

# Cancer Imaging Phenomics Toolkit (CaPTk):

## A Radio(geno)mics Platform for Quantitative Imaging Analytics on Computational Oncology



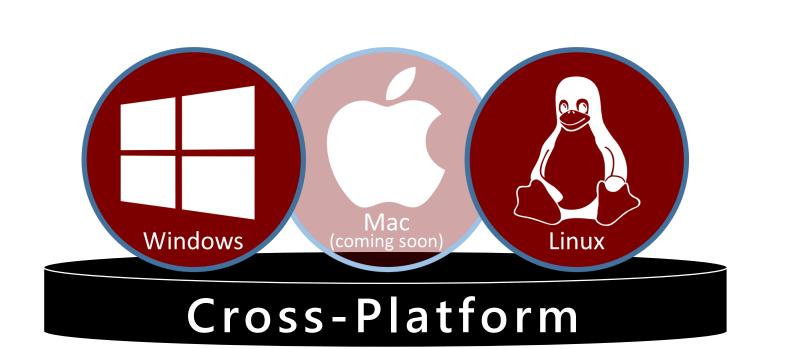
C. Davatzikos, D. Kontos, P. Yushkevich, R. Shinohara, Y. Fan, R. Verma Center for Biomedical Image Computing and Analytics (CBICA), University of Pennsylvania

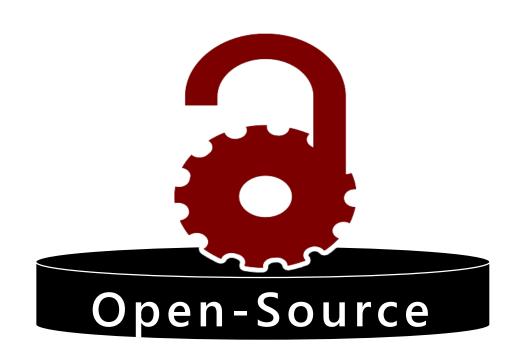
FUNDING: ITCR U24CA189523

**Primary Aim:** To enable swift and efficient translation of cutting-edge academic research into clinically useful tools<sup>[1]</sup>.

1. Clinical experts: facilitating use of complex algorithms for clinically relevant studies through a user-friendly interface.

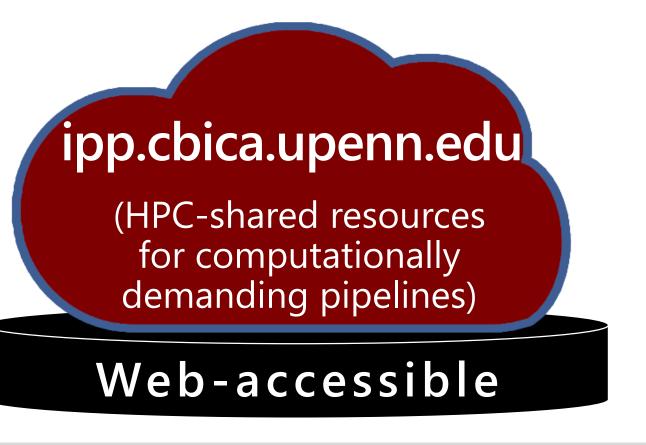
2. Computational experts: allowing for batch-processing and integration of new algorithms.

