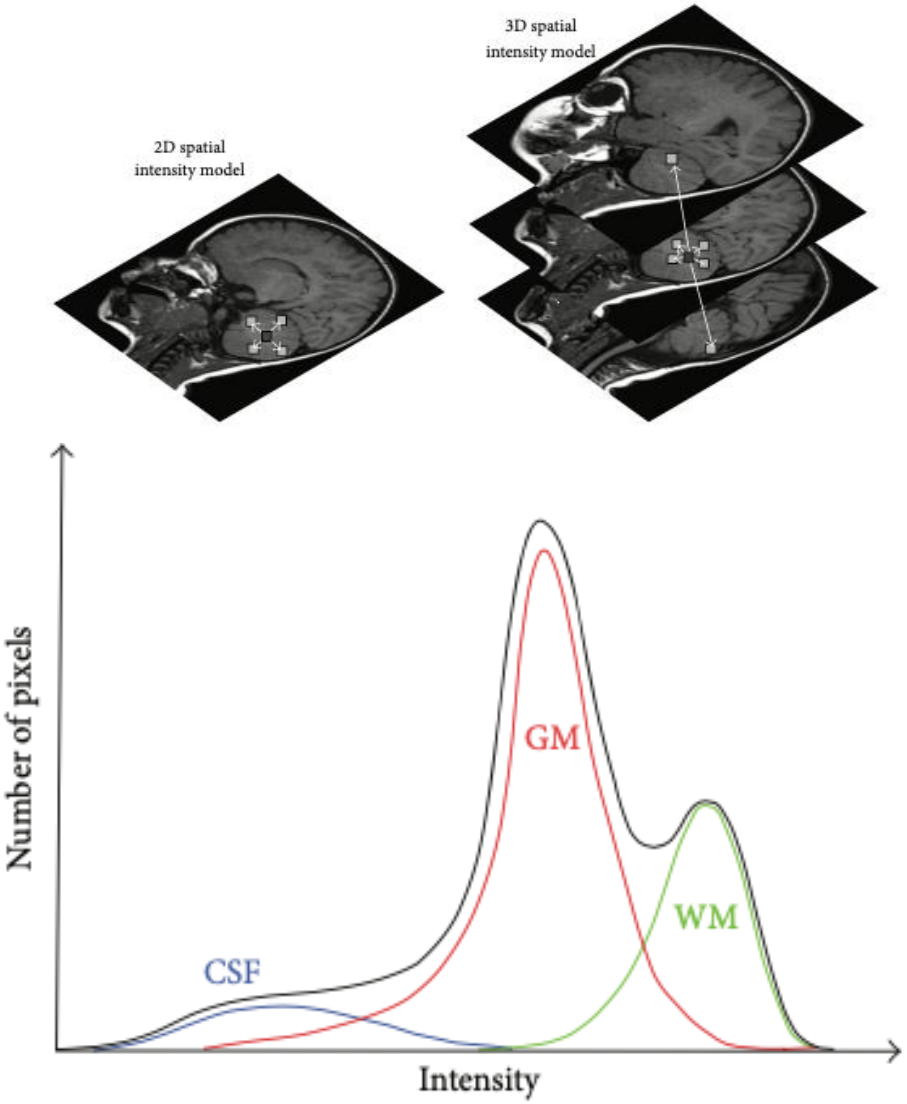
POLITECNICO DI MILANO

Lesion and tissue segmentation in Magnetic Resonance Imaging

Gaia Vettori & Filippo Castellani

Medical images and MRI



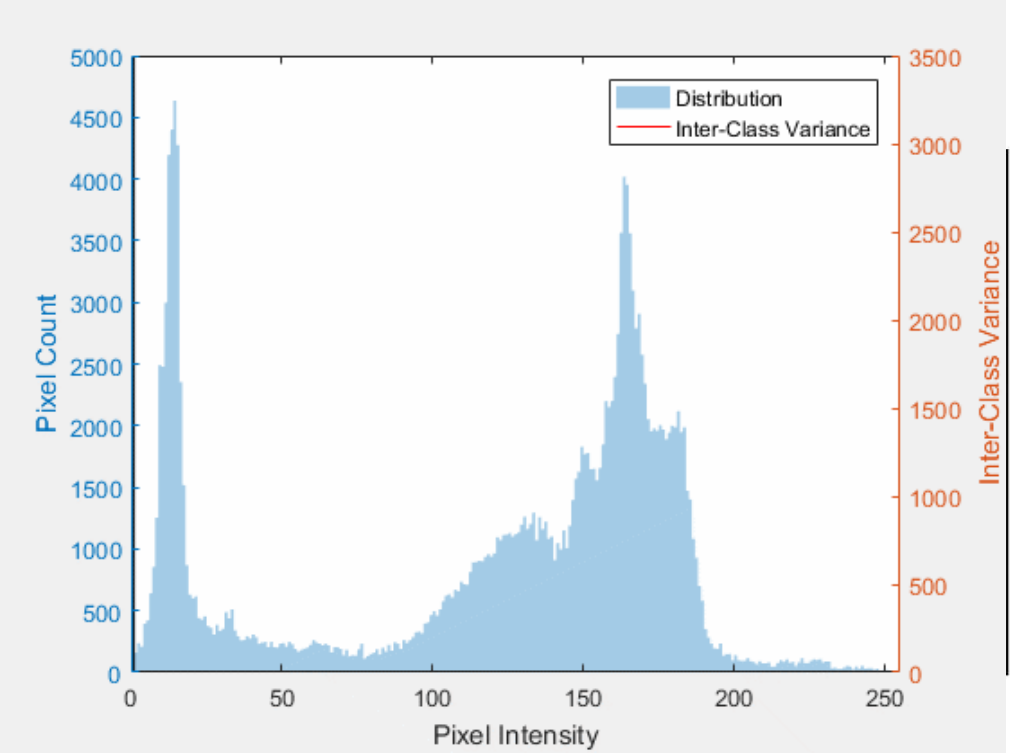
Descriptions

- 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

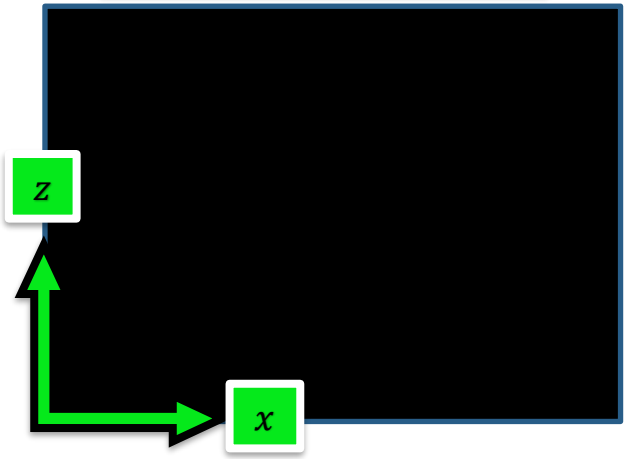
Methods

- **Manual**
- **Intensity-based**
  - Threshold
  - Region growing
