

# Multi-Institutional Paired Expert Segmentations and Radiomic Features of the Ivy GAP Dataset (IvyGAP-Radiomics)

## Summary

This dataset comprises two paired sets of expert segmentation labels for tumor sub-compartments of the pre-operative multi-institutional scans of the [Ivy Glioblastoma Atlas Project \(Ivy GAP\) collection of The Cancer Imaging Archive \(TCIA\)](#). These labels have been approved by independent expert board-certified neuroradiologists at the Hospital of the University of Pennsylvania and at Case Western Reserve University. Furthermore, for each of the paired sets of approved labels, a diverse comprehensive panel of radiomic features is provided, along with their corresponding skull-stripped and co-registered multi-parametric magnetic resonance imaging (mpMRI) volumes (i.e. native (T1) and post-contrast T1-weighted (T1-Gd), T2, T2-FLAIR), in NIfTI format. The pre-operative mpMRI scans were identified in the Ivy GAP collection via radiological assessment. These scans were initially skull-stripped and co-registered to a common anatomical atlas (provided within this dataset), before their tumor segmentation labels were produced following a consistent annotation protocol across the two institutions. The final labels were used to extract a rich panel of radiomic features through the [Cancer Imaging Phenomics Toolkit \(CaPTk\)](#), comprising intensity, volumetric, morphologic, histogram-based, and textural parameters compliant with the [Image Biomarker Standardisation Initiative \(IBSI\)](#), as well as through a [3D Slicer extension for the novel COLLAGE feature family](#). Radiomic features robust to variability in segmentations were then identified following a statistical robustness analysis.

The approved expert segmentation labels should enable quantitative computational and clinical studies without the need to repeat manual annotations, whilst allowing for comparison across studies. They can also serve as a set of manually-annotated gold standard labels for performance evaluation in computational competitions, such as the [International Brain Tumor Segmentation \(BraTS\) challenge](#). The provided panel of robust radiomic features may facilitate research integrative of the molecular characterization offered by the Allen Institute, and hence allow associations with molecular markers (radiogenomics), clinical outcomes, treatment responses and other endpoints, by researchers without sufficient computational background to extract such features. The complete reproducibility analysis can be found in the associated publication citation found in the "Citations & Data Usage Policy".

Specifically, the released data comprises of 1) the available expert segmentation labels of the various tumor sub-compartments performed at each institution (i.e. 34 subjects segmented at UPenn, 34 subjects segmented at CWRU), with a total of 37 subjects (including 31 paired segmentations performed at both UPenn and CWRU), in the original space they were created (i.e., SRI for UPenn and MNI for CWRU), with 2) their corresponding co-registered and skull-stripped structural mpMRI scans (i.e., in SRI for UPenn and in MNI for CWRU), 3) the paired expert segmentation labels that were available for the 31 subjects, all being co-registered in the SRI atlas, 4) the corresponding SRI and MNI anatomical atlas files that we employed, 5) the complete set of 11,700 extracted radiomic features per subject, for each of the 31 included subjects, 6) the metadata relating to the metrics we utilized for the evaluation of the inter-rater agreement, as well as 7) the parameters used for the radiomic feature extraction and the correlation analysis results for identifying robust radiomic features, for the 28 subjects, and finally 8) the specific identified robust/reproducible radiomic features.

All image related files are provided in NIfTI format, while the metadata files are provided in tabular formats (.xlsx and .csv).

MNI atlas: see (Montreal Neurological Institute, <https://mcin.ca/research/neuroimaging-methods/atlas/> )

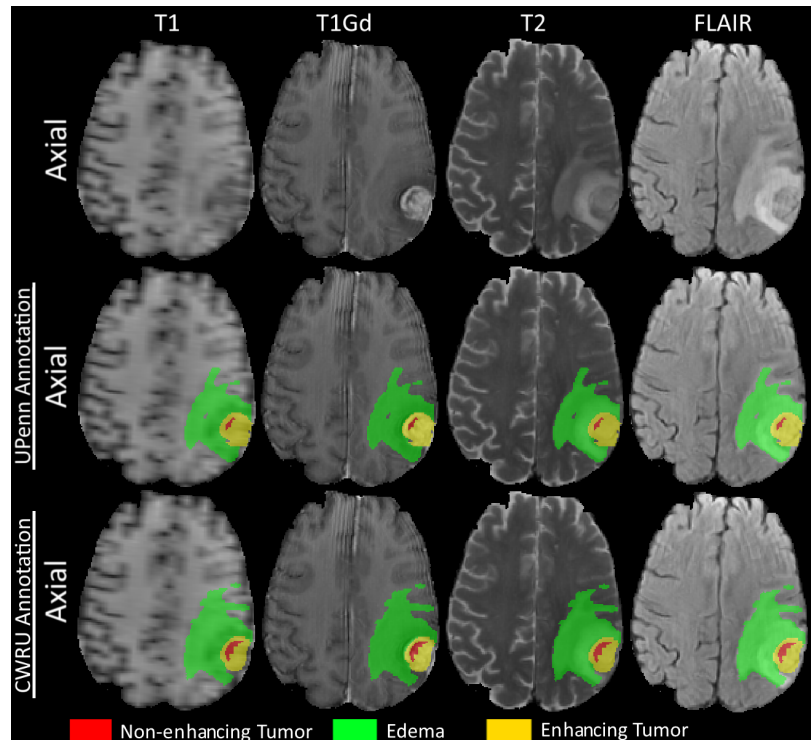
SRI atlas: see (T. Rohlfing, et al. (2010) DOI: [10.1002/hbm.20906](https://doi.org/10.1002/hbm.20906) , [PMC2915788](https://pubmed.ncbi.nlm.nih.gov/2915788/))