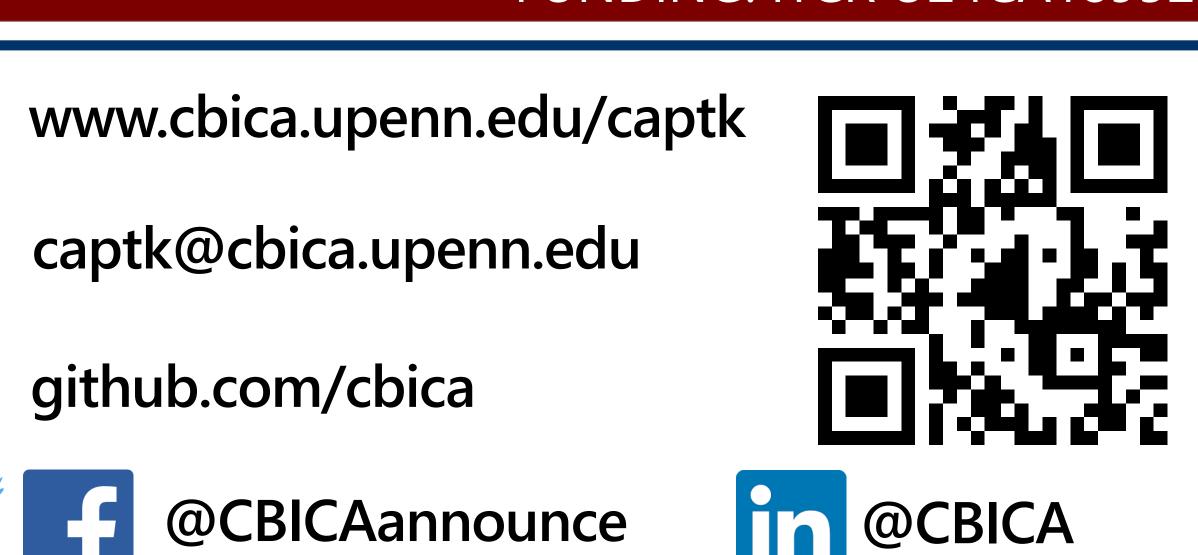






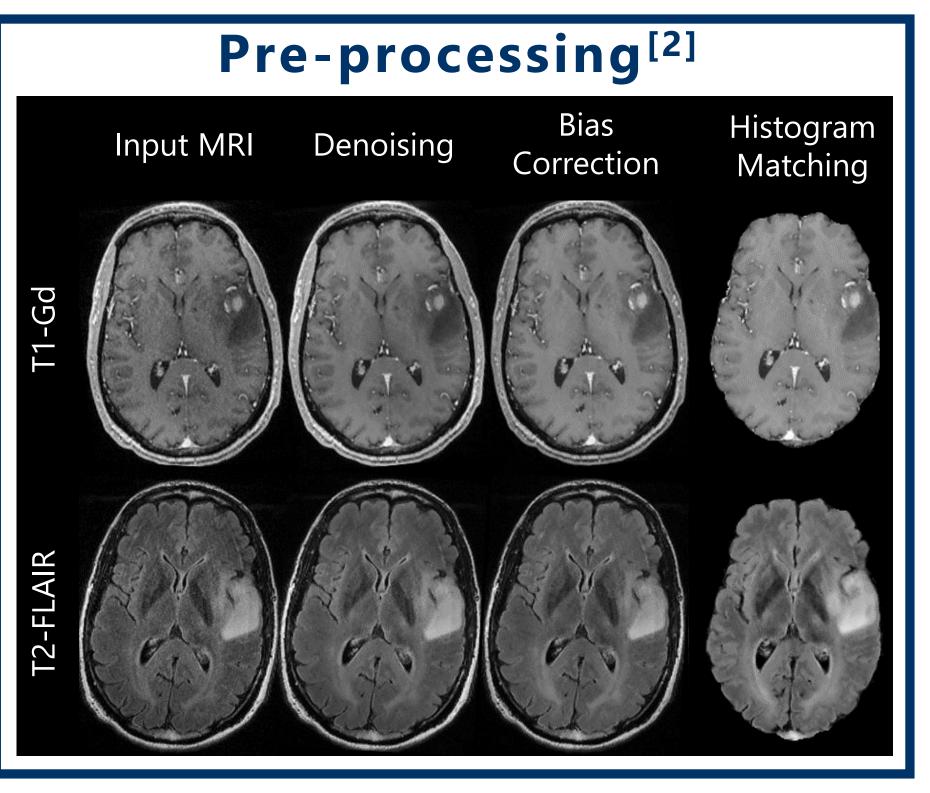