  - Classification
  - Clustering
- **Atlas-based**
- **Surface-based**
- **Hybrid methods**
  - Otsu's method

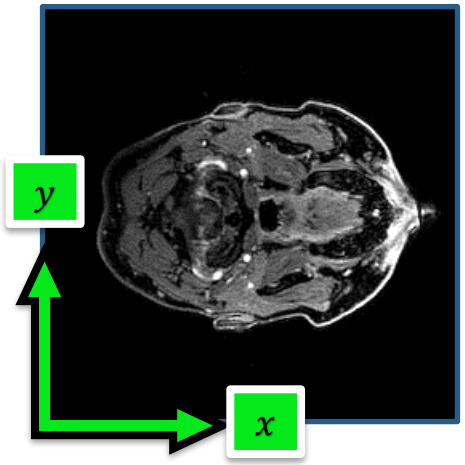


Volume Exploration (2D and 3D exploration of data)

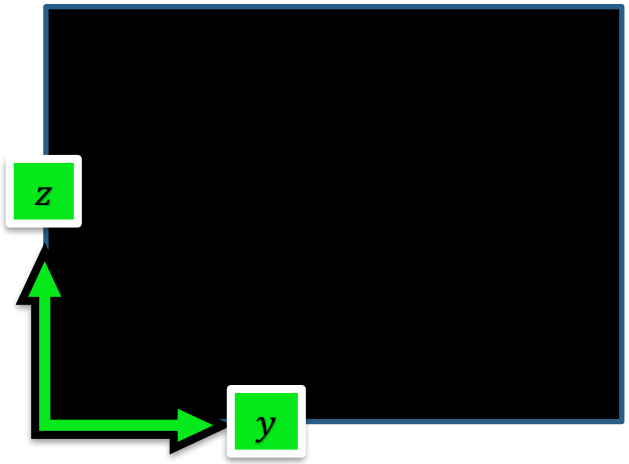
Sagittal Exploration (XZ)

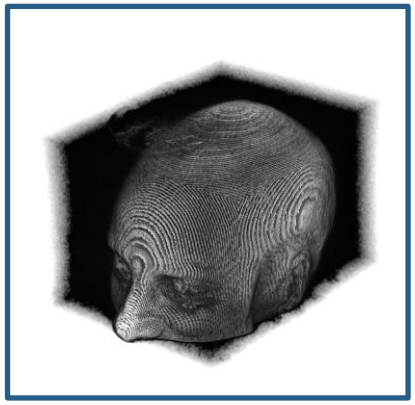


Axial Exploration (XY)

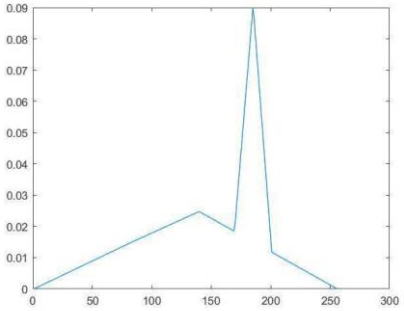


Coronal Exploration (YZ)

