Scope

BraTS has always been focusing on the evaluation of state-of-the-art methods for the segmentation of brain tumors in multimodal magnetic resonance imaging (MRI) scans. BraTS 2018 utilizes multi-institutional pre-operative MRI scans and focuses on the segmentation of intrinsically heterogeneous (in appearance, shape, and histology) brain tumors, namely gliomas. Furthemore, to pinpoint the clinical relevance of this segmentation task, BraTS18 also focuses on the prediction of patient overall survival, via integrative analyses of radiomic features and machine learning algorithms

1 Clinical Relevance

Gliomas are the most common primary brain malignancies, with different degrees of aggressiveness, variable prognosis and various heterogeneous histological sub-regions, i.e. peritumoral edema, necrotic core, enhancing and non-enhancing tumor core. This intrinsic heterogeneity of gliomas is also portrayed in their imaging phenotype (appearance and shape), as their subregions are described by varying intensity profiles disseminated across multimodal MRI scans, reflecting varying tumor biological properties. Due to this highly heterogeneous appearance and shape, segmentation of brain tumors in multimodal MRI scans is one of the most challenging tasks in medical image analysis.

There is a growing body of literature on computational algorithms addressing this important task. Unfortunately, open data sets for designing and testing these algorithms are not currently available, and private data sets differ so widely that it is hard to compare the different segmentation strategies that have been reported so far. Critical factors leading to these differences include, but not limited to, i) the imaging modalities employed, ii) the type of the tumor (GBM or LGG, primary or secondary tumors, solid or infiltratively growing), and iii) the state of disease (images may not only be acquired prior to treatment, but also post-operatively and therefore show radiotherapy effects and surgically-imposed cavities).

2 Tasks

2.1 Task 1: Segmentation of gliomas in pre-operative MRI scans

he participants are called to address this task by using the provided clinically-acquired training data to develop their method and produce segmentation labels of the different glioma subregions. The sub-regions considered for evaluation are: 1) the "enhancing tumor" (ET), 2) the "tumor core" (TC), and 3) the "whole tumor" (WT) [see figure below]. The ET is described by areas that show hyper-intensity in T1Gd when compared to T1, but also when compared to healthy white matter in T1Gd. The TC describes the bulk of the tumor, which is what is typically resected. The TC entails the ET, as well as the necrotic (fluid-filled) and the non-enhancing (solid) parts of the tumor. The appearance of the necrotic (NCR) and the non-enhancing (NET) tumor core is typically hypo-intense in T1-Gd when compared to T1. The WT describes the complete extent of the disease, as it entails the TC and the peritumoral edema (ED), which is typically depicted by hyper-intense signal in FLAIR.

The labels in the provided data are: 1 for NCR NET, 2 for ED, 4 for ET, and 0 for everything else.

2.2 Task 2: Prediction of patient overall survival (OS) from pre-operative scans

Once the participants produce their segmentation labels in the pre-operative scans, they will be called to use these labels in combination with the provided multimodal MRI data to extract imaging/radiomic features that they consider appropriate, and analyze them through machine learning algorithms, in an attempt to predict patient OS. The participants do not need to be limited to volumetric parameters, but can also consider intensity, morphologic, histogram-based, and textural features, as well as spatial information, and glioma diffusion properties extracted from glioma growth models.

Predicted survival status only for subjects with resection status of GTR (i.e., Gross Total Resection). The participants are called to upload a .csv file with the subject ids and the predicted survival values into CBICA's Image Processing Portal for evaluation.

2.3 Data Description Overview

The datasets used in this year's challenge have been updated, since BraTS'16, with more routine clinically-acquired 3T multimodal MRI scans and all the ground truth labels have been manually-revised by expert board-certified neuroradiologists.

Ample multi-institutional routine clinically-acquired pre-operative multimodal MRI scans of glioblastoma (GBM/HGG) and lower grade glioma (LGG), with pathologically confirmed diagnosis and available OS, will be provided as the training, validation and testing data for this years BraTS challenge.

Validation data will be released on July 1, through an email pointing to the accompanying leaderboard. This, will allow participants to obtain preliminary results in unseen data and also report it in their submitted papers, in addition to their cross-validated results on the training data. The ground truth of the validation data will not be provided to the participants, but multiple submissions to the online evaluation platform (CBICA's IPP) will be allowed.

Finally, all participants will be presented with the same test data, which will be made available through email during 30 July-20 August and for a limited controlled time-window (48h), before the participants are required to upload their final results in CBICA's IPP. The top-ranked participating teams will be invited before the end of August to prepare slides for a short oral presentation of their method during the BraTS challenge.

2.4 Imaging Data Description

All BraTS multimodal scans are available as NIfTI files (.nii.gz) and describe a) native (T1) and b) post-contrast T1-weighted (T1Gd), c) T2-weighted (T2), and d) T2 Fluid Attenuated Inversion Recovery (FLAIR) volumes, and were acquired with different clinical protocols and various scanners from multiple (n=19) institutions, mentioned as data contributors here.

All the imaging datasets have been segmented manually, by one to four raters, following the same annotation protocol, and their annotations were approved by experienced neuroradiologists. Annotations comprise the GD-enhancing tumor (ET label 4), the peritumoral edema (ED label 2), and the necrotic and non-enhancing tumor core (NCR/NET label 1), as described in the BraTS reference paper, published in IEEE Transactions for Medical Imaging (also see Fig.1). The provided data are distributed after their pre-processing, i.e. co-registered to the same anatomical template, interpolated to the same resolution (1 mm^3)$and skull-stripped$.

2.5 Survival Data Description

The overall survival (OS) data, defined in days, will be included in a comma-separated value (.csv) file with correspondences to the pseudo-identifiers of the imaging data. The .csv file will also include the age of patients, as well as the resection status. Note that only subjects with resection status of GTR (i.e., Gross Total Resection) will be evaluated, and you are only expected to send your predicted survival data for those subjects.