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## Data Access

### Data Access

Data Type	Download all or Query/Filter	License
MNI-atlas MR/Segmentations, CWRU annotations only, Images (NIFTI, 131 files, 669 MB)	<a href="#">Download</a> (Download and apply the <a href="#">IBM-Aspera-Connect plugin</a> to your browser to retrieve this faspex package)	CC BY 3.0
SRI-atlas MR/Segmentations, UPenn & CWRU annotations, Images (NIFTI, 202 files, 469 MB)	<a href="#">Download</a> (Download and apply the <a href="#">IBM-Aspera-Connect plugin</a> to your browser to retrieve this faspex package)	CC BY 3.0
Subject Meta-data (csv, 7 KB)	<a href="#">Download</a>	CC BY 3.0
Radiomic Features and Reproducibility Evaluation on SRI data (zip, 17.2 MB)	<a href="#">Download</a>	CC BY 3.0

### Collections Used in this Third Party Analysis

Below is a list of the Collections used in these analyses:

Source Image Data	Download or Query/Filter	License
Corresponding Original MR Images from IvyGAP (130.4 GB)	<a href="#">Download Search</a> (Download requires the <a href="#">NBIA Data Retriever</a> and permission)	TCIA Restricted

- [Ivy Glioblastoma Atlas Project \(IvyGAP\)](#)

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#### Detailed Description

### Detailed Description

	Radiology Imaging Statistics
Modalities	MR, segmentation
Number of Participants	37
Number of Studies	
Number of Series	
Number of Images	332
Images Size (GB)	1.07 GB

The data comprises of expert segmentation labels from each institution (i.e. 34 subjects from both UPenn and CWRU, with a total of 37), along with the corresponding co-registered and skull-stripped structural MRI scans in the space they were created (i.e., SRI for UPenn and MNI for CWRU), and the expert segmentation labels for the 31 common subjects co-registered in the SRI atlas. For brevity, we have included the corresponding SRI and MNI anatomical atlas files that we employed, the complete set of extracted radiomic features per subject for each of the 31 included subjects, along with the parameters used for the radiomic feature extraction and the correlation analysis results for identifying robust radiomic features, and finally, the identified robust radiomic features.

#### Citations & Data Usage Policy

### Citations & Data Usage Policy

Users must abide by the [TCIA Data Usage Policy and Restrictions](#). Attribution should include references to the following citations:



#### Data Citation

Pati, S., Verma, R., Akbari, H., Bilello, M., Hill, V.B., Sako, C., Correa, R., Beig, N., Venet, L., Thakur, S., Serai, P., Ha, S.M., Blake, G.D., Shinohara, R.T., Tiwari, P., Bakas, S. (2020). Data from the **Multi-Institutional Paired Expert Segmentations and Radiomic Features of the Ivy GAP Dataset**. DOI: <https://doi.org/10.7937/9j41-7d44>.



#### Publication Citation

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#### TCIA Citation

Clark, K., Vendt, B., Smith, K., Freymann, J., Kirby, J., Koppel, P., Moore, S., Phillips, S., Maffitt, D., Pringle, M., Tarbox, L., & Prior, F. (2013). **The Cancer Imaging Archive (TCIA): Maintaining and Operating a Public Information Repository**. Journal of Digital Imaging, 26(6), 1045–1057. <https://doi.org/10.1007/s10278-013-9622-7>

## Other Publications Using This Data

TCIA maintains [a list of publications](#) which leverage TCIA data. If you have a manuscript you'd like to add please [contact TCIA's Helpdesk](#).

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Data Type	Download all or Query/Filter	License
Images (NIfTI, 669 MB) MNI MR/Segs (CWRU annotations only)	<a href="#">Download</a> (Download and apply the <a href="#">IBM-Aspera-Connect plugin</a> to your browser to retrieve this faspex package)	CC BY 3.0
Images (NIfTI, 469 MB) SRI MR/Segs (UPenn & CWRU annotations)	<a href="#">Download</a> (Download and apply the <a href="#">IBM-Aspera-Connect plugin</a> to your browser to retrieve this faspex package)	CC BY 3.0
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Radiomic Features and Reproducibility Evaluation on SRI data (zip, 17.2 MB)	<a href="#">Download</a>	CC BY 3.0

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#### Version 1: Updated 2020/04/14

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Subjects' Meta-data (csv, 7 KB)	<a href="#">Download</a>
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