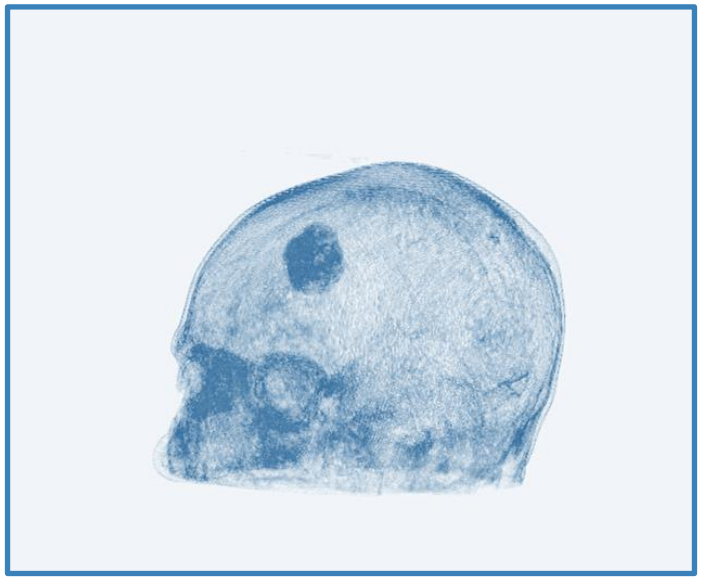




Original Volume



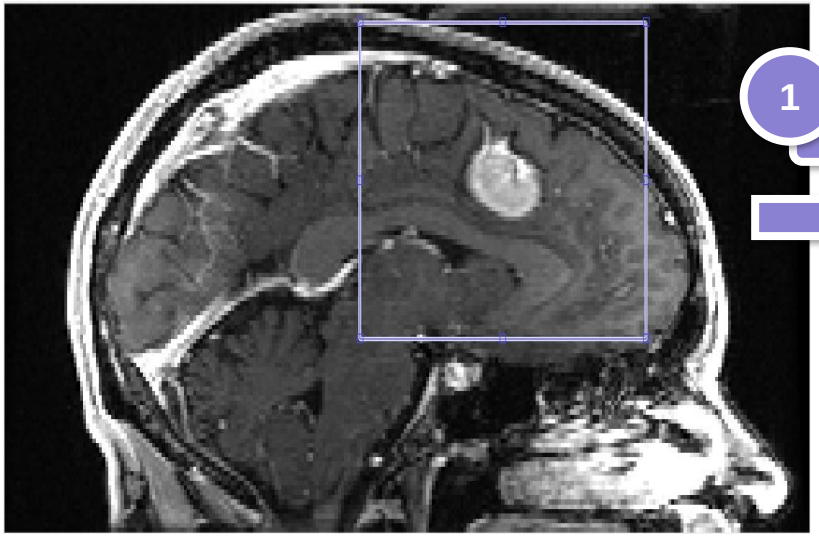
Alphamap Tranformation
(regulates transparency level, used to highlight hard/soft tissues)



