

Which MRI modalities are helpful for treatment response classification in glioblastomas?

Ana Matoso^{1,2*}, Catarina Passarinho¹, Marta P. Loureiro¹, José Maria Moreira², Pedro Vilela³, Patrícia Figueiredo¹, Rita G Nunes¹

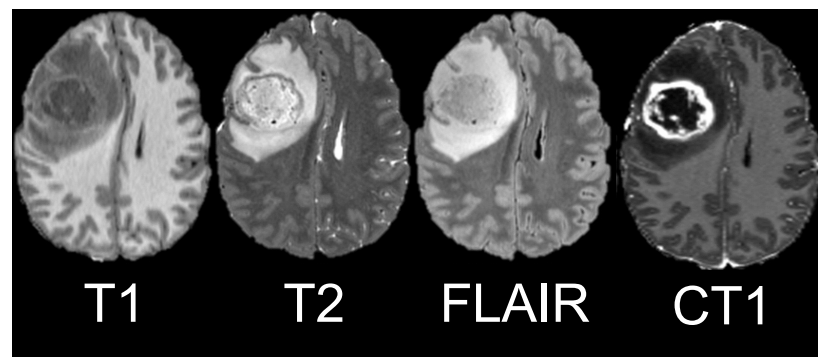
¹Institute for Systems and Robotics – Lisboa and Department of Bioengineering, Instituto Superior Técnico, University of Lisbon, Portugal;

²Learning Health, Hospital da Luz, Luz Saúde, Lisbon, Portugal; ³Imaging Department, Hospital da Luz, Luz Saúde, Lisbon, Portugal;

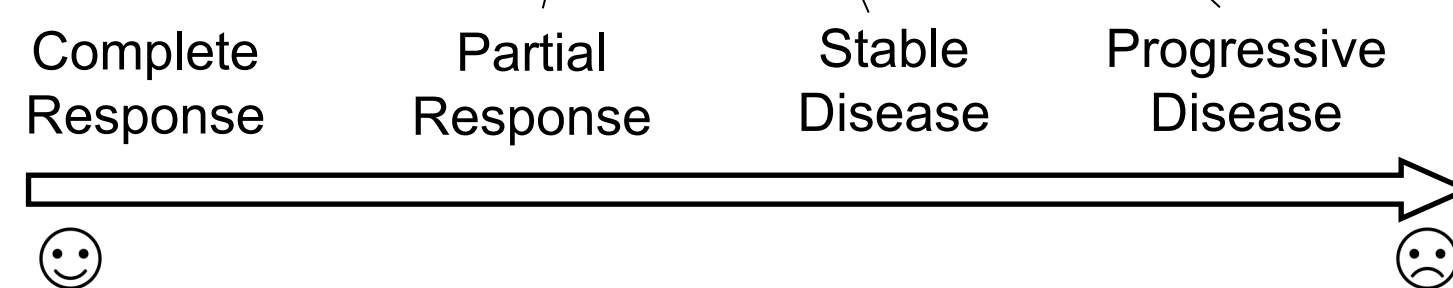
*anamatoso@tecnico.ulisboa.pt

Introduction

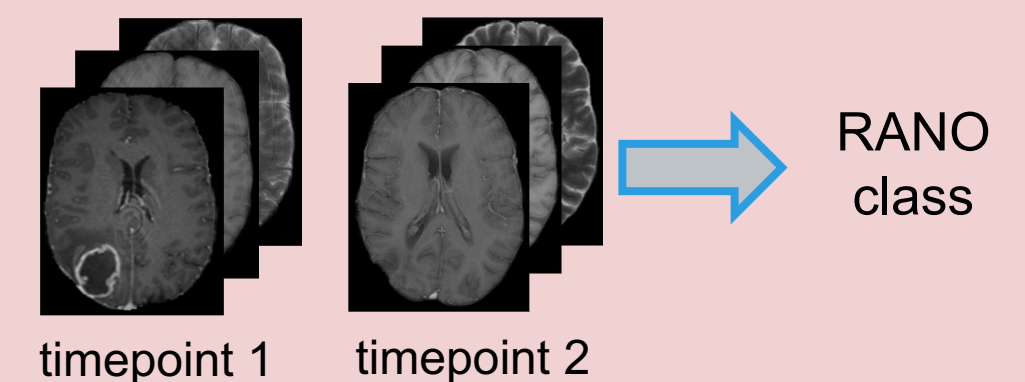
- **Glioblastoma** is the most malignant type of brain tumor¹
- Frequent MRI scans are done to assess **treatment response**²