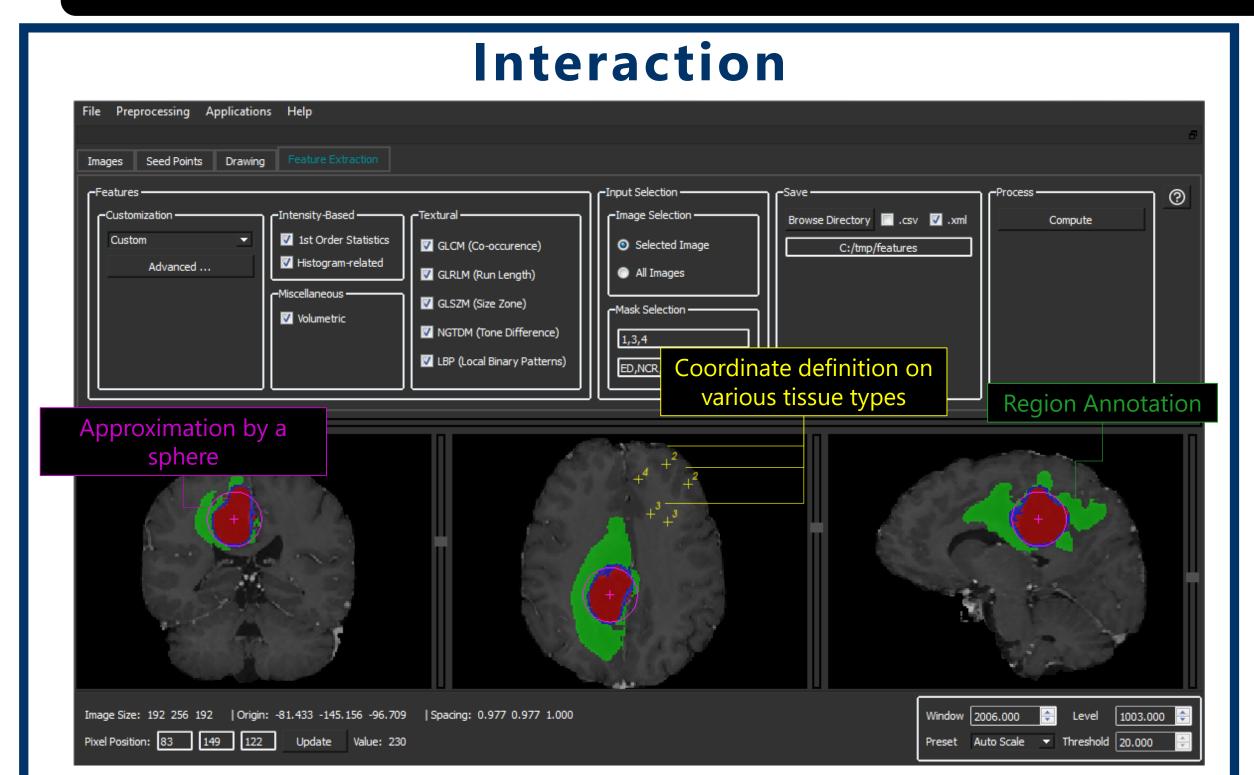


