

# Interreg

## ITALIA-SLOVENIJA



### TRAIN



UNIONE EUROPEA  
EVROPSKA UNIJA

Progetto standard co-finanziato dal Fondo europeo di sviluppo regionale  
Standardni projekt sofinancira Evropski sklad za regionalni razvoj

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# **Virtual Biopsy**

## **Vincent Torre - SISSA**

**Humanitas Milan (Miran Skrap)**

**SISSA (Laio, Torre)**

**Univ Genova (Verri)**

**Glance Vision Technology Srl**

**DataMind Srl**

**BioValley Investments**

# TUMOR PATHOLOGY

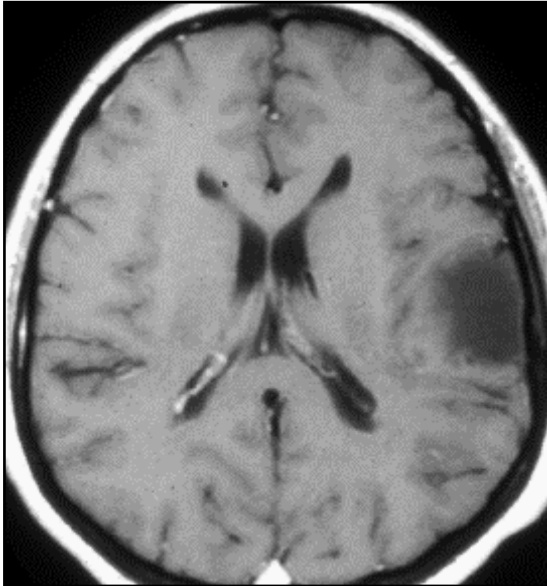
- **THE MOST IMPORTANT OPERATIVE PLATFORM IN NEUROSURGERY**
- it represent the 70 - 80 % of neurosurgical cases
- urgent or relatively urgent treatment
- the surgical experience still remain essential in spite of the many tools are available

## BIG OPPORTUNITY

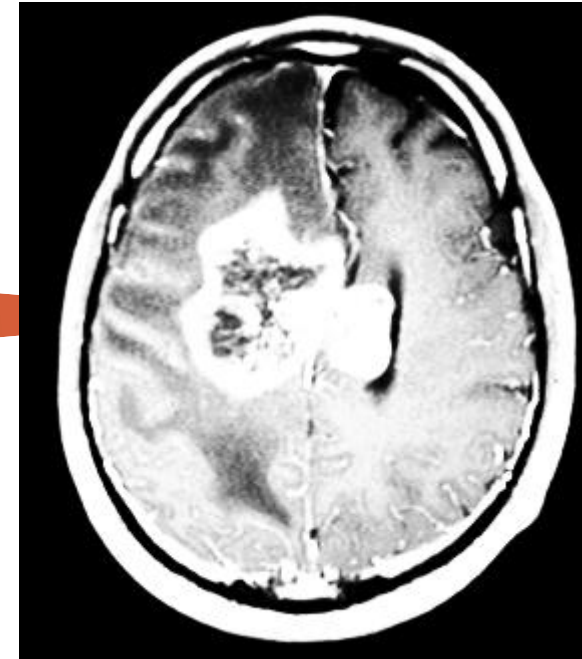
- for developing new technical devices
- for research and applications

## **GLIOMAS with low and high malignancy**

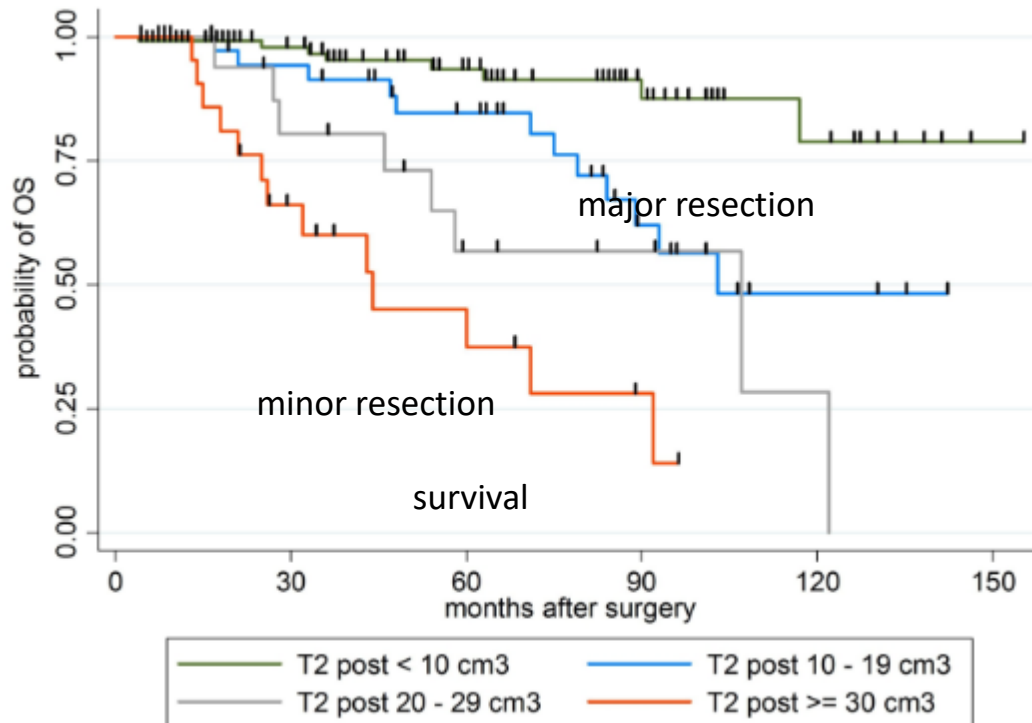
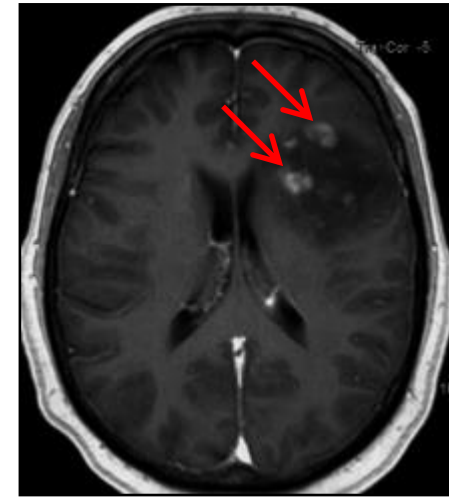
**low grade**



