Benchmarking Deep Learning Approaches for RANO Criteria Classification in Glioblastoma

Ana Matoso[1,2*], Catarina Passarinho[1], Marta P. Loureiro[1], José Maria Moreira[2], Pedro Vilela[3], Patrícia Figueiredo[1], Rita G Nunes[1]
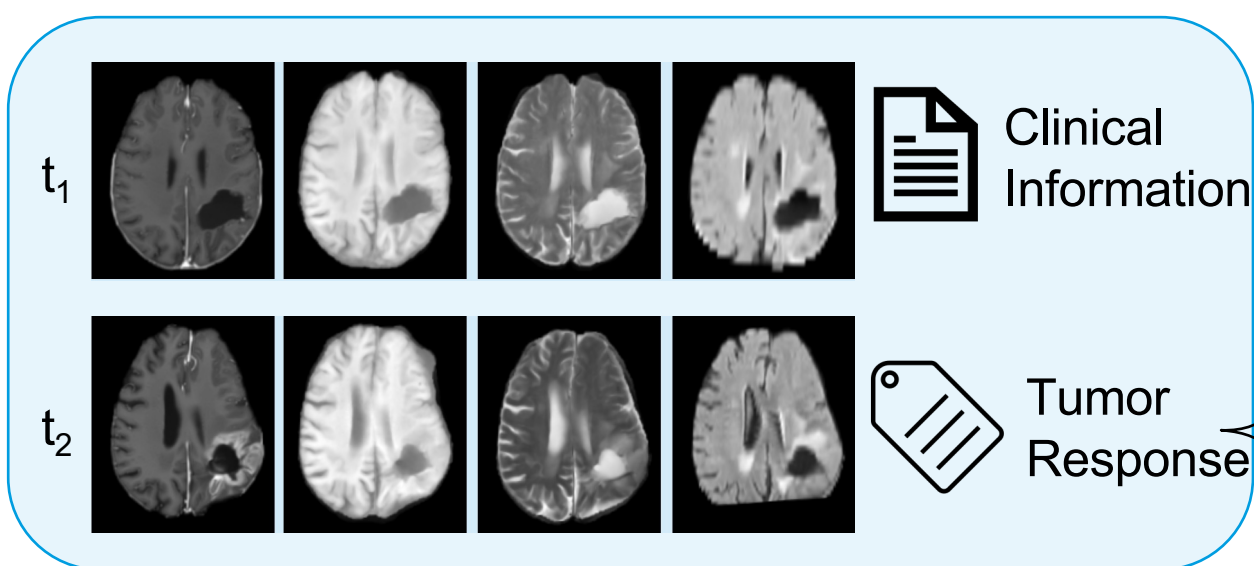
[1]Institute for Systems and Robotics – Lisboa and Department of Bioengineering, Instituto Superior Técnico, Portugal; [2]Learning Health, Hospital da Luz, Lisbon, Portugal; [3]Imaging Department, Hospital da Luz, Lisbon, Portugal;

- Glioblastoma is the most malignant brain cancer
- Longitudinal Assessment is needed
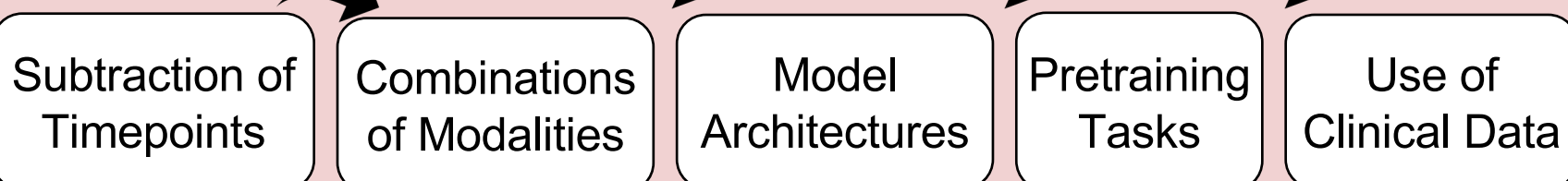- Patients do frequent scans to monitor disease