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*

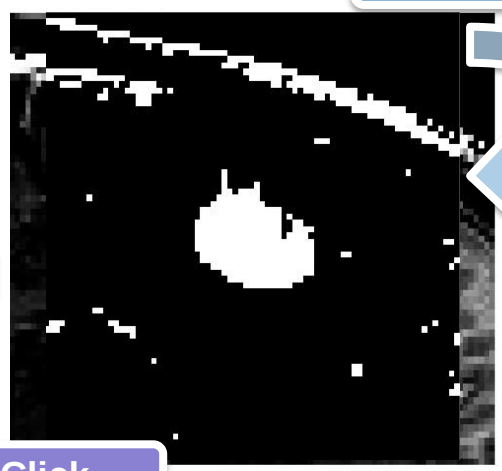


manual action

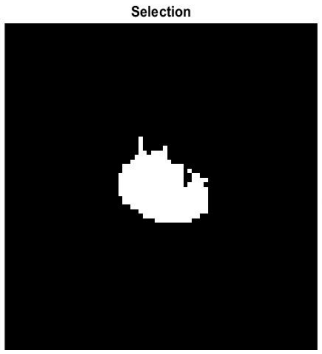
1 Crop

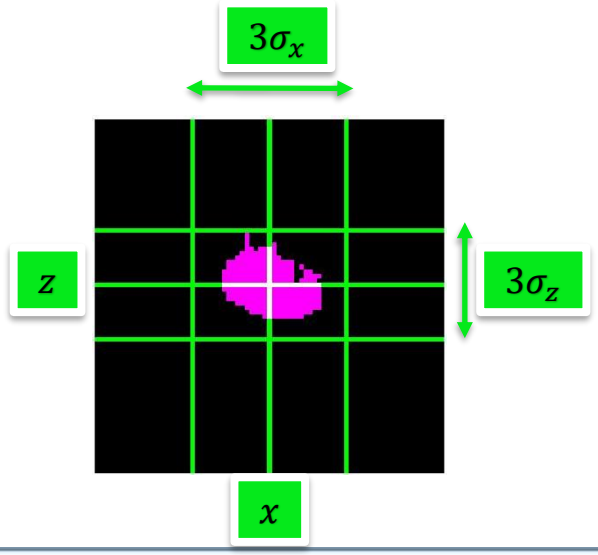
2 Enhancement*

3 Binarization



4 Click

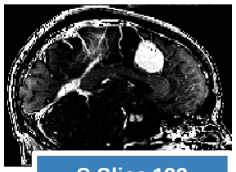


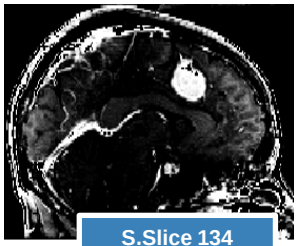


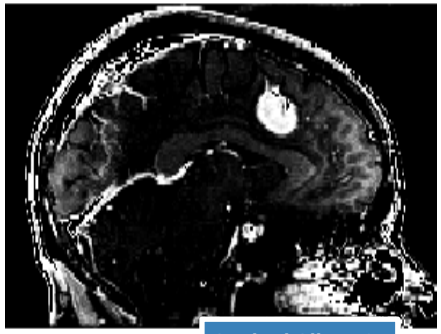
Automatic segmentation (Segmentation loop)