**high grade**



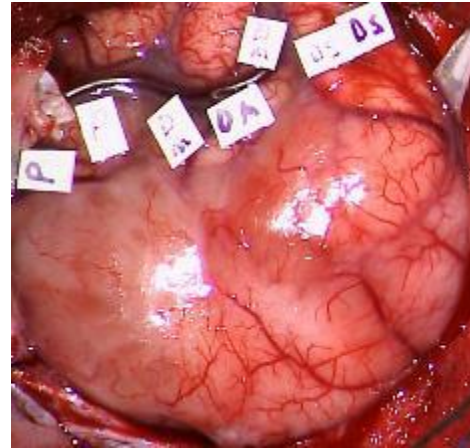
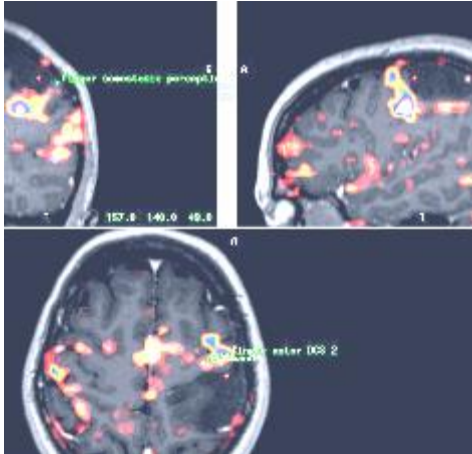
the high grade are the most frequent tumors .The low grade is more rarely detected.  
In few years also the low grade glioma will become highly malignant.



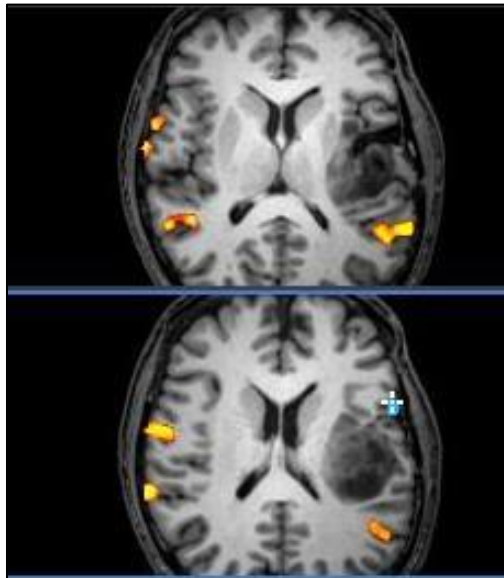
**TODAY THE BEST TREATMENT IS THE SURGICAL MAJOR POSSIBLE RESECTION .**  
**THE LIMIT FOR A RADICAL RESECTION IS THE VICINITY OF AN IMPORTANT FUNCTIONAL AREA WHICH IS INFILTRATED BY TUMORAL CELLS. (language, movement ...)**

**BIG EFFORT TO IDENTIFY THE FUNCTIONS IN THE BRAIN BEFORE AND DURING SURGERY**

# FUNCTIONAL MRI BEFORE SURGERY INTRAOPERATIVELY TO CONFIRM THE FUNCTIONAL LOCATION



**quite simple for the movement**



**more complex for language and  
more cognitive functions.  
We do an awake craniotomy to  
have the collaboration of the patient**

