The Cancer Phenomics Toolkit (CaPTk)

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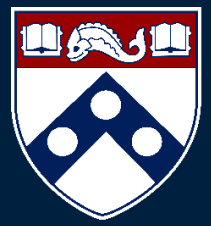


Penn
University of Pennsylvania

Center for Biomedical Image Computing and Analytics

Computational Breast Imaging Group
Penn Image Computing and Science Lab
Penn Statistical Imaging and Visualization Endeavor
Section for Biomedical Image Analysis

Overview

Center for Biomedical Image Computing and Analytics (CBICA)

Neuroinformatics and Computational Clinical Neuroscience

(Neurodegenerative diseases, neurodevelopmental and neuropsychiatric disorders, MS,…)

Oncologic Image Analysis

- Brain Cancer
- Breast Cancer
- Lung Cancer

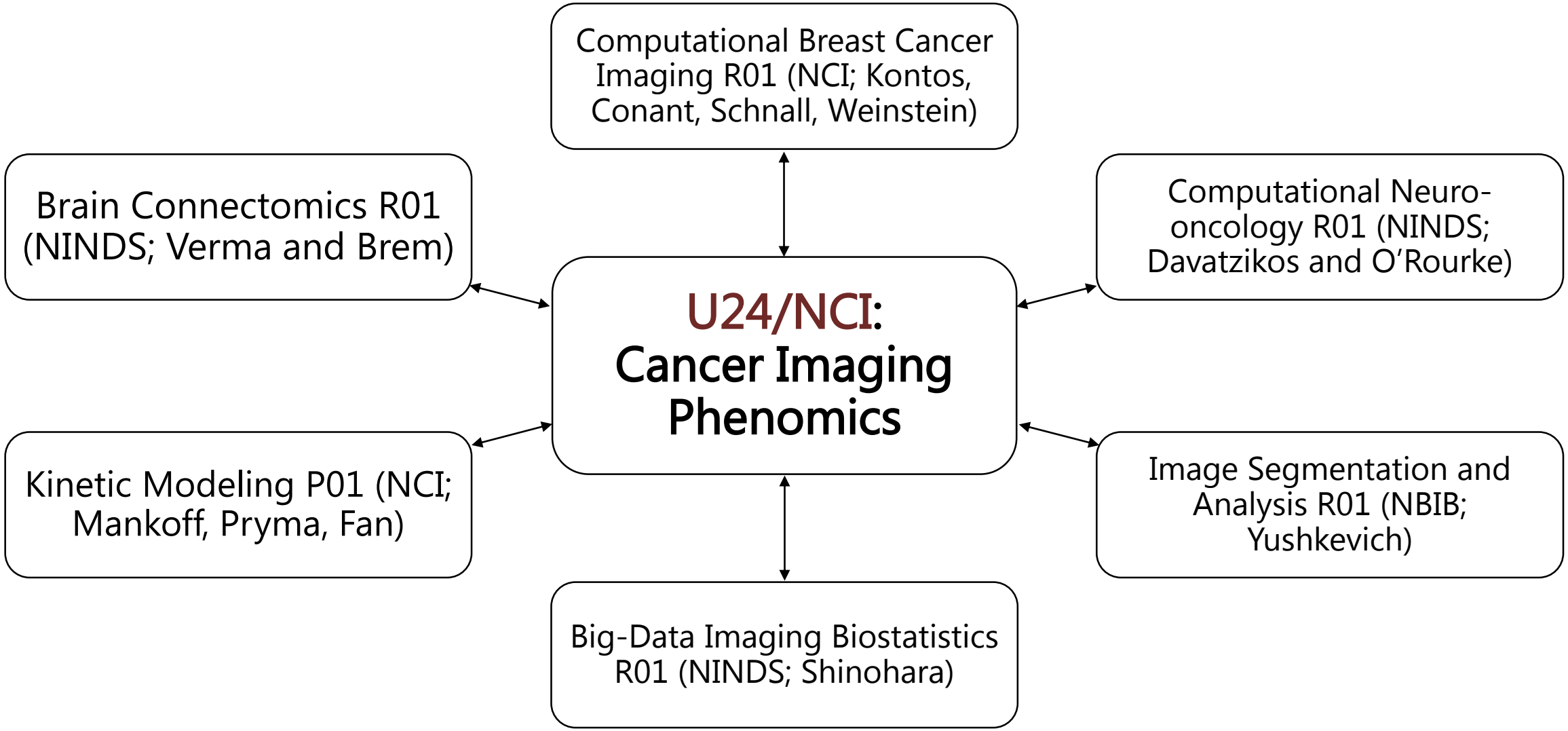
Lots of Interface with the TCE's of the ACC