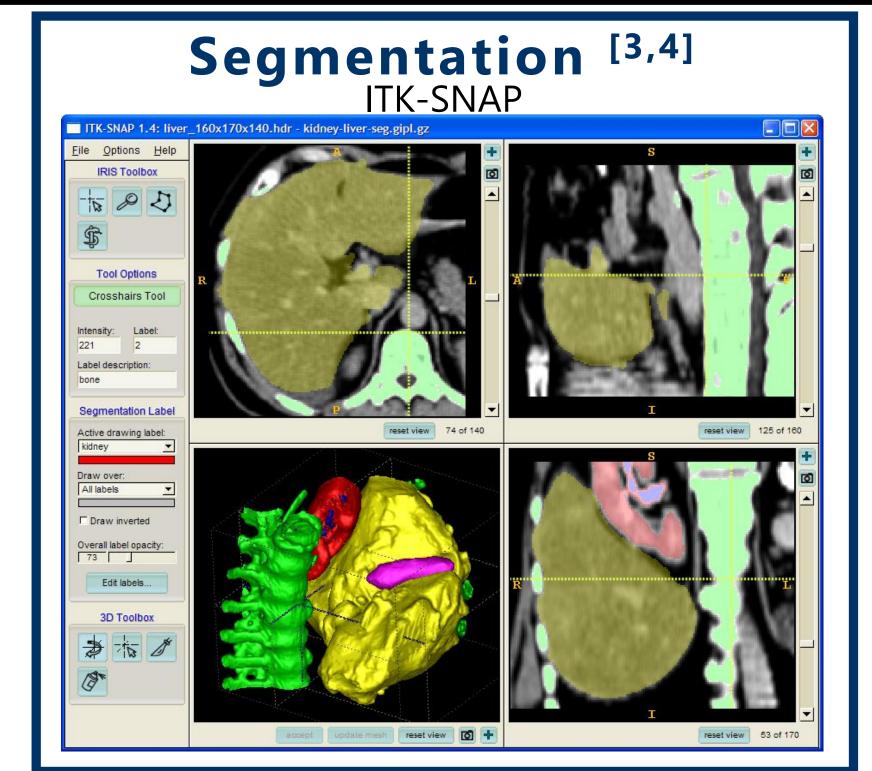


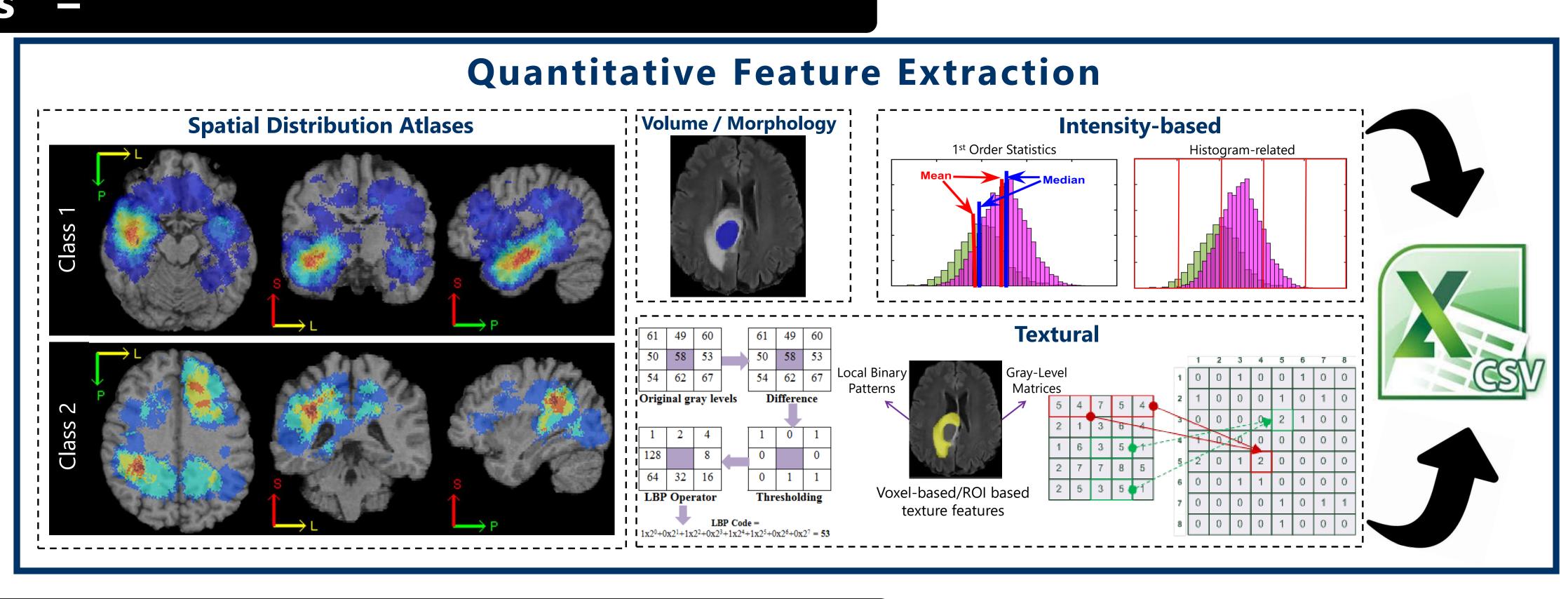