## Novel Biomarker (*gene analysis*)

*Different prognosis is correlated with differences in transcriptome*

RNA deep sequencing  
analysis

82 genes

Proteins involved in other solid cancer with  
Positive prognostic value

**LGG BAD**  
79/82  
up-regulated

**LGG GOOD**  
3/82  
up-regulated

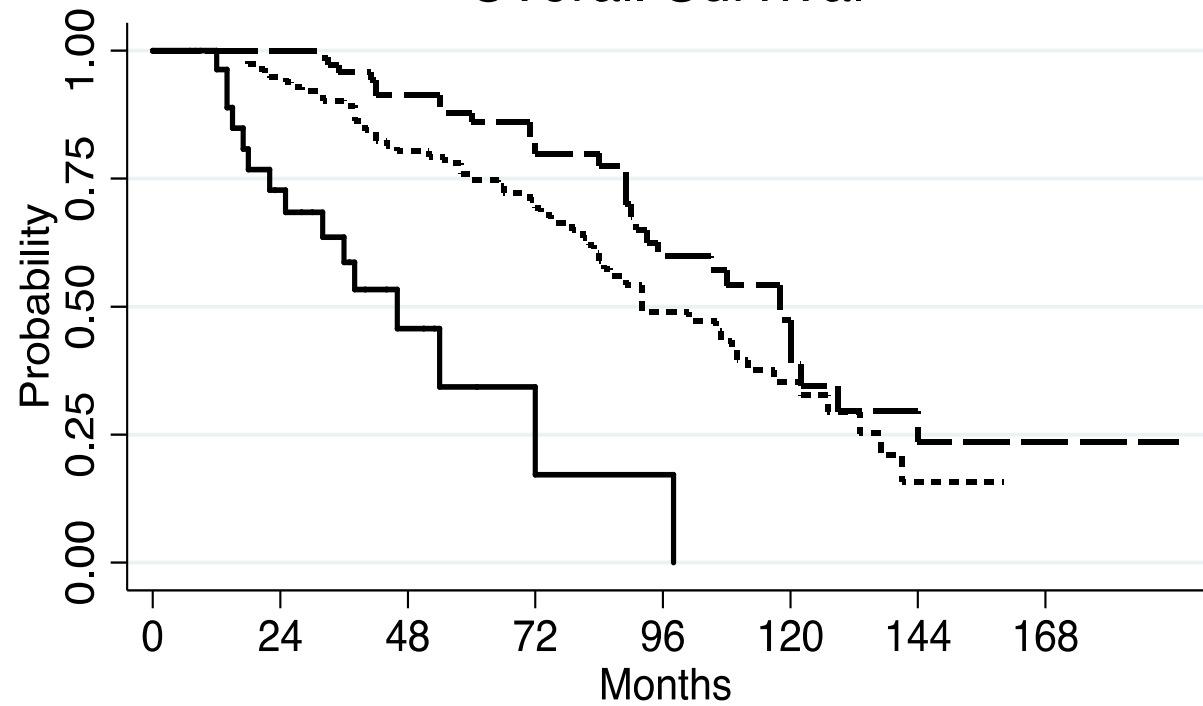
ICAM1, IL1A, IL6, CXCL2, CXCL3,  
CCL20, PTGDS...

**Functional analysis:**  
genes involved in the **inflammatory response**, in the **communication between innate and adaptive immune cells** and a **deregulation of pathways involved in metabolism**

NPTX1, ITGA8,  
TMEM119

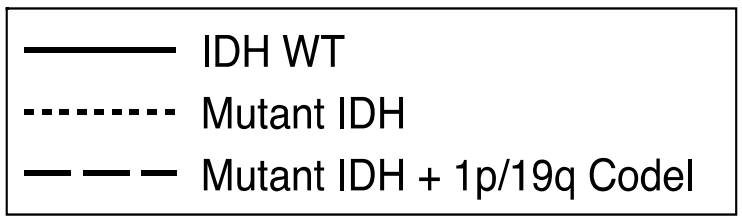
The hallmarks of cancer comprise  
six biological capabilities acquired during  
the multistep development of human tumors.

# Overall Survival



Number at risk

IDH WT	31	17	6	2	1	0	0	0
Mutant IDH	129	105	77	50	28	15	3	0
Mutant IDH + 1p/19q Code1	79	76	55	40	23	11	5	2