"If you cannot measure it, then it is not science"

From lecture to the Institution of Civil Engineers, London (3 May 1883)

Lord Kelvin, 1824-1907

Oncologic Imaging Analytics



Two Major Foci of CapTk Program

- To leverage a rich family of advanced image computing algorithms

- To leverage extensive and long-standing collaborations with clinical teams who have provided input in the development of the algorithms, as well as data for training and validation of models

U24/ NCI: Cancer Imaging Phenomics

Main Elements of CaPTk

Image Analysis Algorithms: Extraction of rich set of multi-parametric imaging features; image segmentation and co-registration

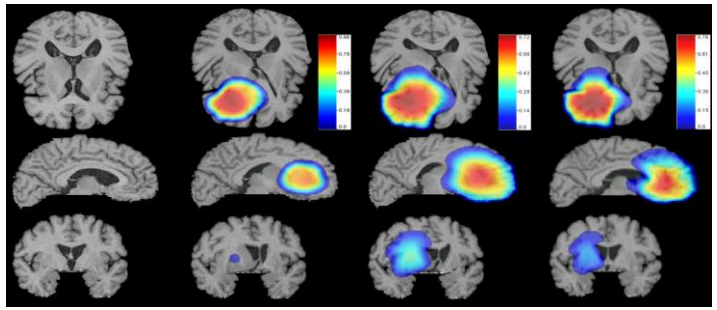
Precision Diagnostics Using Machine Learning: Risk for cancer development, risk for recurrence, prediction of survival, imaging genomics

Personalized Treatment Planning: Guide tumor resection and targeted radiation, estimate functional loss based on connectomic features…

1. Neurosurgical planning workstation: from precision diagnostics to personalized treatment
2. Precision diagnostics workstation of breast cancer

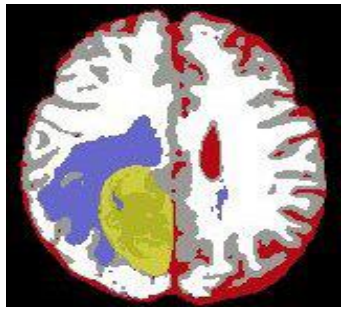
Computational Neuro-Oncology

Modeling tumor growth



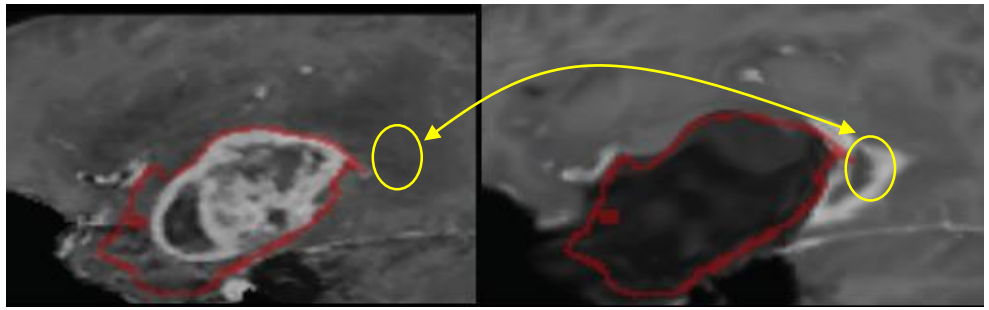
Hogea et al., J. Math. Biol., 2008

Segmentation



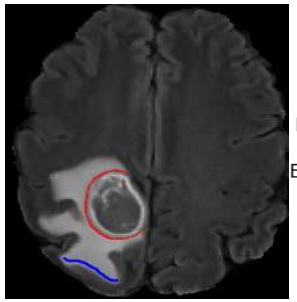
Gooya et al.,TMI, 2012
Bakas et al., MICCAI BRATS 2015 1st prize

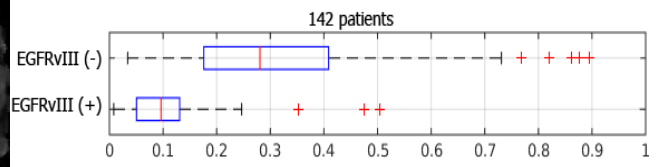
Pre-operative to Post-Recurrence Registration



Kwon et al., TMI, 2014

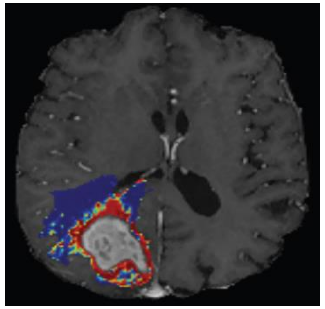
Imaging Signatures of Molecular Characteristics





