# STUDY OF GLIOBLASTOMA INTRA-TUMOR VARIATION WITH RADIOMICS

## Motivation:

Intra-tumor heterogeneity in glioblastoma (GBM) is a critical aspect that complicates the understanding and treatment of this aggressive brain cancer [1]. The diversity within a single tumor can significantly impact therapeutic resistance and disease progression [2]. A review of the current literature reveals various dimensions of this heterogeneity, including genetic, cellular, and microenvironmental variations that contribute to the complex nature of GBM. In the article "Seeing the GBM diversity spectrum" [3], authors discuss the extensive phenotypic and genetic heterogeneity within GBM. This diversity is a fundamental reason for the resistance of GBM to current therapies, making it a challenging disease to treat.
Another article from the AACR Journals [4] delves into dissecting intra-tumor heterogeneity in GBM. It emphasizes the importance of understanding the heterogeneous nature of GBM to develop more effective treatment strategies and discusses how the variation within tumors poses significant challenges for diagnosis, treatment, and prognosis.
The above articles are just a tiny fraction of the research that underscores the complexity of GBM and the is a clear need for continued research to unravel the intricacies of GBM intra-tumor heterogeneity. One of the possibilities to deepen the understanding of the intra-tumor variability is to study local radiomics – radiomic features extracted from the iso-volumetric tumor parts. Such an approach could potentially show the discrepancy between the different tumor regions and would help to unravel the heterogeneity. The detection of the statistically significant GBM intra-tumor variations based on radiomics will solidify our understanding of the GBM heterogeneity and may potentially revolutionize treatment strategies.

## Main Goal:

Analyze whether there is the possibility to detect statistically significant GLB intra-tumor heterogeneity based on the extracted radiomics features.

## Materials & Methods:

Student would work on the University Hospital Zurich glioblastoma cohort. They will perform all steps of the big data analysis: data preprocessing, feature extraction, statistical analysis, and evaluation of the achieved results. Local radiomics will be studied with the in-house developed software – Z-Rad. They will modify the existing software and develop personal scripts/programs for medical data analysis.

**Estimated duration:** 6 – 9 mo.

## Bonus Task (more feasible for the 9mo. MSc thesis):

When student completes the main part of the project, they can deepen the investigation of the radiomics features by diving into the deep learning-based features, which can be extracted with the help of neural networks like convolution neural networks. Deep learning approaches showed themselves as promising tools in many directions of medical physics, implementing them in the

radionics feature-based projects is an opportunity to implement the power of artificial intelligence in radiation oncology research settings.

**Requirements:**

- Solid knowledge of Python is mandatory;
- Knowledge of the different statistical and machine learning methods is prioritized;
- Knowledge of the basics of medical physics is beneficial.

**Resources:**

1. Leopoldo A. García-Montaño, Yamhilette Licón-Muñoz, Frank J. Martinez, Yasine R. Keddari, Michael K. Ziemke, Muhammad O. Chohan, Sara G.M. Piccirillo; Dissecting Intra-tumor Heterogeneity in the Glioblastoma Microenvironment Using Fluorescence-Guided Multiple Sampling. *Mol Cancer Res* 1 August 2023; 21 (8): 755–767. https://doi.org/10.1158/1541-7786.MCR-23-0048

2. Prasetyanti, P.R., Medema, J.P. Intra-tumor heterogeneity from a cancer stem cell perspective. *Mol Cancer* **16**, 41 (2017). https://doi.org/10.1186/s12943-017-0600-4

3. Hubert, C.G., Lathia, J.D. Seeing the GBM diversity spectrum. *Nat Cancer* **2**, 135–137 (2021). https://doi.org/10.1038/s43018-021-00176-x

4. Leopoldo A. García-Montaño, Yamhilette Licón-Muñoz, Frank J. Martinez, Yasine R. Keddari, Michael K. Ziemke, Muhammad O. Chohan, Sara G.M. Piccirillo; Dissecting Intra-tumor Heterogeneity in the Glioblastoma Microenvironment Using Fluorescence-Guided Multiple Sampling. *Mol Cancer Res* 1 August 2023; 21 (8): 755–767. https://doi.org/10.1158/1541-7786.MCR-23-0048