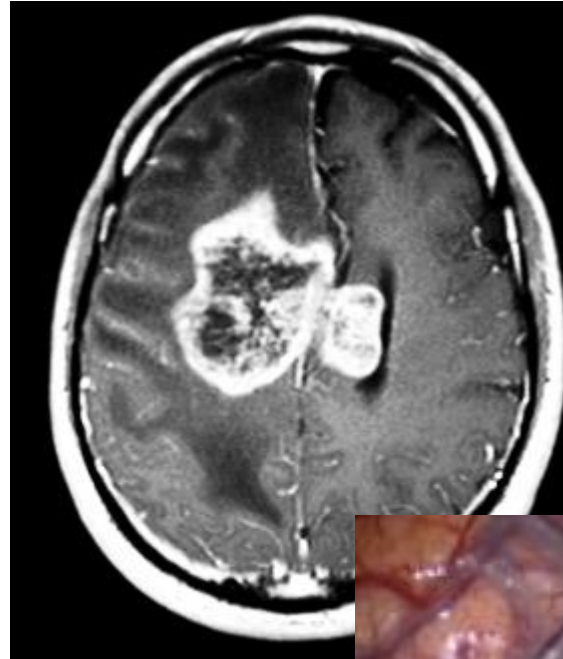
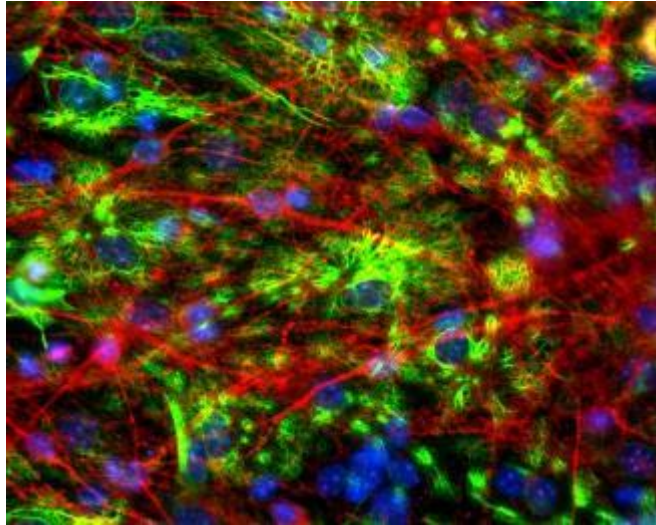
**The key questions in Neurosurgery:**

**The patient has to be operated?**

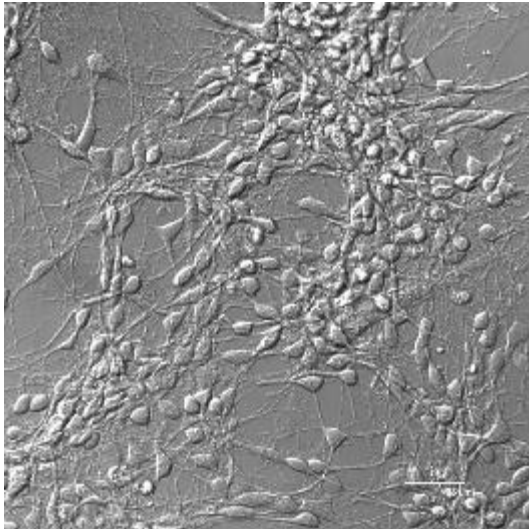
**If so how much brain has to be removed?**

**Can we avoid a real biopsy and use Artificial Intelligence?**

# Artificial Intelligence for Biomedical Images



To understand  
almost  
automatically  
this kind of  
biomedical  
images



# Clinical predictions from the data

LEARNING

Features



Ground  
Truth

Extract features containing sufficient  
information for reproducing the ground  
truth observation

# Clinical predictions from the data

**LEARNING**

Features



Ground  
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**PREDICTING**

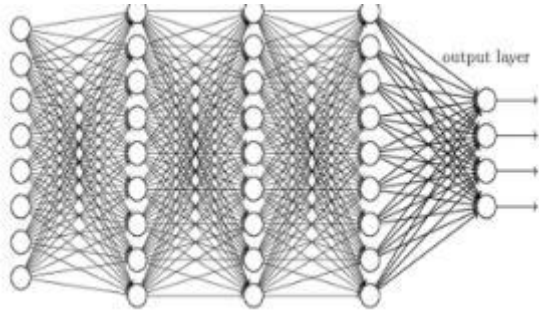
Features



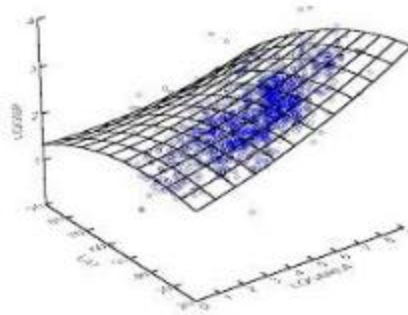
Prediction

# Which tool should we use?

Neural networks. Deep learning.



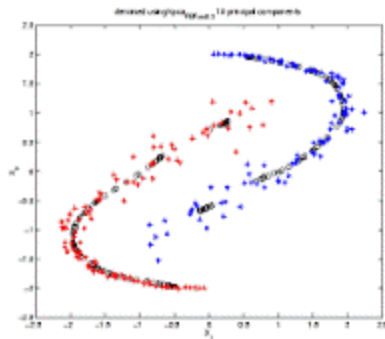
Multivariate regression.