Response Assessment in Neuro-Oncology (RANO) criteria³

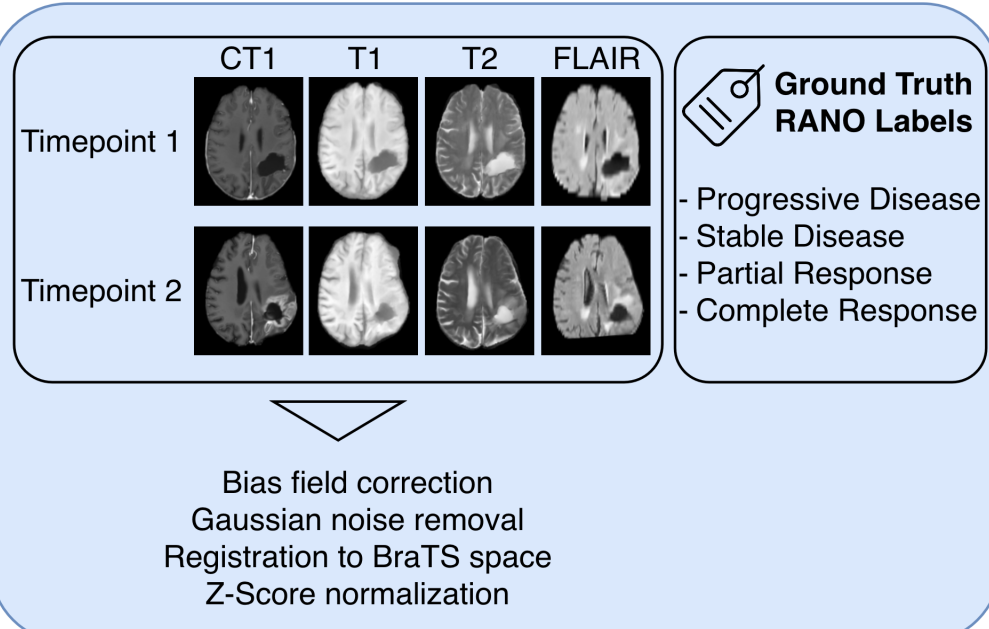


GOAL: Test different modality MRI combinations for RANO criteria classification



Methods

Data Preprocessing



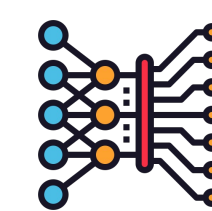
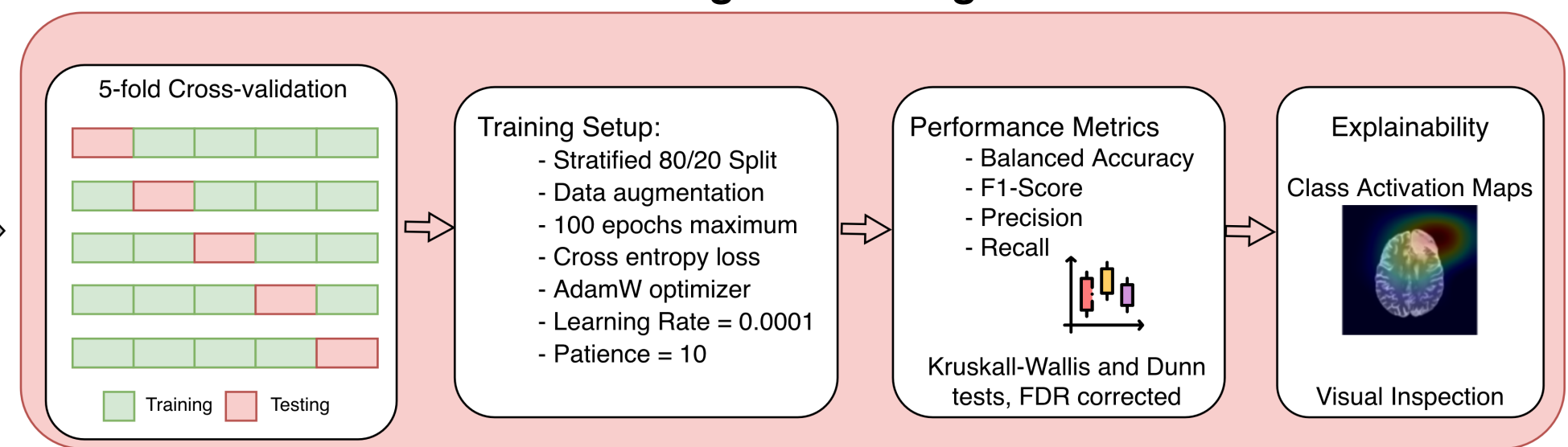
Data Selection