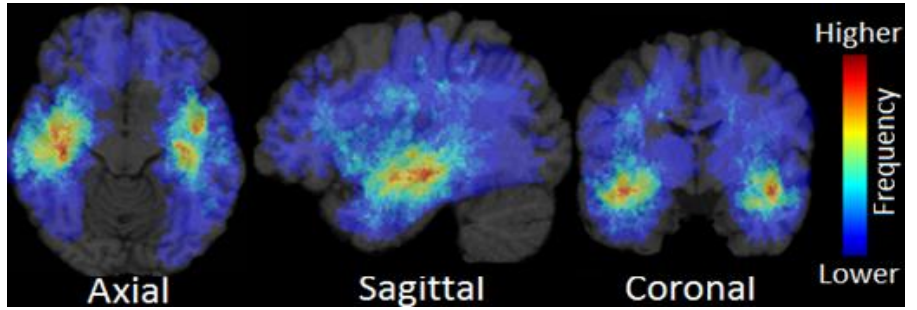
Bakas et al., SNO 2015

Predicting Recurrence



Akbari et al., Radiology, 2014
Akbari et al., Neurosurgery, 2016

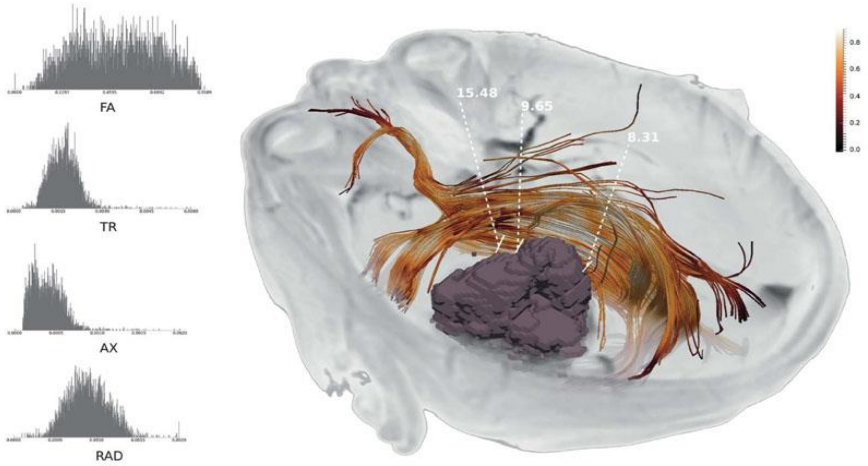
Spatial Distribution Atlases



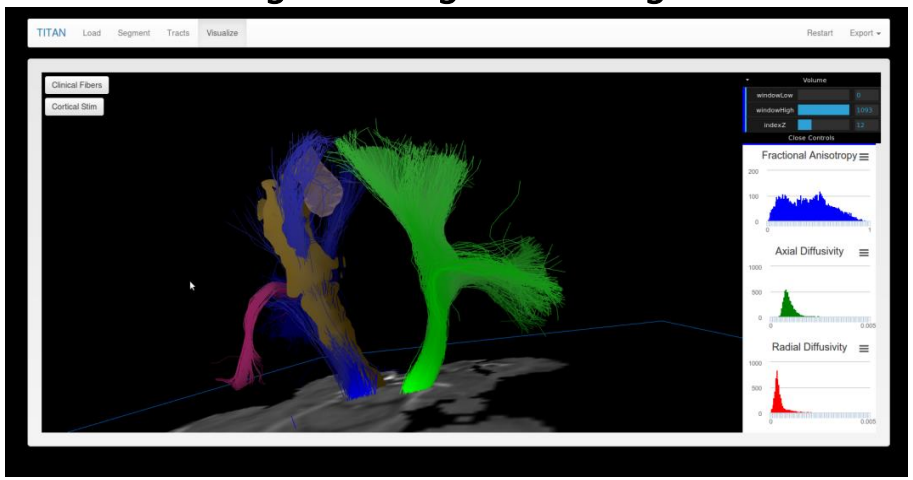
Bilello et al., NeuroImage: 2016

Computational study of Brain Connectivity

Peri-lesional Effects of GBMs

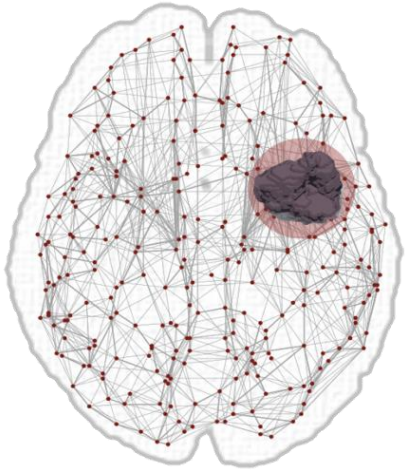


Web-based Integrated Surgical Planning Environment

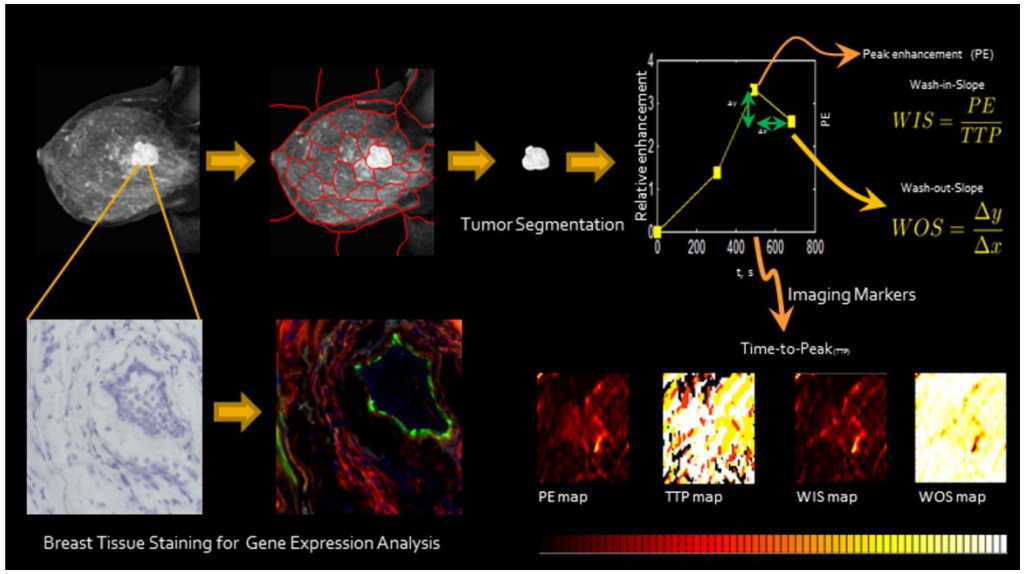


- Automated atlas-based tract extraction (using connectivity signatures instead of shape help address mass effect)
- Edema invariant tractography (using multicompartment models fitted to multishell imaging)
- Tumor connectome (effect of tumor on distant regions, regional vulnerability and functional rerouting)