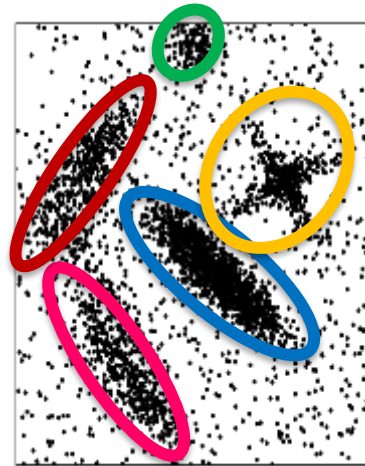
Bayesian inference

$$P(q|Y) = P(Y|q) P(q) / P(Y)$$

Kernel PCA

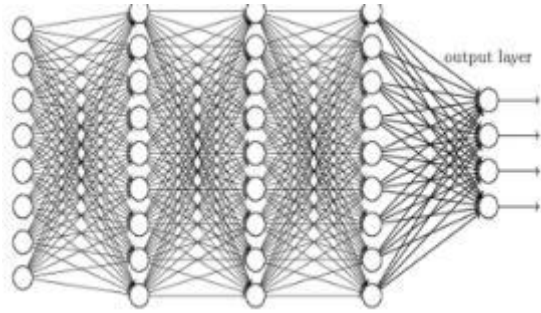


Clustering

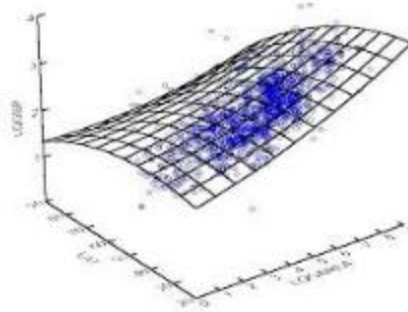


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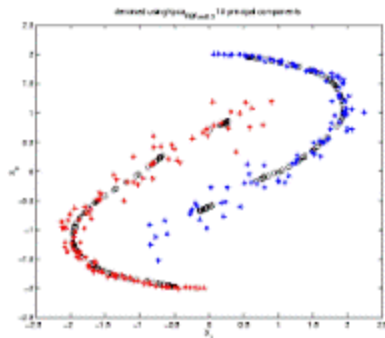
**Threats:**

- Irrelevant features (many)
- Inaccurate ground truth
- Censoring
- A relevant features is missing
- Too few patients
- .....

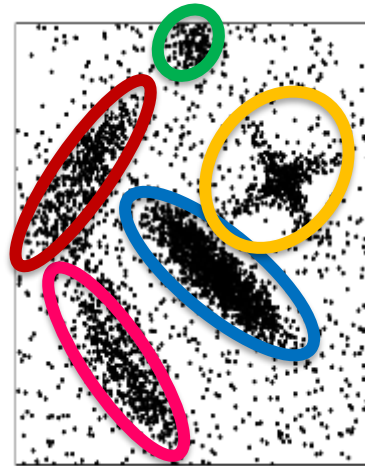
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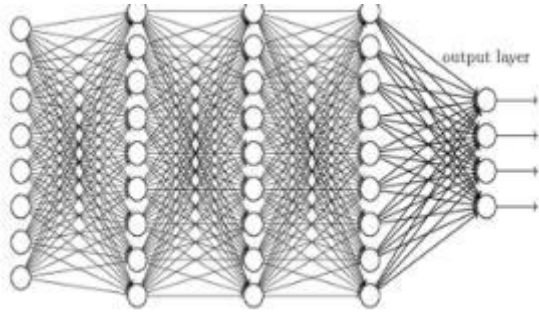
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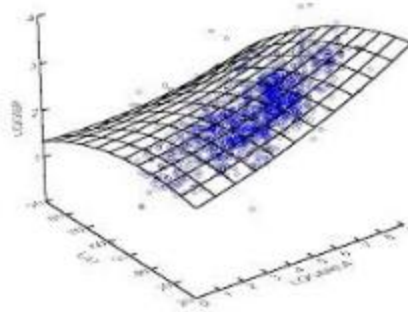