Response **A**ssessment in **N**euro-**O**ncology (**RANO**) criteria
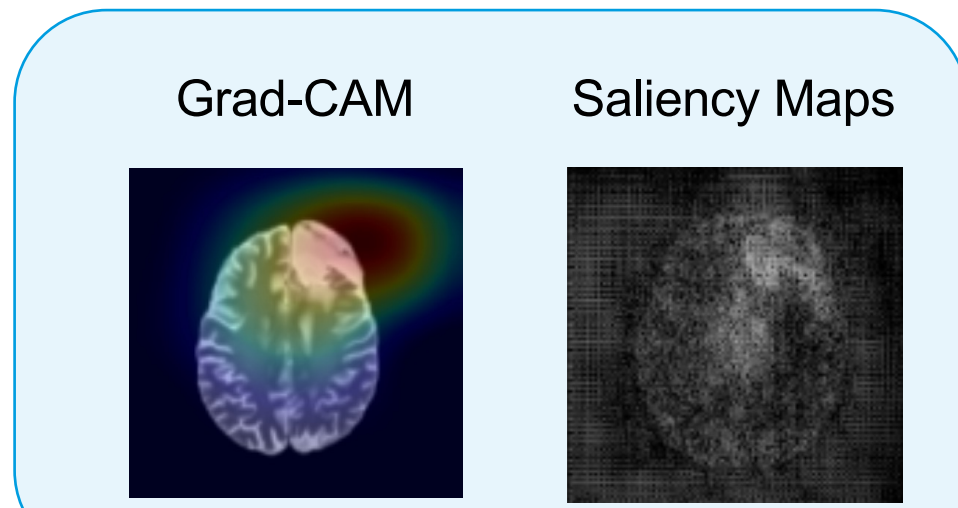
Data

Clinical Information

Tumor Response

Progressive Disease (PD)
Stable Disease (SD)
Partial Response (PR)
Complete Response (CR)

Training and Testing

Sequentially Tested Approaches (best option chosen at each stage):

Subtraction of Timepoints → Combinations of Modalities → Model Architectures → Pretraining Tasks → Use of Clinical Data

Explainability

Grad-CAM | Saliency Maps

Check the preprint

Results

Subtraction → **Modality** → **Architecture** → **Pretraining** → **Clinical Data**

Balanced Accuracy

F1-Score

Subtraction: Without, With
Modality: All, CT1, CT1+FLAIR, T1+FLAIR, T1+T2+FLAIR
Architecture: Densenet121, Densenet169, Densenet264, ViT, AlexNet3D
Pretraining: No Pretraining, Self-Supervised, MedMNIST, MedicalNet
Clinical Data: Without, With

☐ Best Option

Explainability examples

| | Ground Truth | Class PD | | | Class SD | | | Ground Truth | Class PR | | | Class CR | | |

Ground Truth — Class PD

T2 image (z=55, z=77, z=99)
Grad-CAM (Predicted class)
Saliency Map (Predicted class)

Probability
Classes (Predicted | Ground Truth)	PD	SD	PR	CR
Probability (%)	_17.1_	22.6	16.6	**43.7**

Class SD

T2 image (z=55, z=77, z=99)

Classes	PD	SD	PR	CR
Probability (%)	18.6	**_45_**	16.8	19.6

Ground Truth — Class PR

T2 image (z=66, z=77, z=88)

Classes (Predicted | Ground Truth)	PD	SD	PR	CR
Probability (%)	19.3	**45.3**	_21.3_	14

Class CR

T2 image (z=44, z=66, z=77)

Classes	PD	SD	PR	CR
Probability (%)	8.7	13.8	8.3	**69.2**