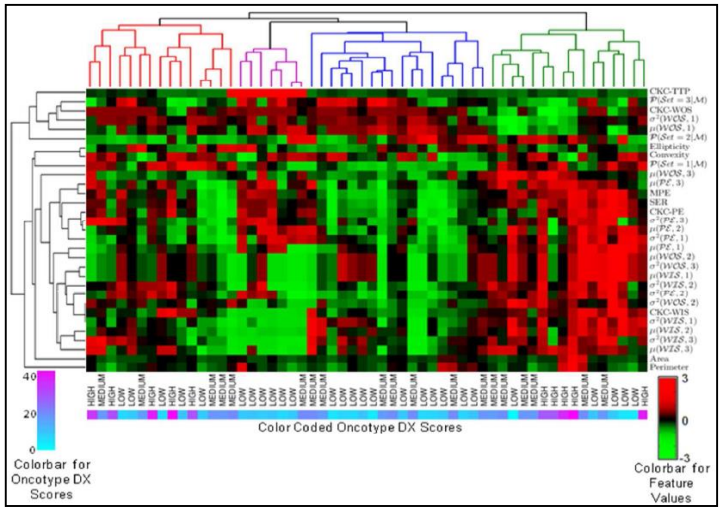
Global Effects of GBMs



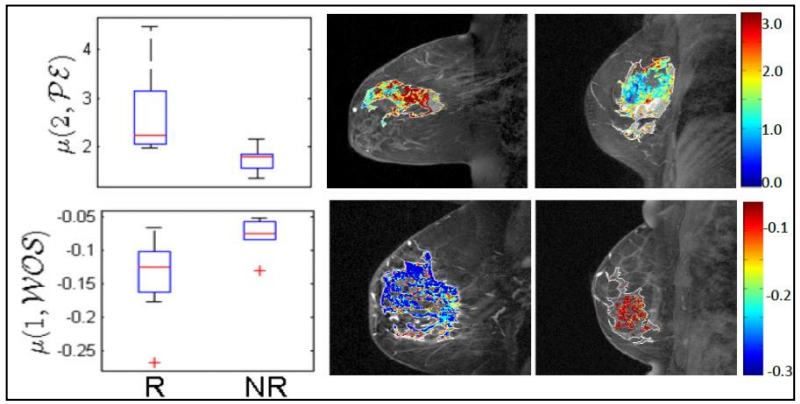
Radiomic Breast Cancer Phenotypes



Ashraf et al., IEEE TMI 2013; Mahrooghy et al. IEEE TBME 2015



Intrinsic Imaging Phenotypes for Breast Cancer Prognostic and Predictive Value



Breast Cancer Phenotyping via Imaging:

- Segmentation and multi-parametric feature extraction
- Identification of intrinsic phenotype patterns
- Prognostication and treatment response prediction

Goals

- Enable the larger scientific community (radiologists, clinicians, neuro-scientists and other researchers who don't deal with command line interfaces) to use cutting edge algorithms from computational research centers for clinically relevant studies through a user-friendly, platform-independent interface.