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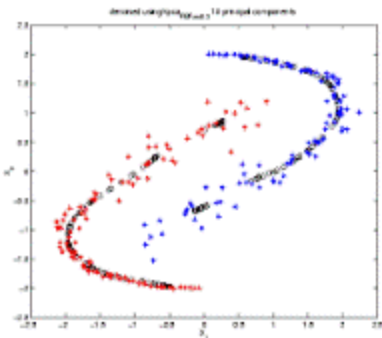
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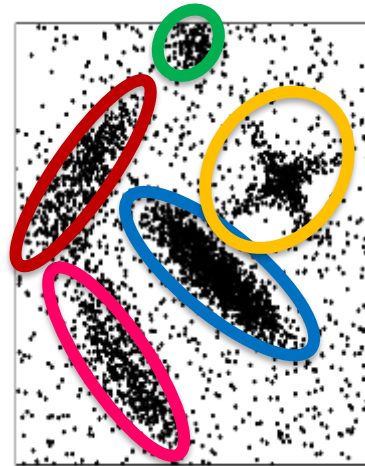
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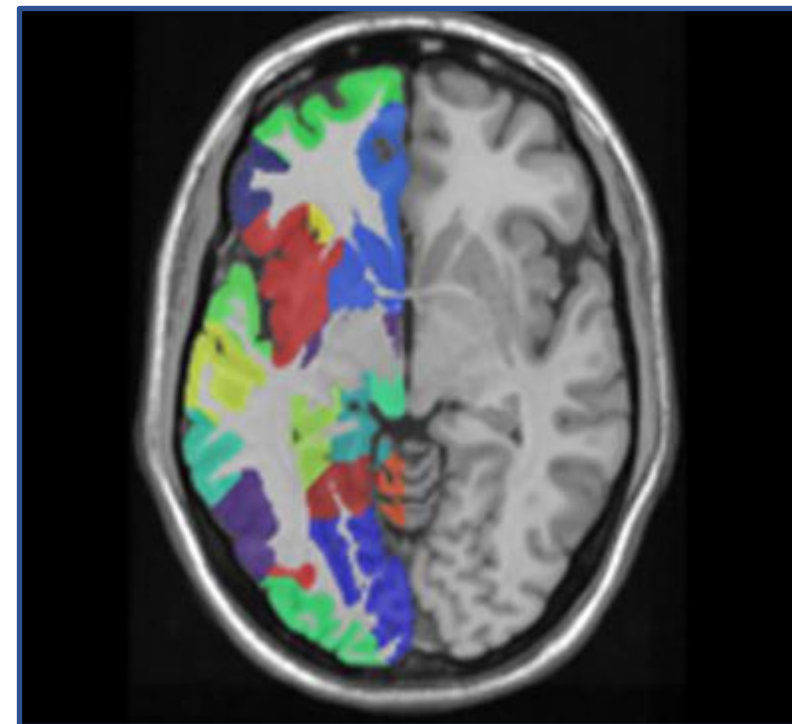
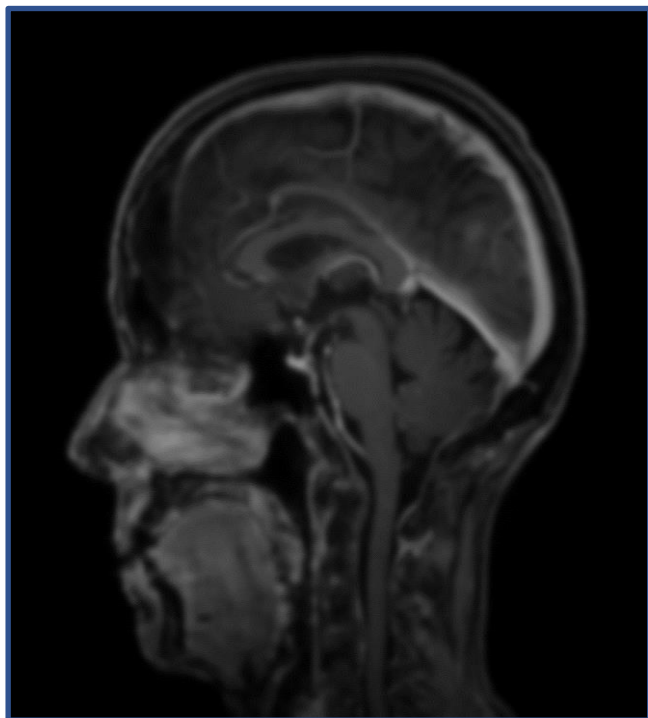
**Our goal:**

Finding the most threat-resistant prediction tool  
*for the specific task of  
the project* (virtual  
biopsy of gliomas)