### General Purpose Tools



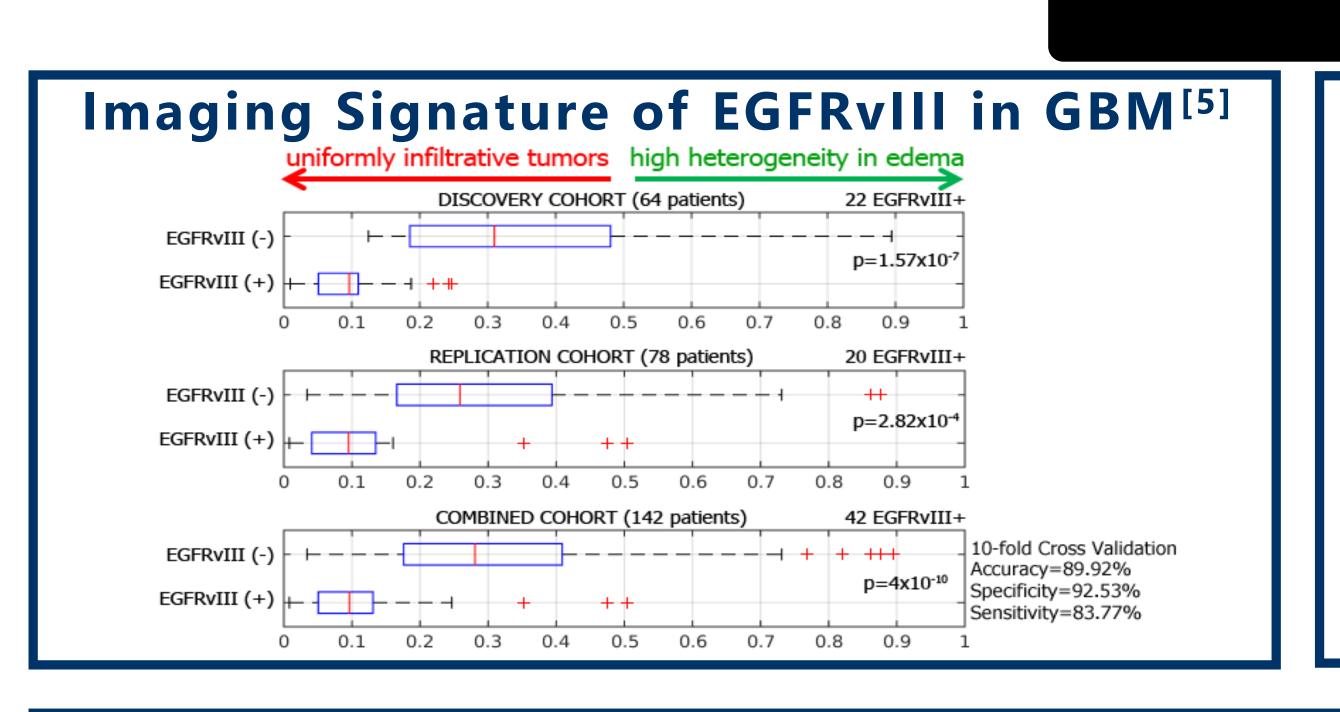
**LIBRA** [8,9]