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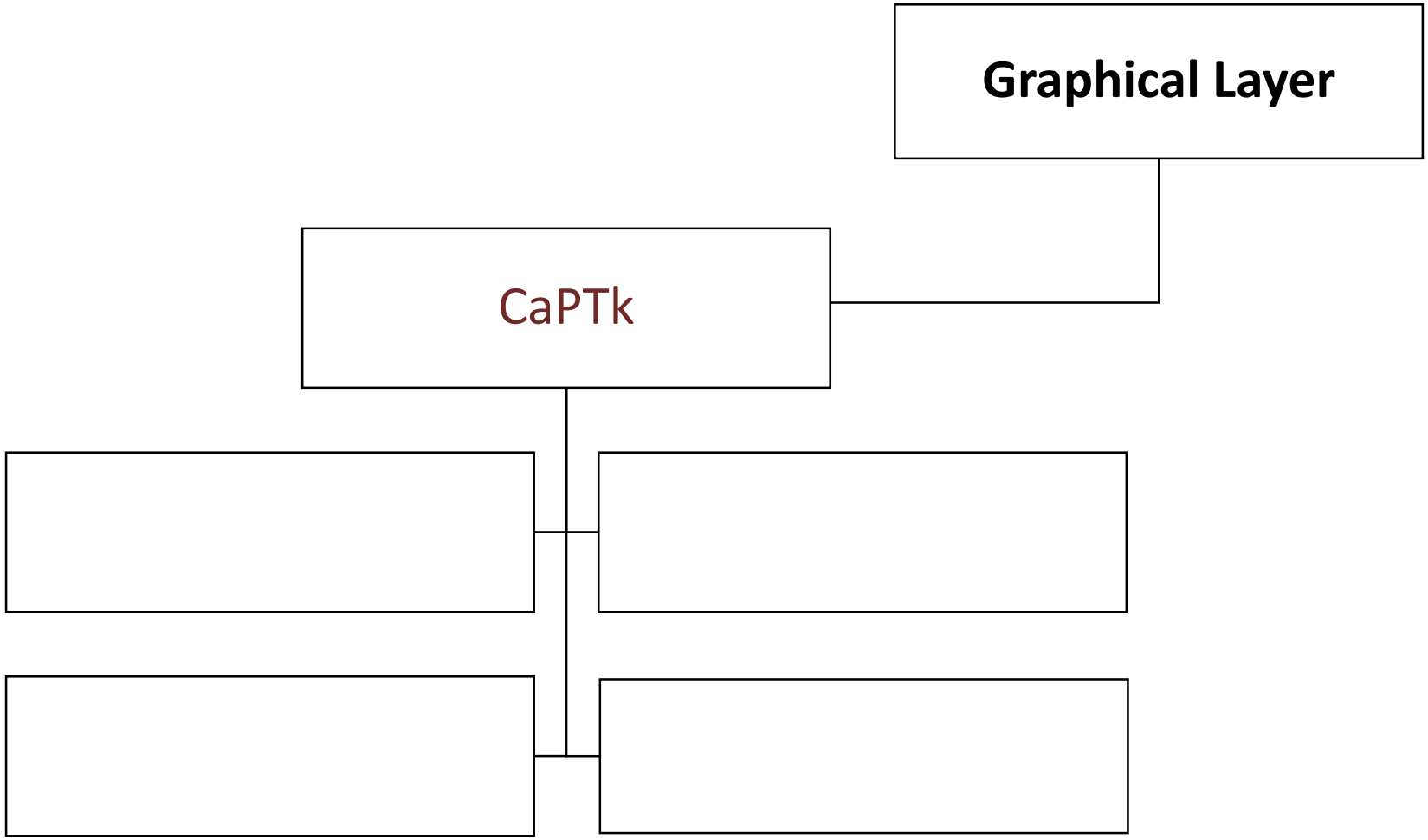
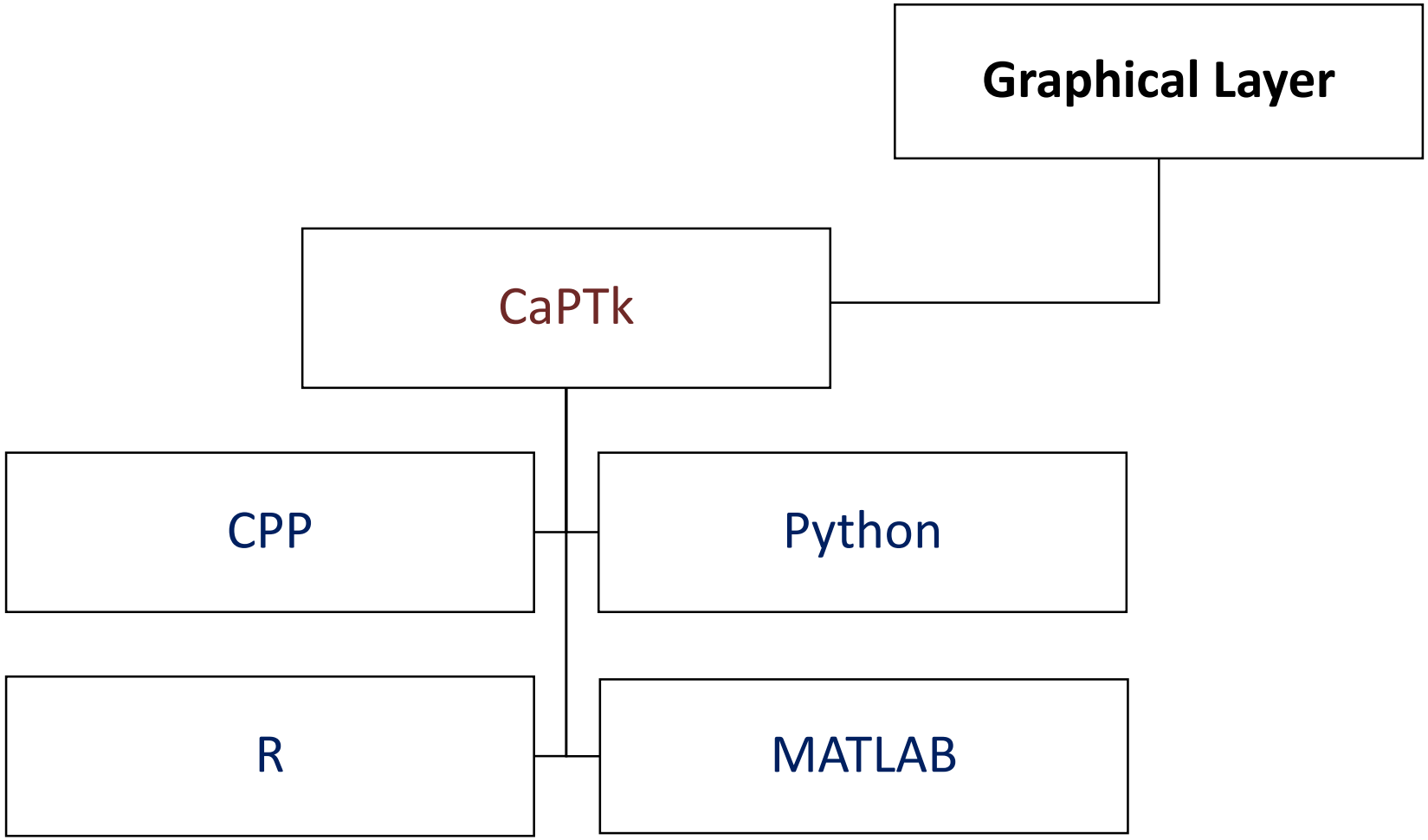
- Provide a platform for researchers from computational centers to incorporate their algorithms in a form which can be used to target the larger scientific community as quickly as possible.