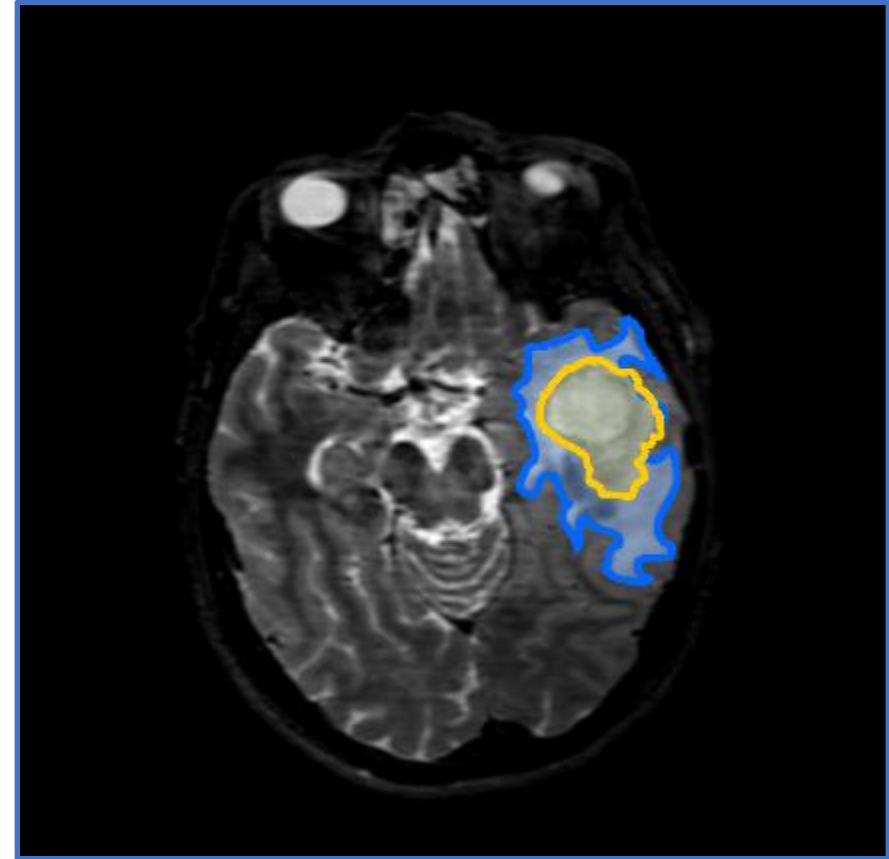
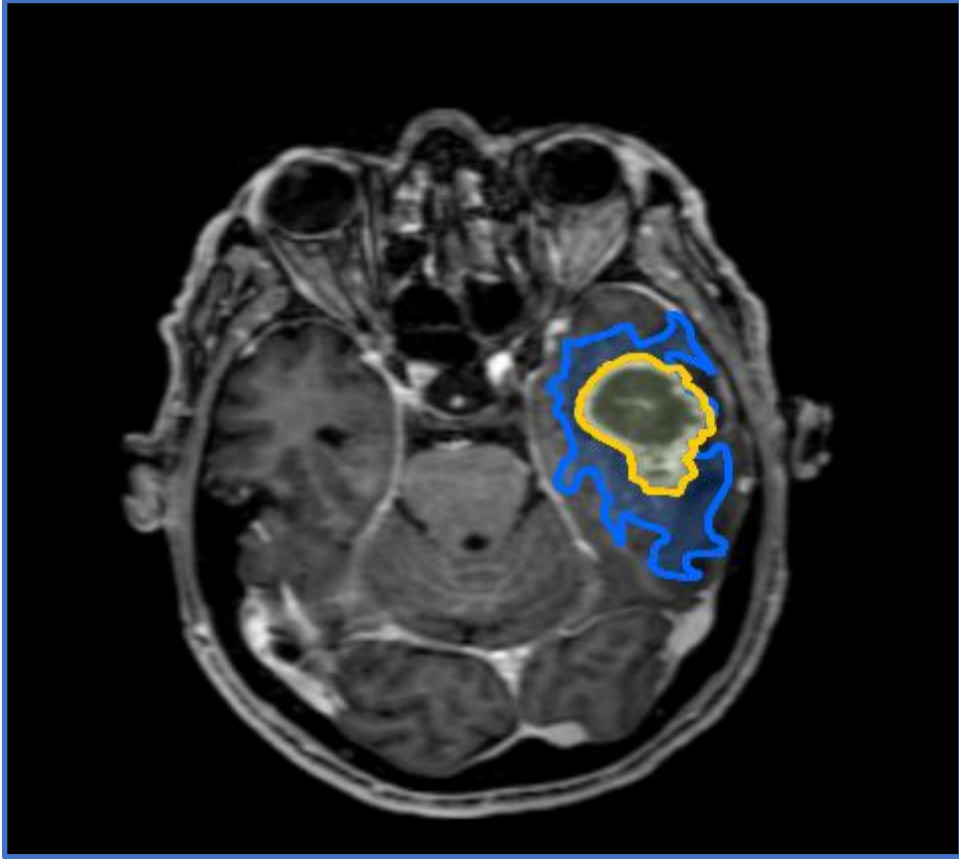
**What we have done so far**



