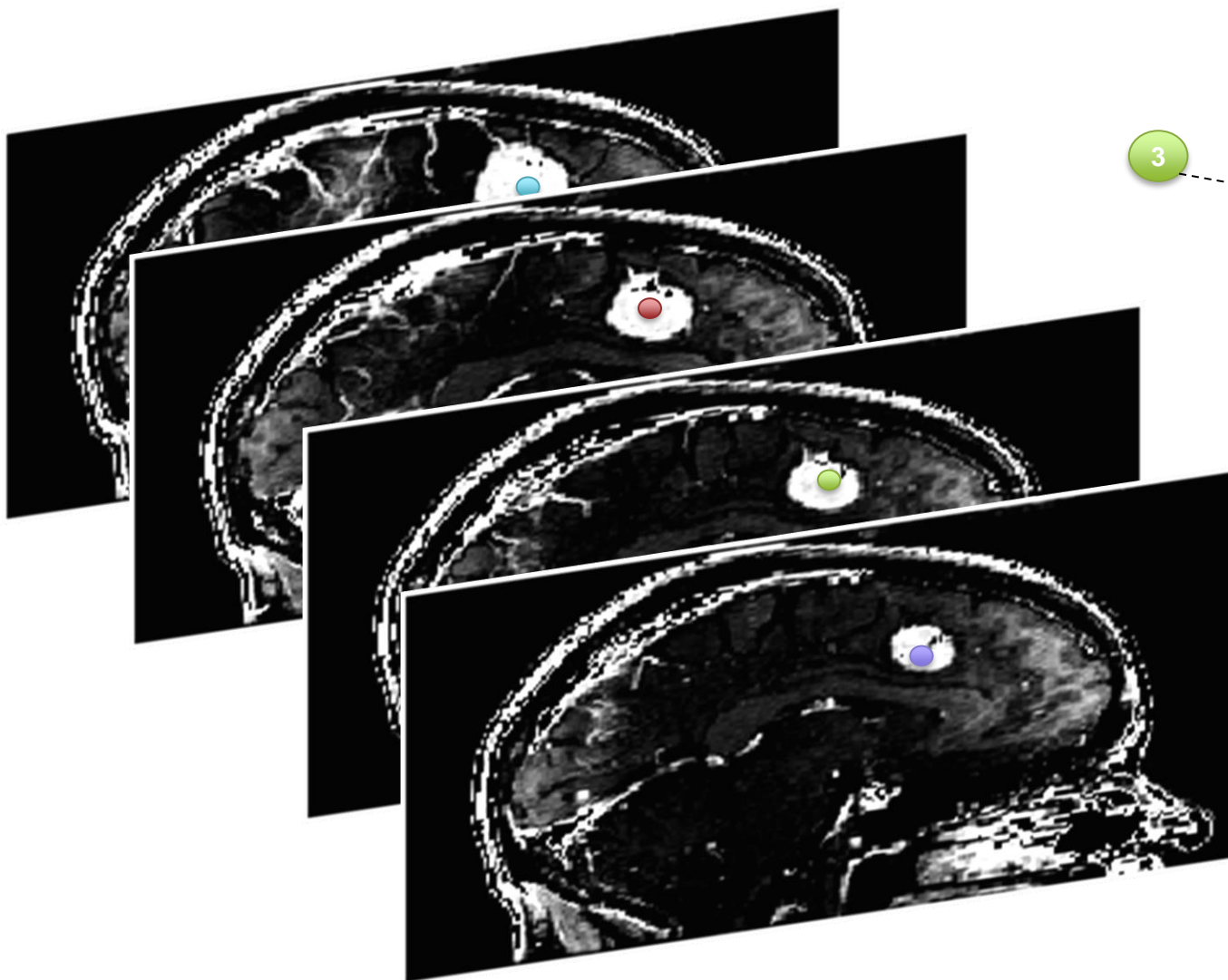$$g = 0.2$$

Enhanced Image

$$y = \frac{(1+g)}{1 + e^{\left(k \cdot \frac{1}{2} - k \cdot x\right)}} - \frac{g}{2}$$

Otsu's method will be applied on this image in order to binarize it.