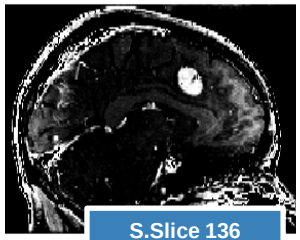
After slides enhancement

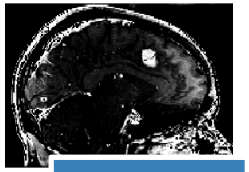
Decreasing y ⟵ ⟶ *Increasing y*

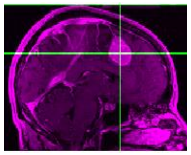

S.Slice 133

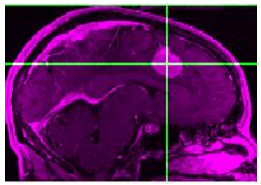

S.Slice 134

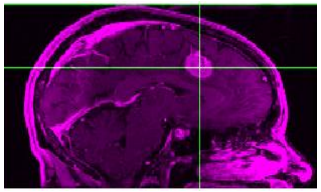

Sagittal Slice 135

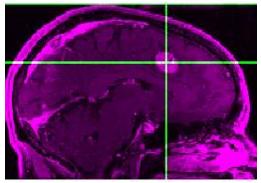

S.Slice 136

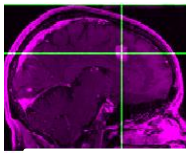

S.Slice 137



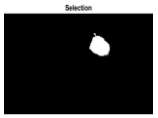








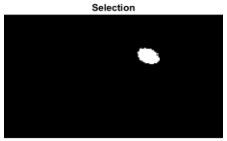
After binarization + automatic «click»*



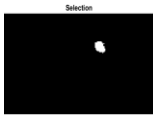
S.Slice 133

S.Slice 134

Sagittal Slice 135

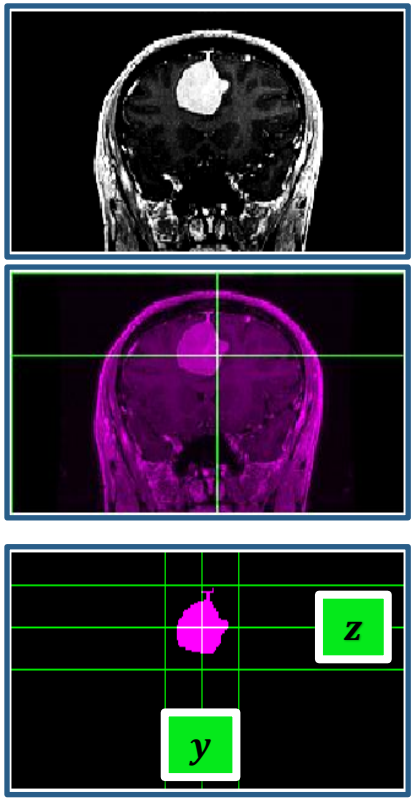


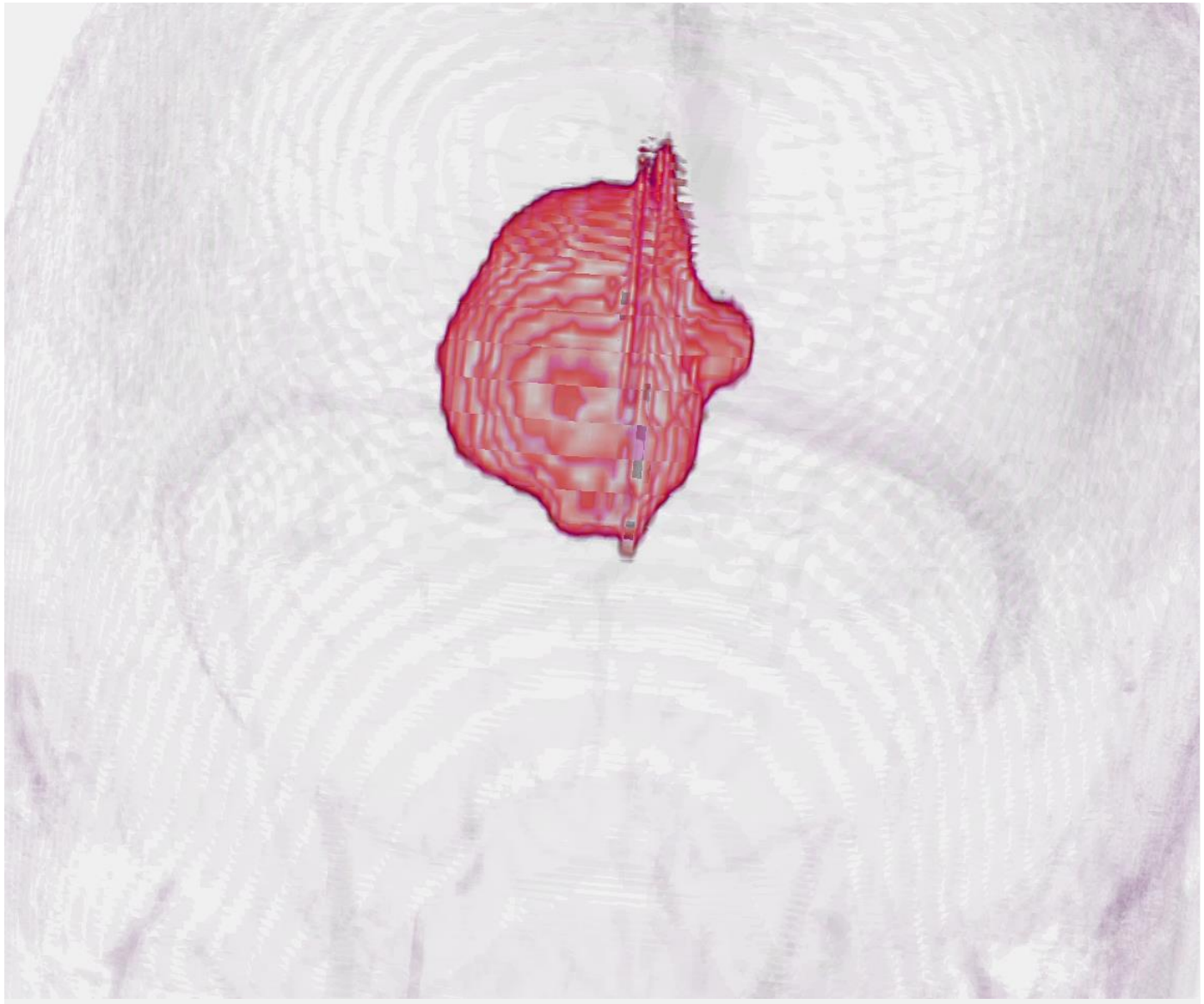
S.Slice 136



S.Slice 137

Results & Conclusions (Segmentation and lesion volume estimate)





***Voxels** classified as **lesioned** 14427*

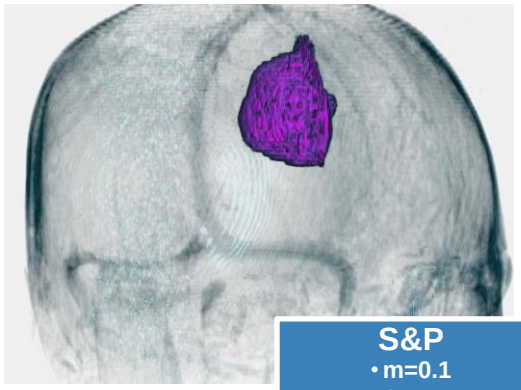
Volume estimate
$17.8\ cm^3$

Noise effect (Salt&Pepper and Gaussian, varying parameters)