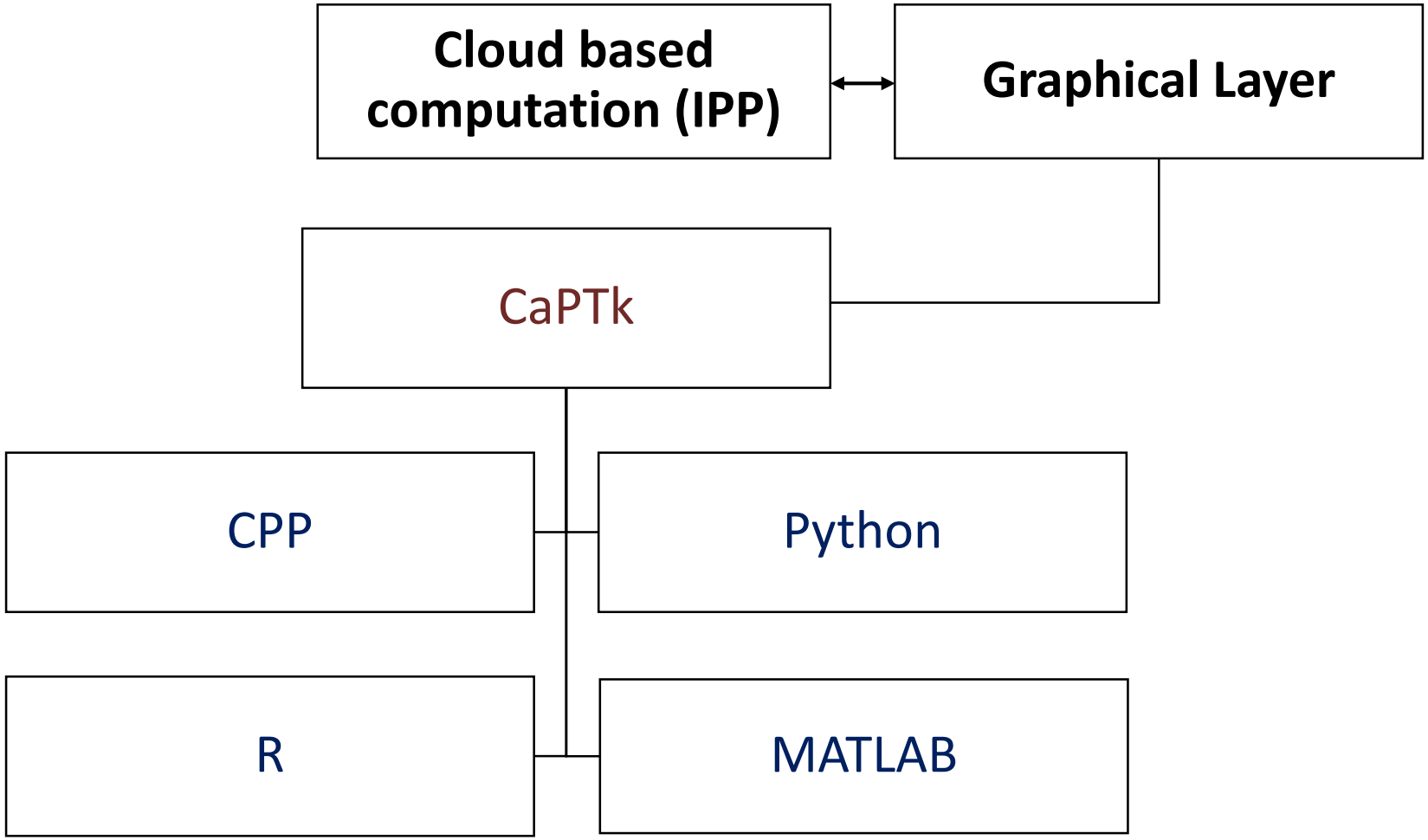
Overview of Architecture



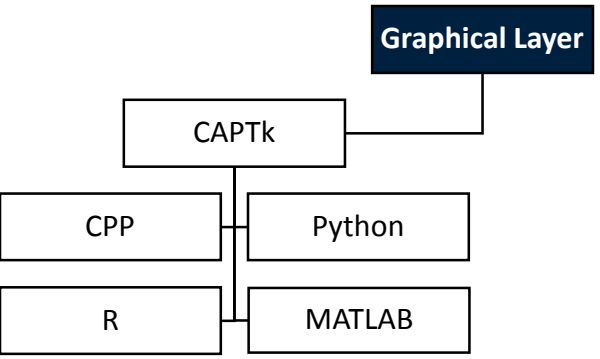
Overview of Architecture