Modality Combinations	Number of timepoints	Classes Distribution			
CT1+T1+T2+FLAIR	337	228	66	20	23
T1+T2+FLAIR	338	229	66	20	23
T1+FLAIR	338	229	66	20	23
CT1+FLAIR	344	235	66	20	23
CT1+T2	351	238	68	20	25
CT1	355	242	68	20	25

Progressive Disease Stable Disease
Partial Response Complete Response

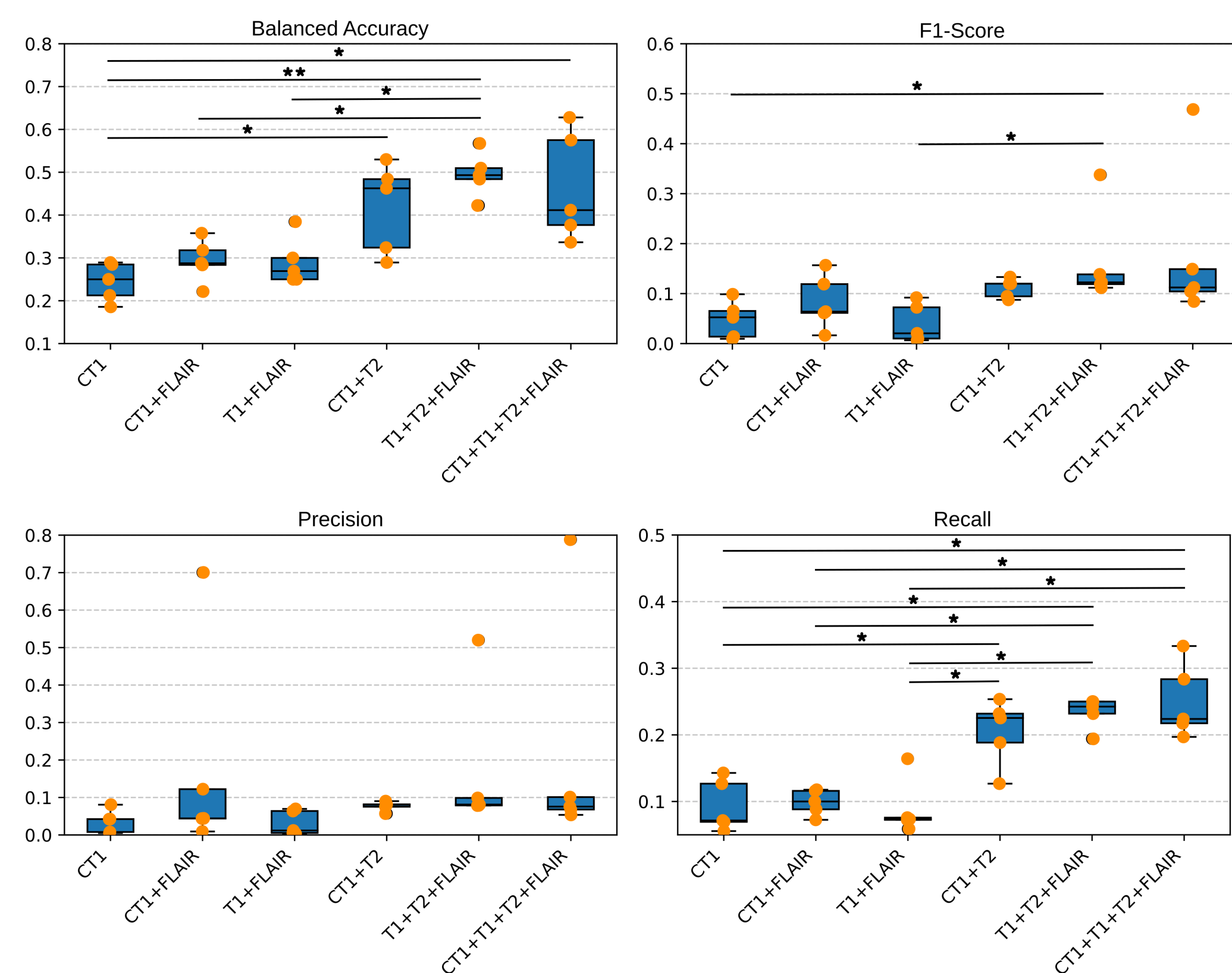
Selection of consecutive timepoints with at least the specified modalities