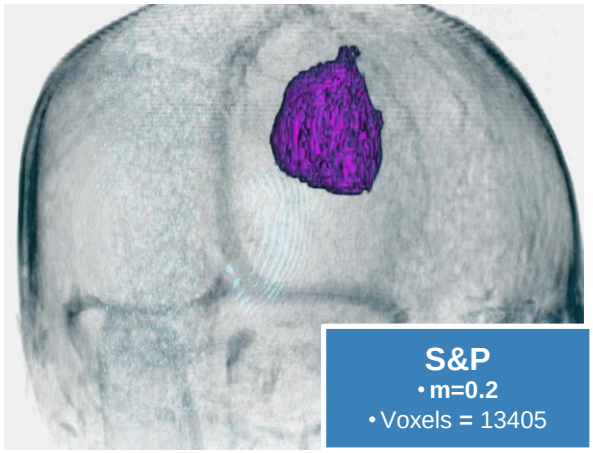
Performances after noise

Increasing noise

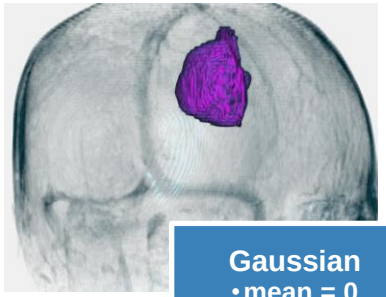
S&P
- **m=0.01**
- Voxels = 14391



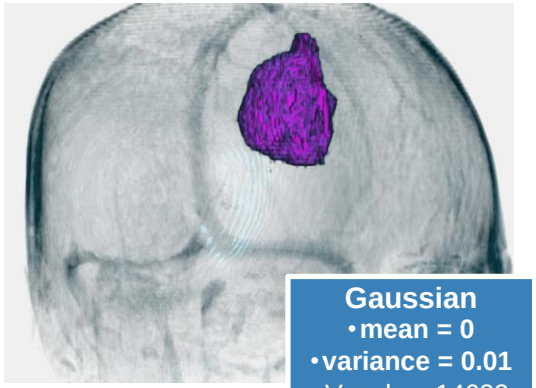
S&P
- **m=0.1**
- Voxels = 13949



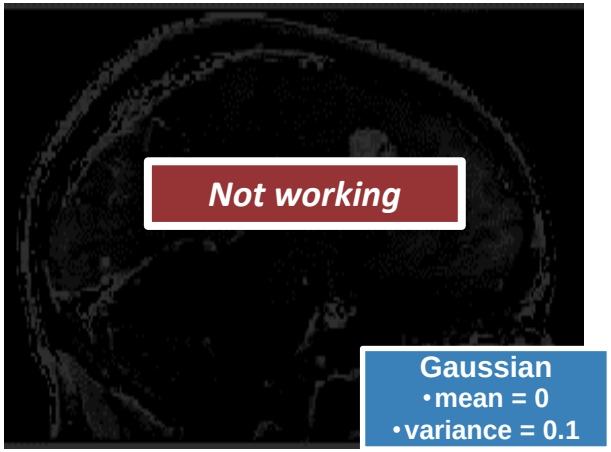
S&P
- **m=0.2**
- Voxels = 13405



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



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



Gaussian
- **mean = 0**
- **variance = 0.1**

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Thank you for your attention

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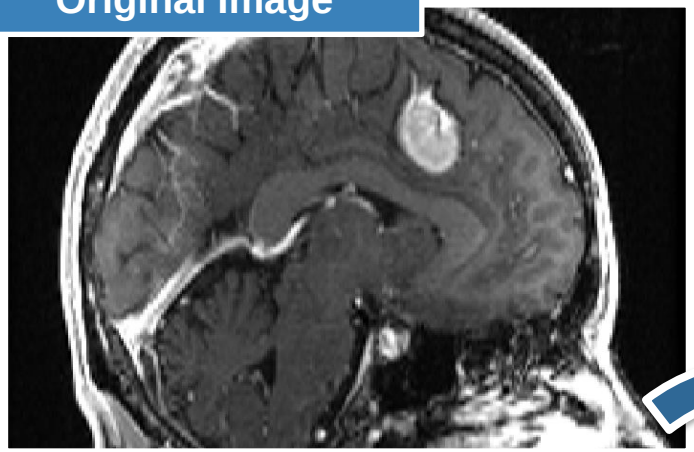
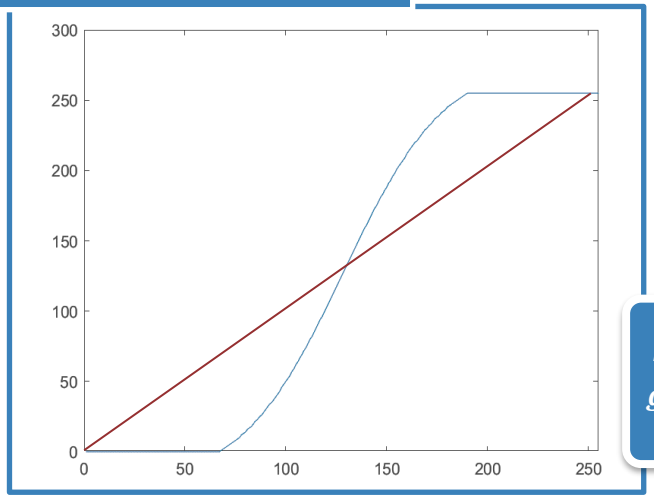
[EXTRA] Enhancement (Point Operator Transformation)