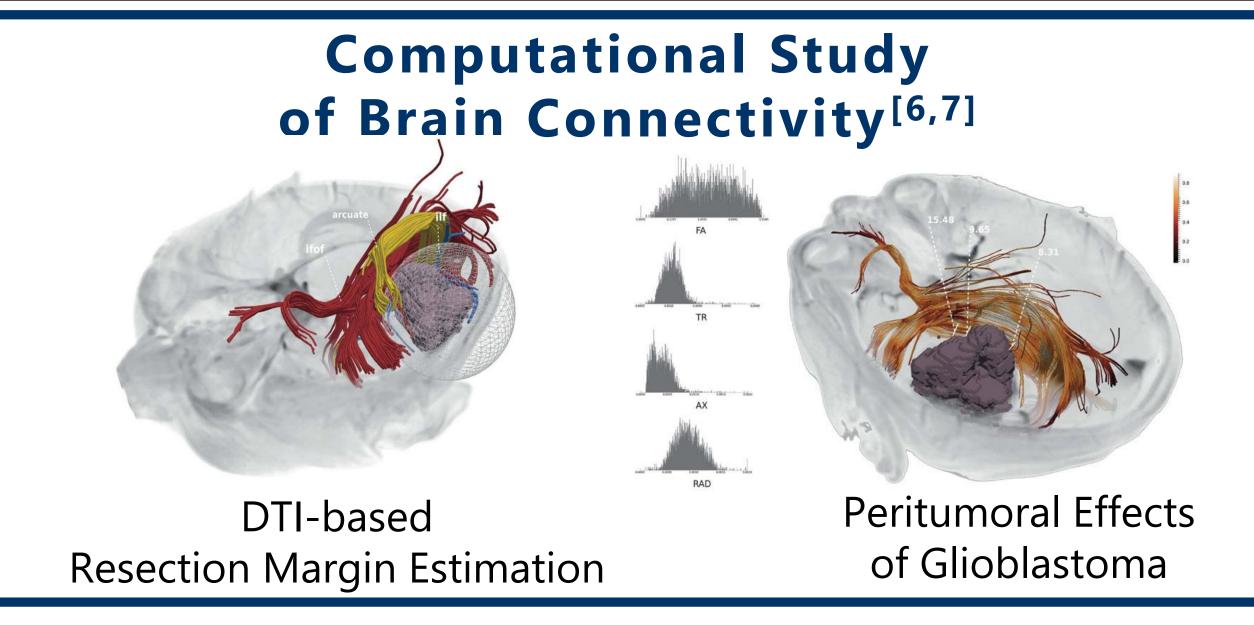






#### - Specialized Applications -





— Enhancing

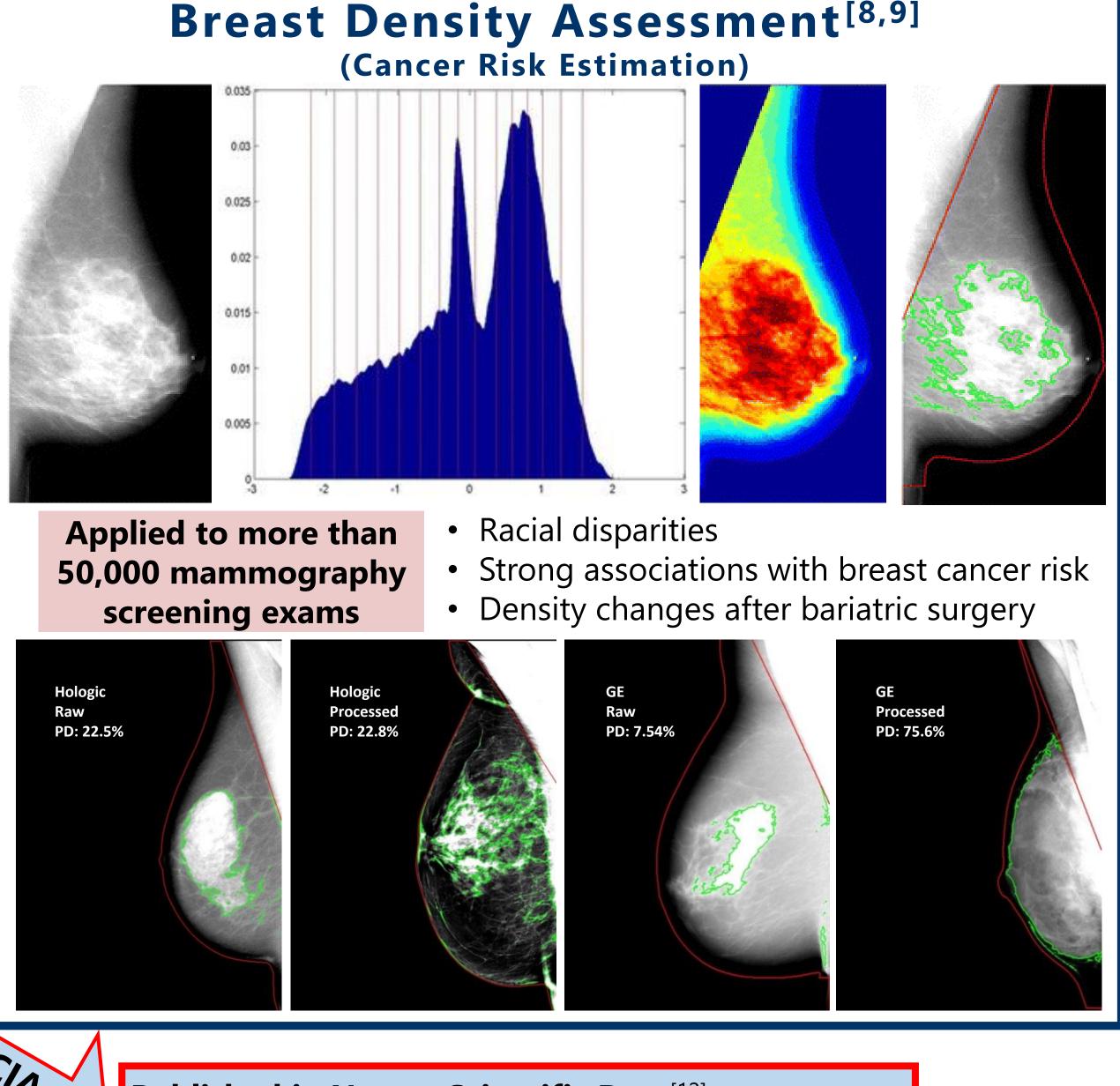
Non-enhancing

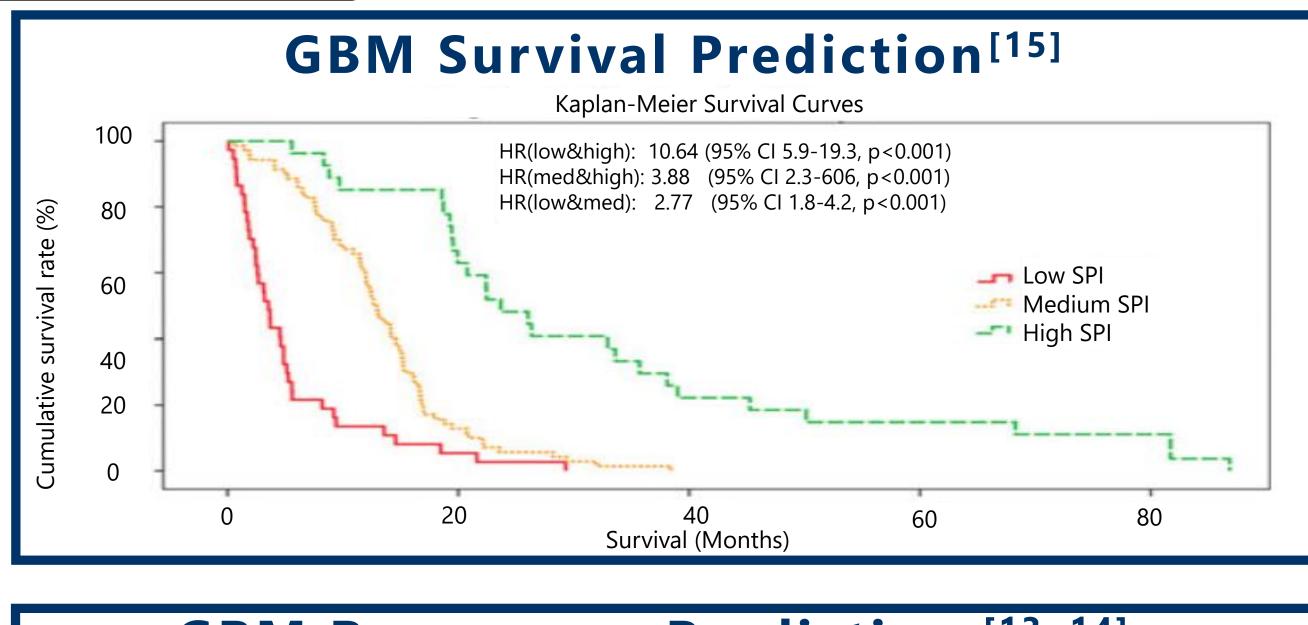
Edema/Invasion

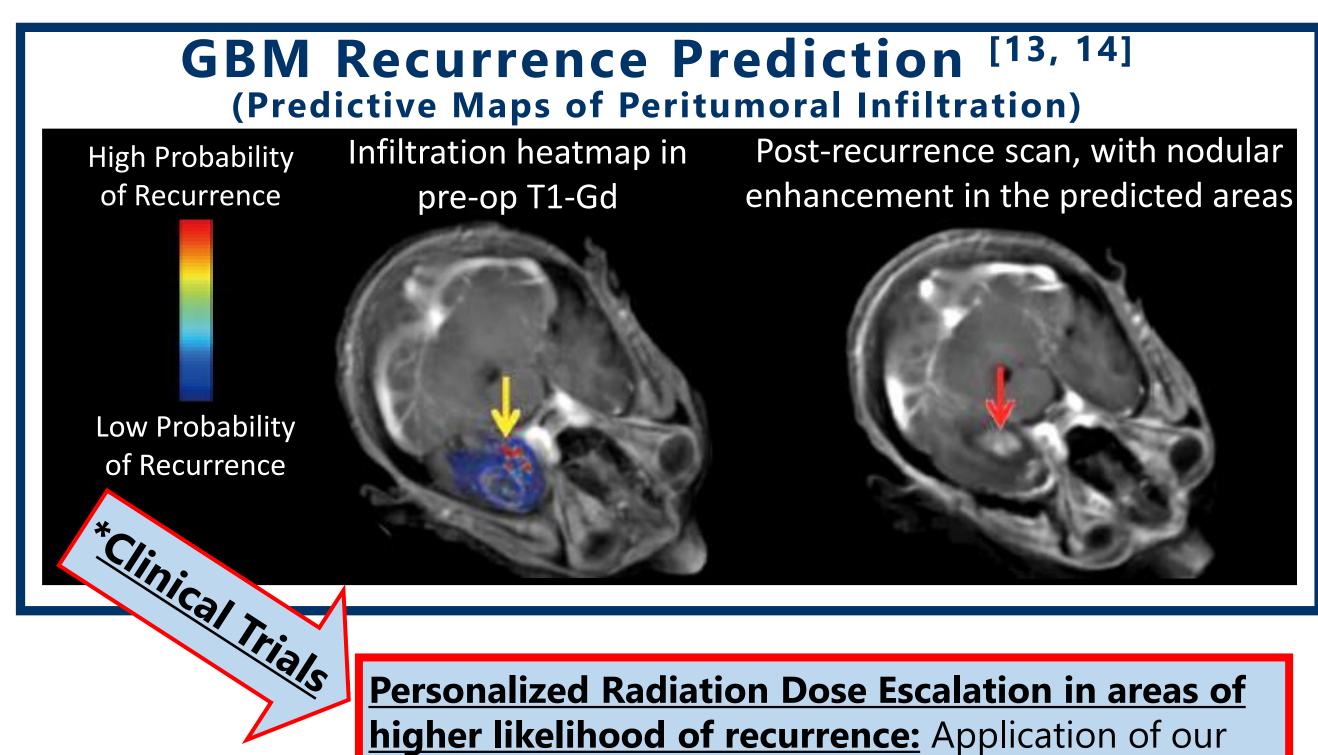
Cerebrospinal Fluid

— White Matter

— Gray Matter







<u>Center</u> and to an <u>NRG</u> trial.

predictive maps to a trial funded by Abramson Cancer

Published in Nature Scientific Data<sup>[12]</sup> enriching the TCGA-GBM & TCGA-LGG datasets with manual tumor segmentations and radiomic features, publicly available on the TCIA webpage.

### Future Work

GLISTRboost<sup>[1]</sup>

**Deep Learning** pipelines for segmentation<sup>[17]</sup> **Brain:** Distinct radiographic subtypes of GBM<sup>[14]</sup> **Model Training** Functionality **Breast:** Comprehensive parenchymal texture characterization

[1] Davatzikos et al., Cancer imaging phenomics toolkit: quantitative imaging analytics for precision diagnostics and predictive modeling of clinical outcome, Journal of Medical Imaging, 2018

**Specialized Segmentation** 

Lung Tumor [10]

- [2] Shinohara et al., Statistical normalization techniques for magnetic resonance imaging, Neuroimage Clinical, 2014