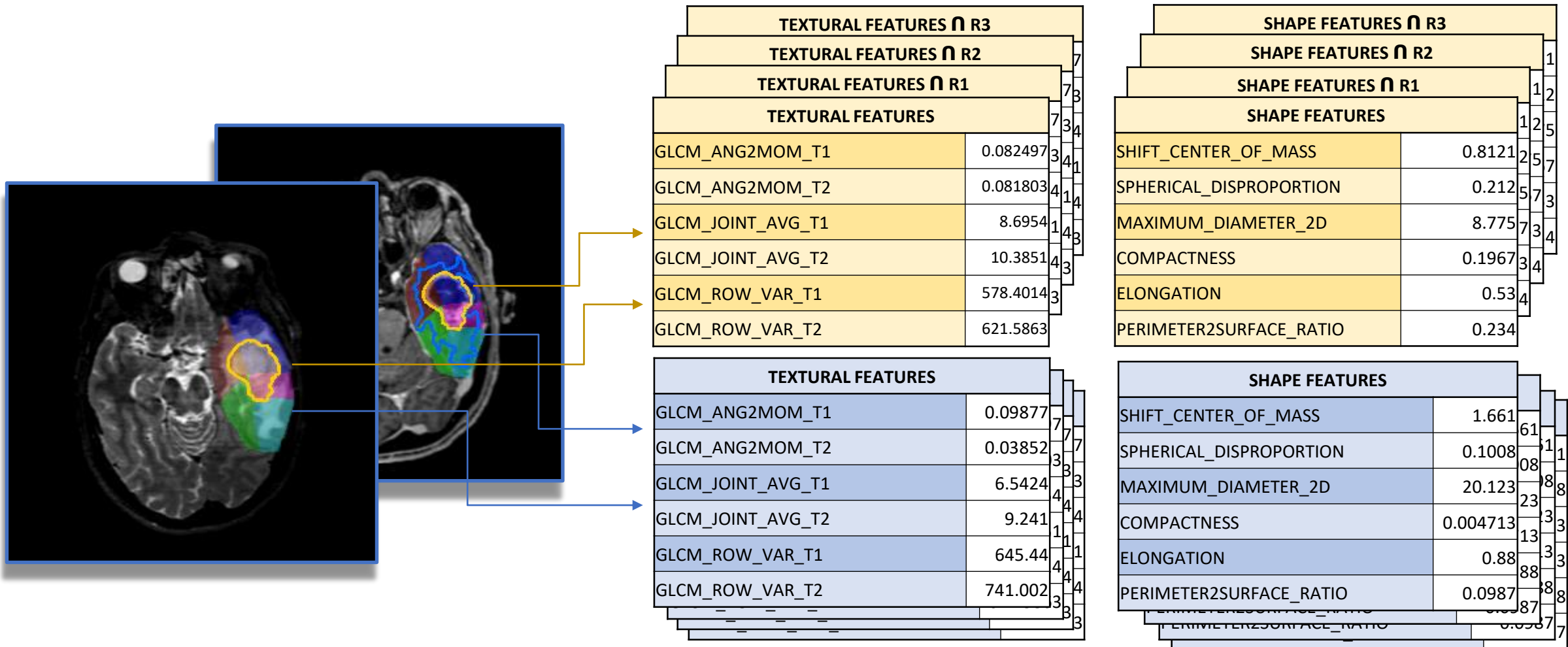
# Brain Regions Map



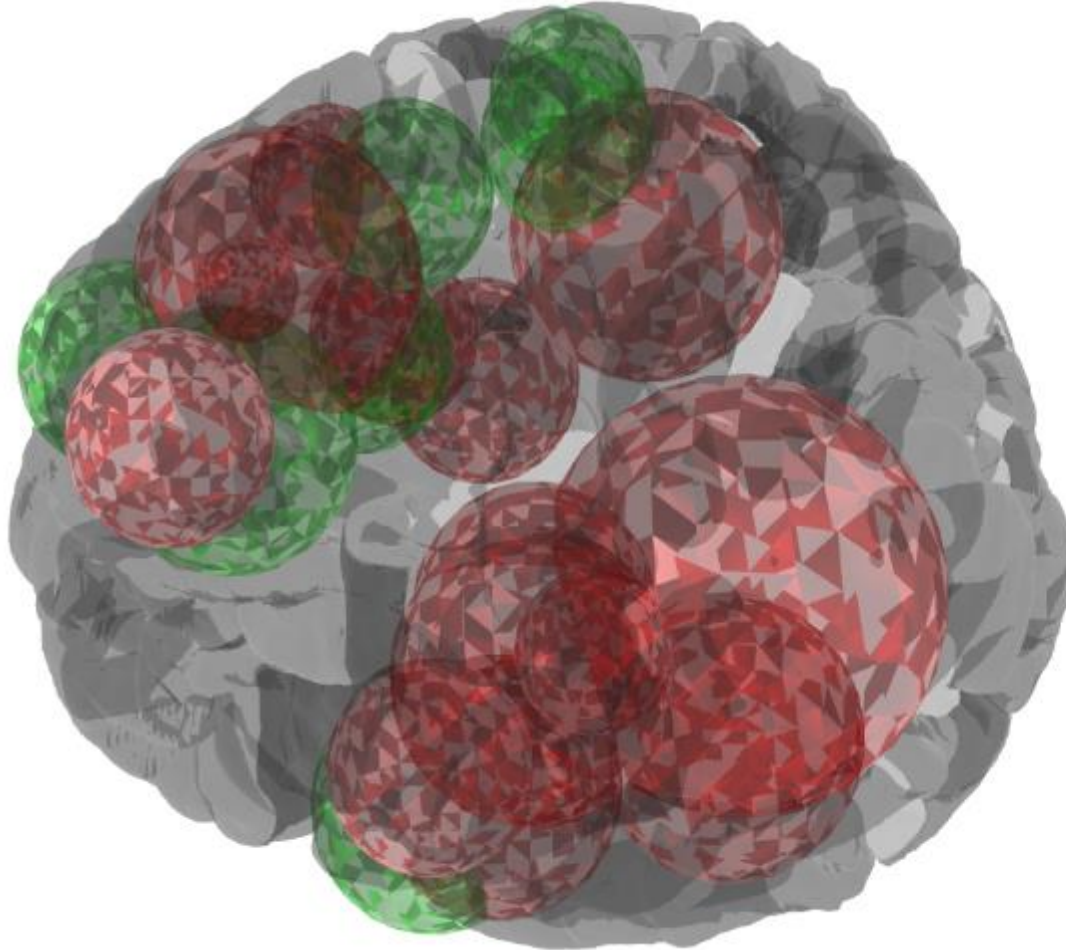
# Automatic Segmentation of Lesion and Edema



# Multimodal Feature Extraction for Virtual Biopsy



# Mapping of glioma from patients on a reference brain



**We can easily select:**

- **Survival time**
- **Various genomic clinical data**
- **Location of glioma**

# **What we plan to achieve: best suggestions**

- **For extent of removal (EOR)**
- **Combination of radiotherapy and chemotherapy**
- **Rehabilitation therapy**