Original Image

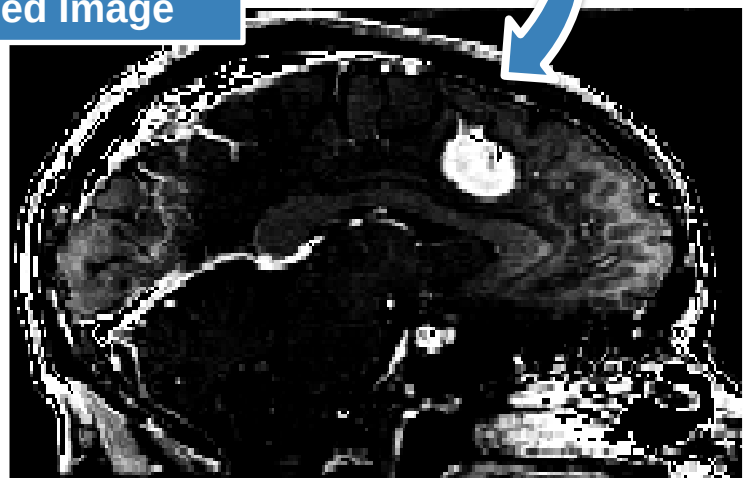


Transformation



$k = 10$
$g = 0.2$

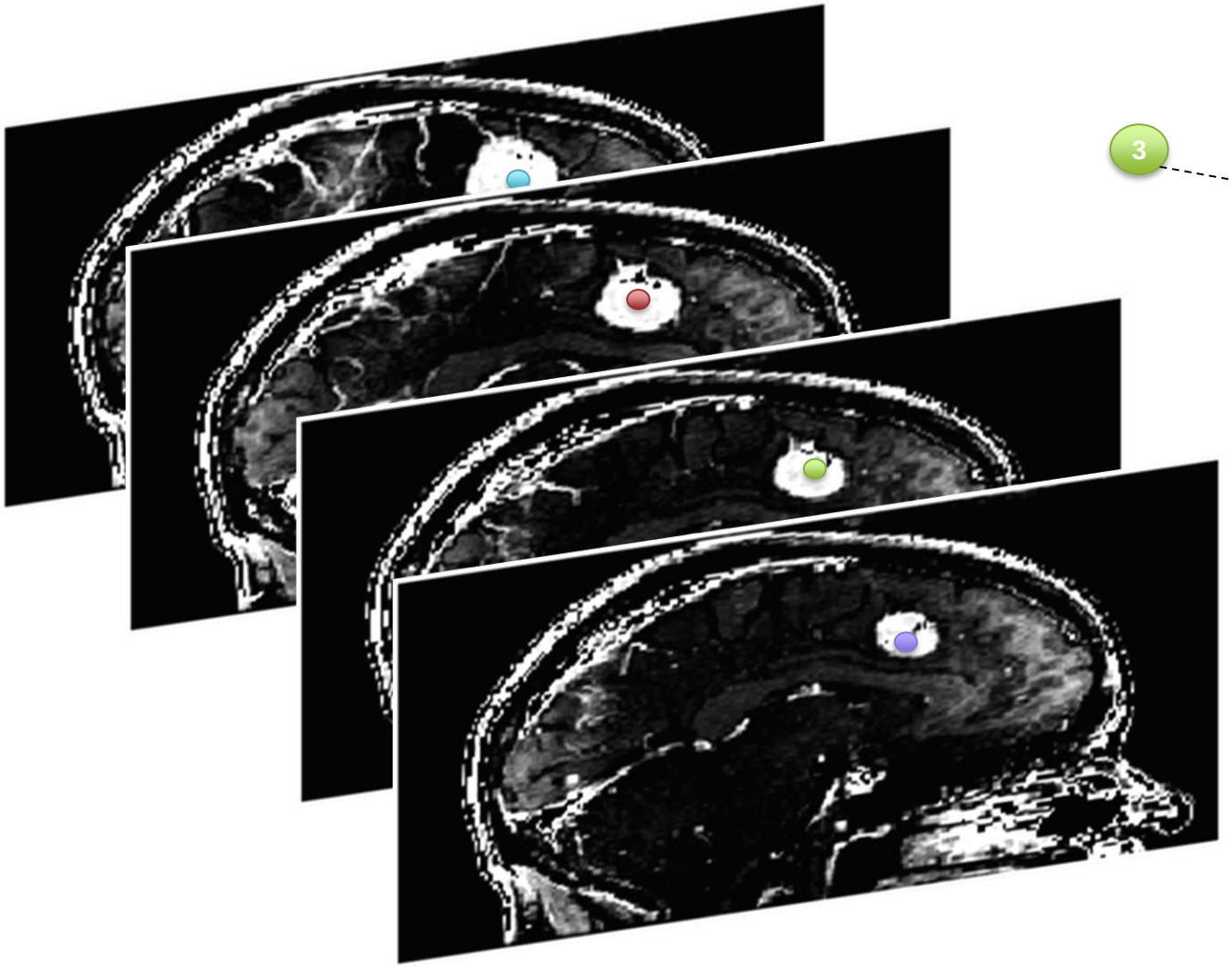
Enhanced Image

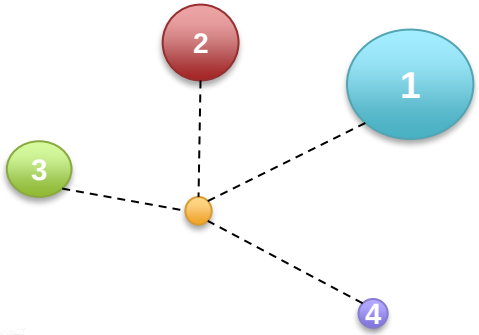


$$y = \frac{(1+g)}{1+e^{\left(k\cdot\frac{1}{2}-k\cdot x\right)}} - \frac{g}{2}$$