- [3] Gaonkar et al., Adaptive geodesic transform for segmentation of vertebrae on CT images, Medical Imaging, 2014 [4] Yushkevich et al., ITK-SNAP: An interactive tool for semi-automatic segmentation of multi-modality biomedical images, IEEE Eng Med Biol Soc., 2016 [5] Bakas et al., In vivo detection of EGFRvIII in glioblastoma via perfusion magnetic resonance imaging signature consistent with deep peritumoral infiltration,
- Clinical Cancer Research, 2017 [6] Tunc et al., Individualized Map of white matter pathways: connectivity-based paradigm for neurosurgical planning, Neurosurgery, 2016
- [8] Keller et al., Estimation of breast percent density in raw and processed full field digital mammography images, Medical Physics, 2012
- [7] Tunc et al., Automated tract extraction via atlas based Adaptive Clustering, Neurolmage, 2014

- [10] Li et al., Predicting treatment response and survival of early-stage non-small cell lung cancer patients treated with stereotactic body radiation therapy using unsupervised two-way clustering of radiomic features, Int. Workshop on Pulmonary Imaging, 2017
- [11] Bakas et al., GLISTRboost: Combining multimodal MRI segmentation, registration, and biophysical tumor growth modeling with gradient boosting machines for glioma segmentation, Springer, LNCS, 2016
- [12] Bakas et al., Advancing TCGA glioma MRI collections with expert segmentation labels and radiomic features, Nature Scientific Data, 2017.
- [13] Akbari et al., Imaging Surrogates of infiltration obtained via multiparametric imaging pattern analysis predict subsequent location of recurrence of glioblastoma, Neurosurgery, 2016
- [14] Rathore et al., Radiomic signature of infiltration in peritumoral edema predicts subsequent recurrence in glioblastoma: Implications for personalized radiotherapy planning, Journal of Medical Imaging, 2018
- [15] Macyszyn et al., Imaging patterns predict patient survival and molecular subtype in glioblastoma via machine learning techniques, **Neuro-Oncology**, 2016 [16] Rathore et al., Imaging pattern analysis reveals three distinct phenotypic subtypes of GBM with different survival rates, Neuro-Oncology, 2016

- [9] Keller et al., Preliminary evaluation of the publicly available Laboratory for Breast Radiodensity Assessment (LIBRA) software tool, Breast Cancer Research 2015 [17] Kamnitsas et al., Efficient multi-Scale 3D CNN with fully connected CRF for accurate brain lesion segmentation, Medical Image Analysis, 2016