Training and Testing

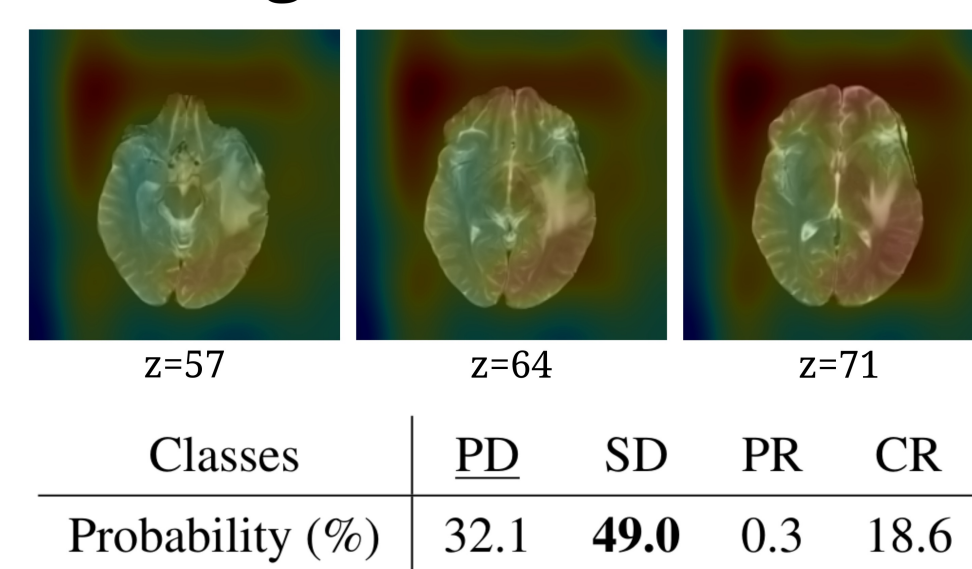


Using DenseNet264 from MONAI and PyTorch

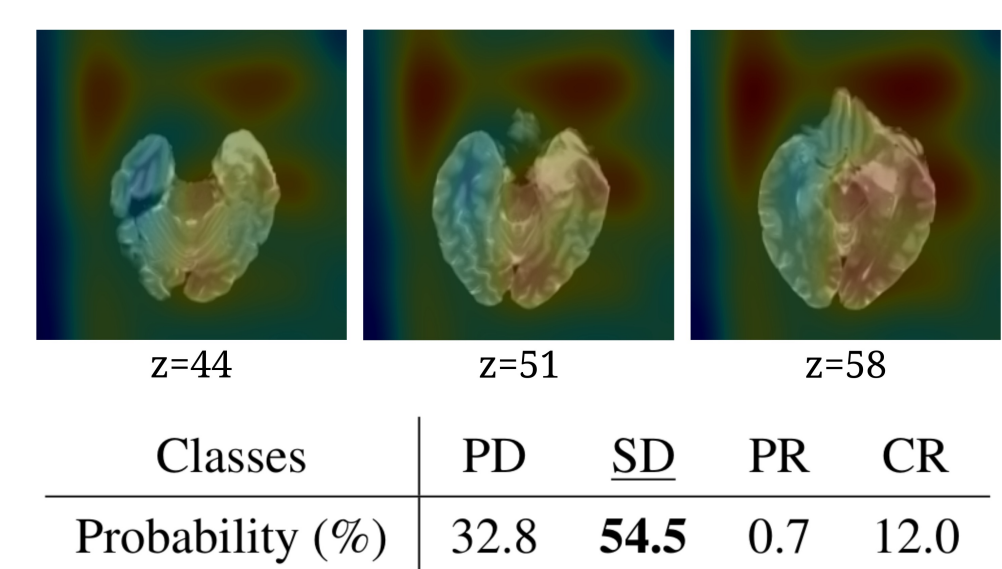
Results and Discussion



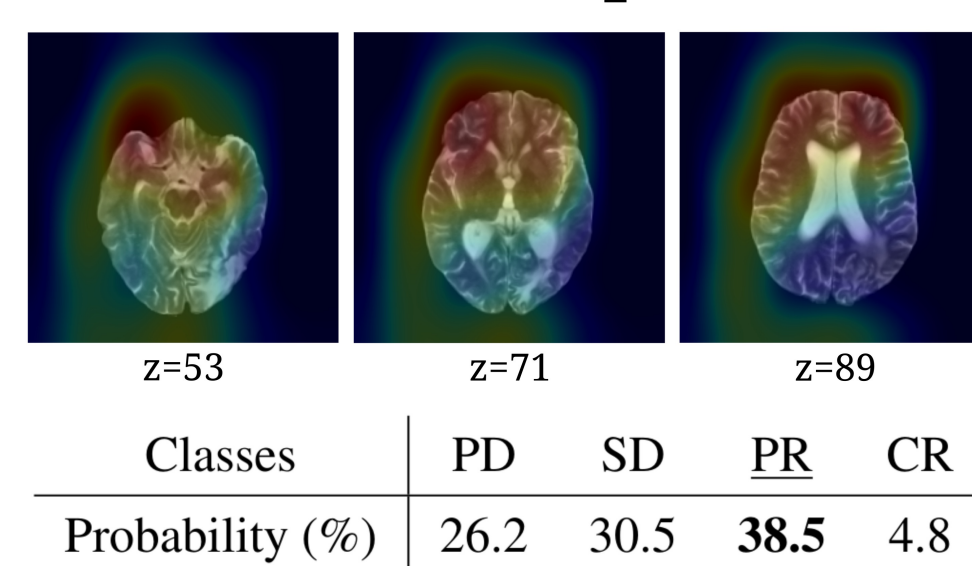
Progressive Disease



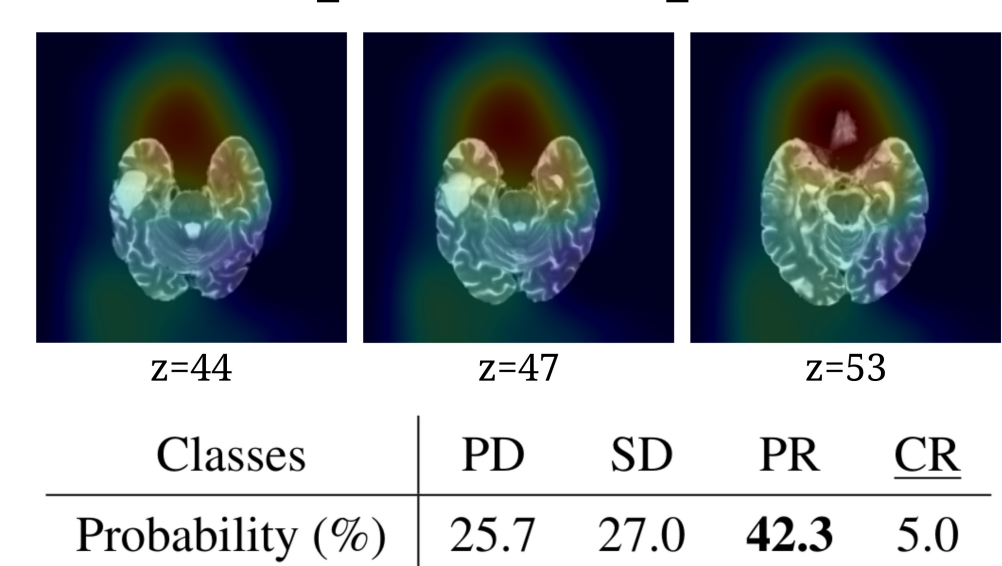
Stable Disease



Partial Response



Complete Response



PD=Progressive Disease; SD=Stable Disease

PR=Progressive Response; CR=Complete Response

- Using **all modalities** yielded the **best performance**: Balanced Accuracy = 62%
- No significant difference between using all modalities and **T1+T2+FLAIR** and **CT1+T2**, which presented **higher median** values of metrics
- More **advanced modalities**, namely diffusion and perfusion could provide complementary information

- Adding **T2** significantly **improved performance**
- In most Grad-CAM images the brain was highlighted, often the tumor region
- Applying a **bounding box** to the tumor region could help steering the model
- External Validation is needed
- Generating **synthetic data** could improve performance

Conclusion

- This study **benchmarked** the **automatic classification of RANO criteria** in a longitudinal dataset of glioblastoma
- Top performance was achieved using **all modalities** reaching a **Balanced Accuracy of 62%**
- Explainability methods highlighted the tumor regions in some cases