$$weigth_n = \frac{1}{1.2^n}$$
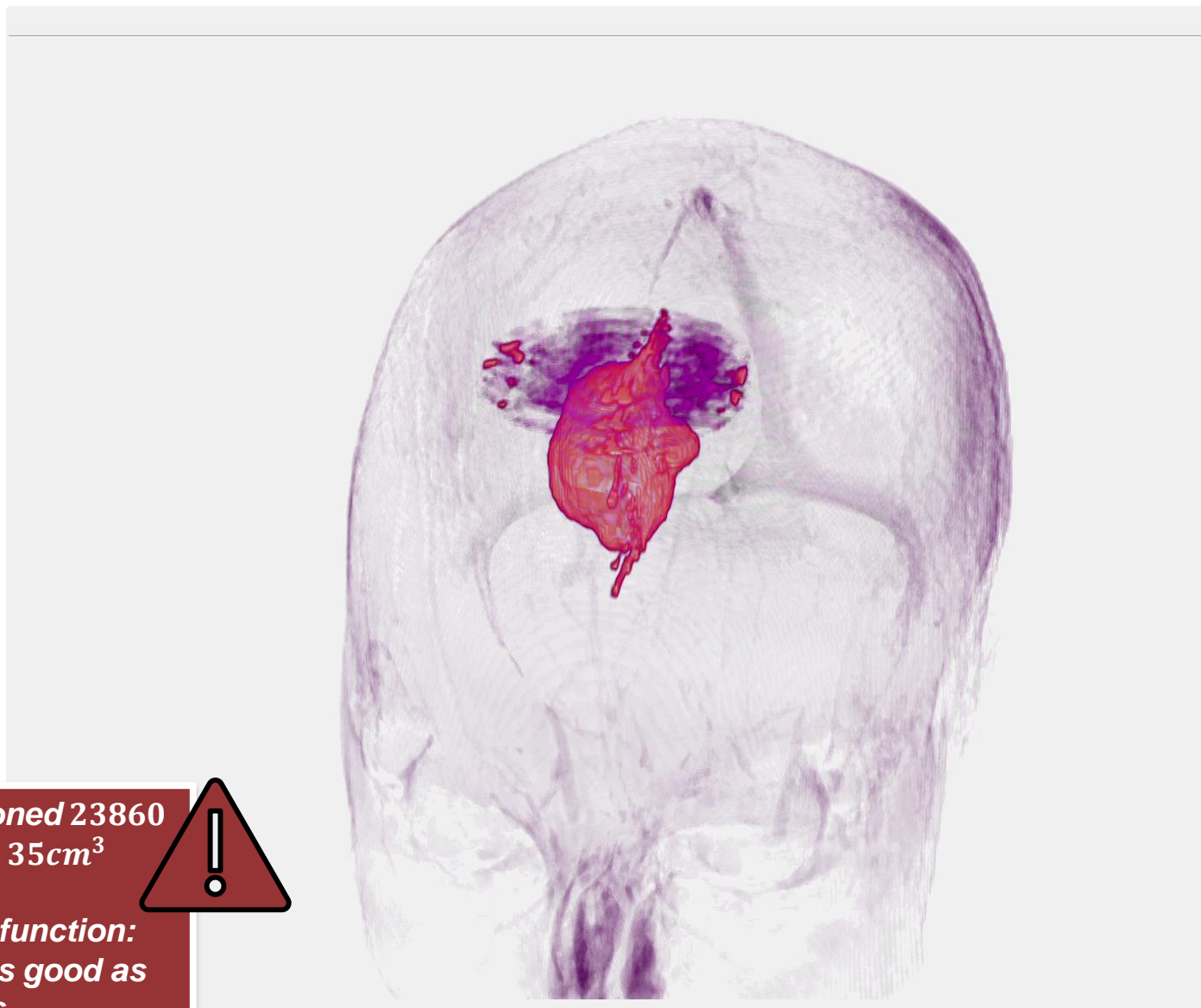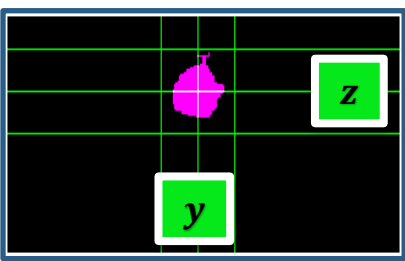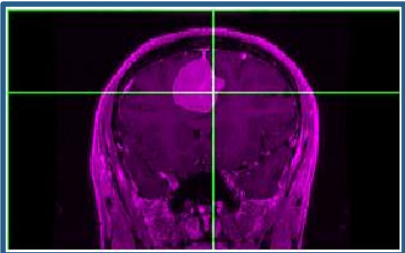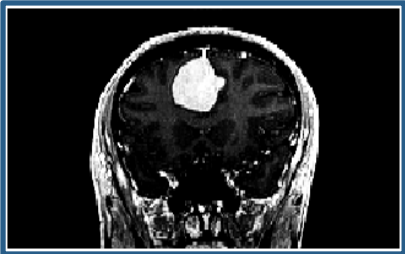
Voxels classified as lesioned 23860
Volume estimate 29.35cm³

Issues with imfill() function:
Actually not working as good as sagittal slices