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

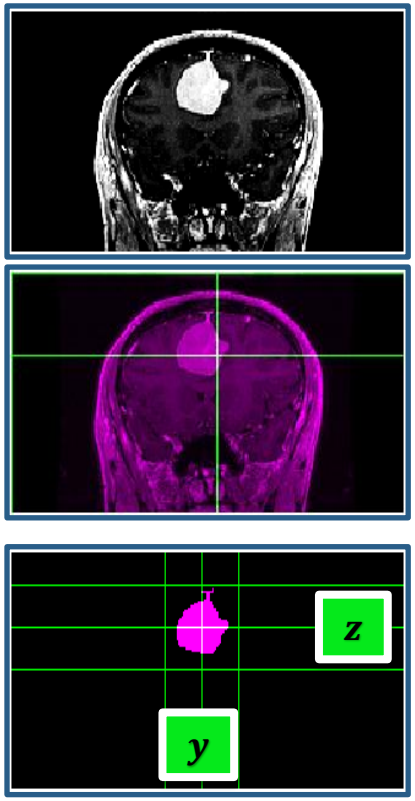
[EXTRA] Automatic seeding (Weighted average of previous centers)

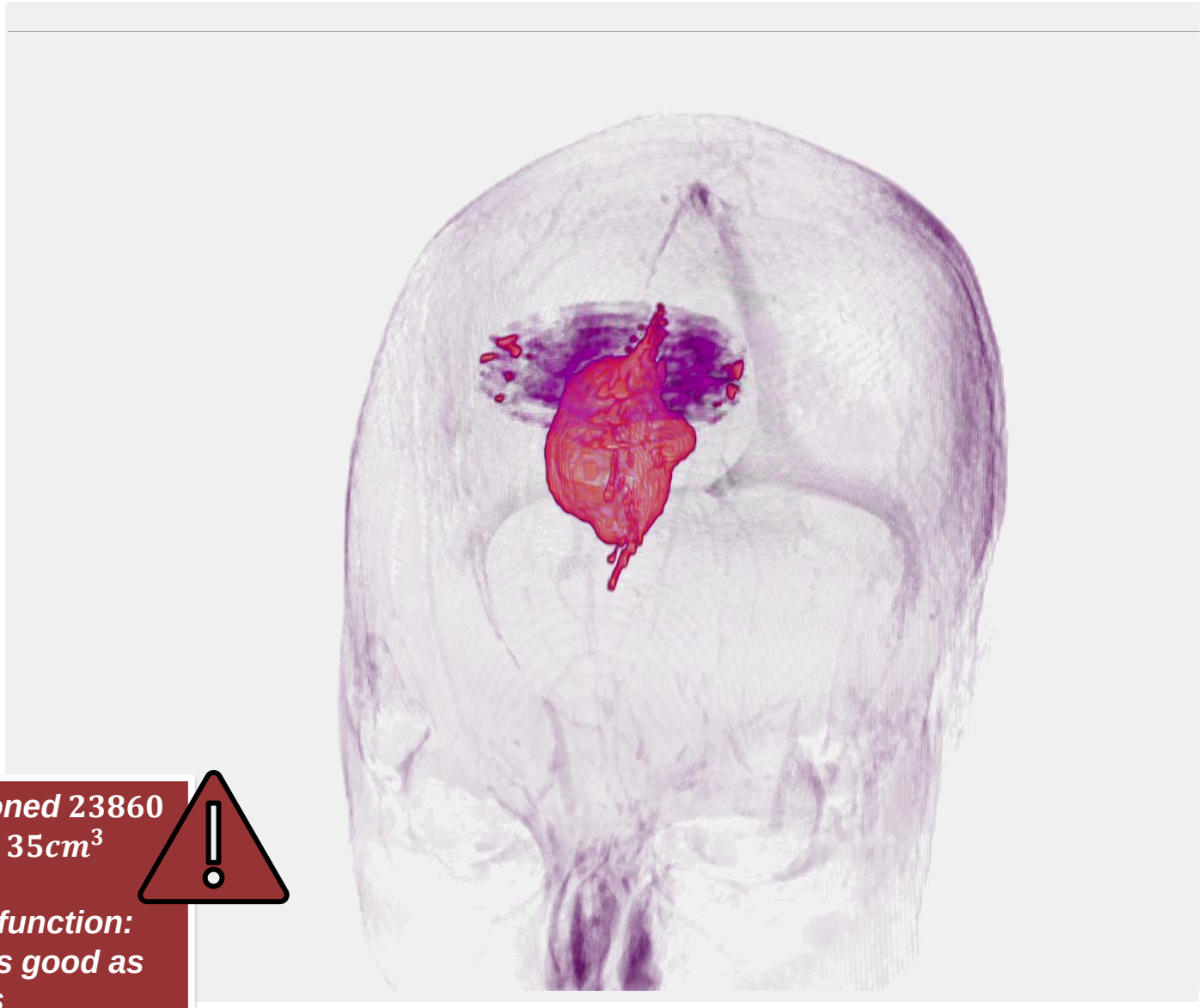




$$weigth_n = \frac{1}{1.2^n}$$

[EXTRA] Results using axial slices (Segmentation performed with the same logic)





***Voxels** classified as **lesioned** 23860*
***Volume estimate** $29.35 cm^3$*

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