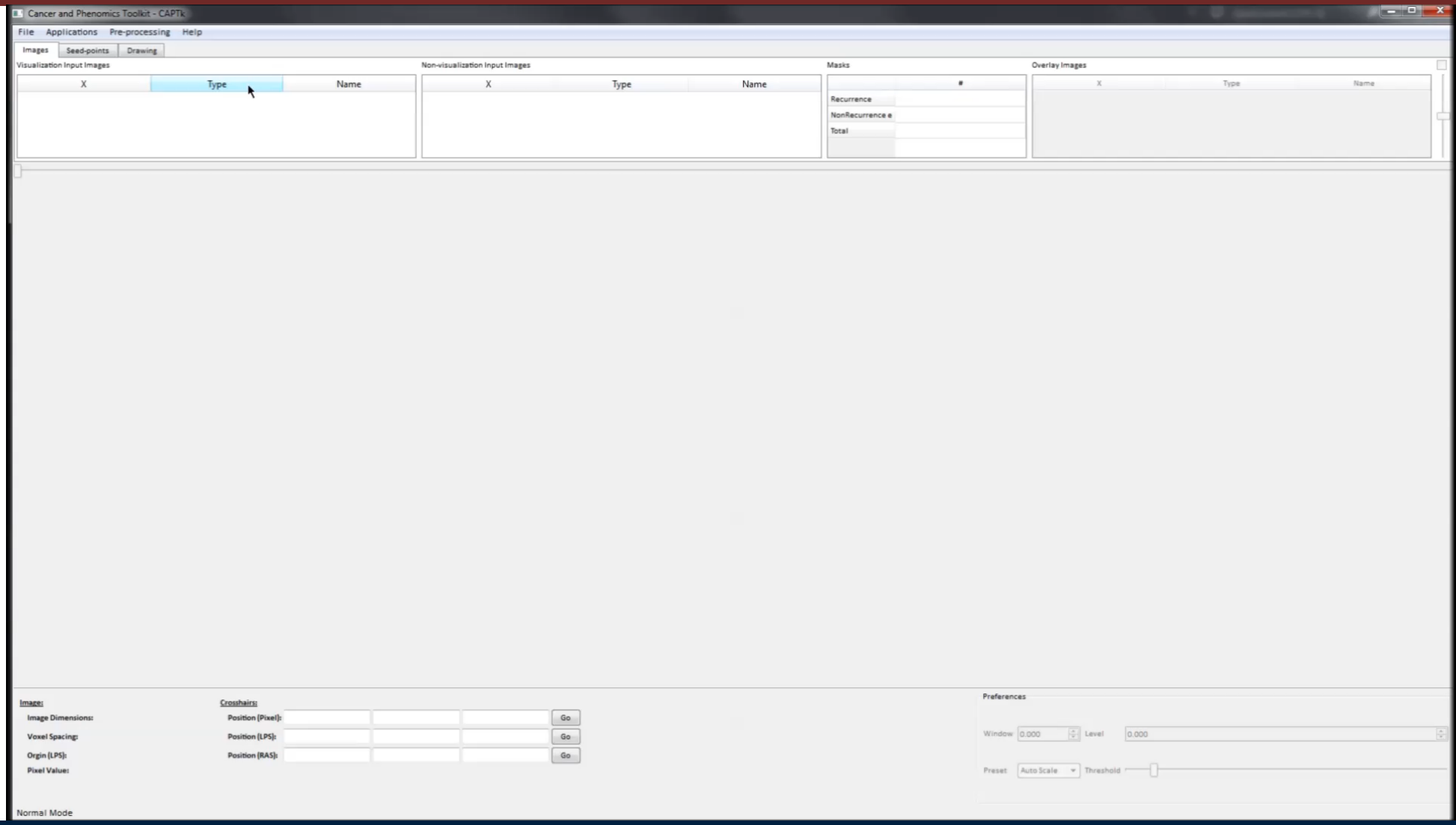


Overview of Architecture

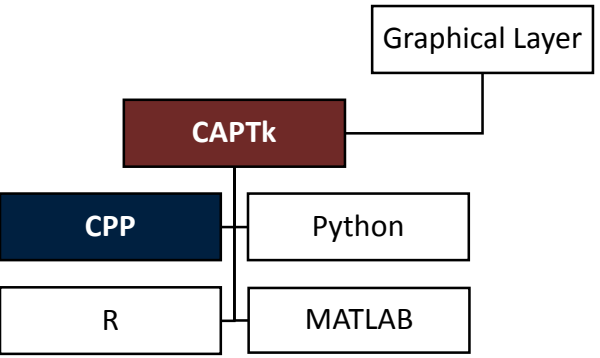


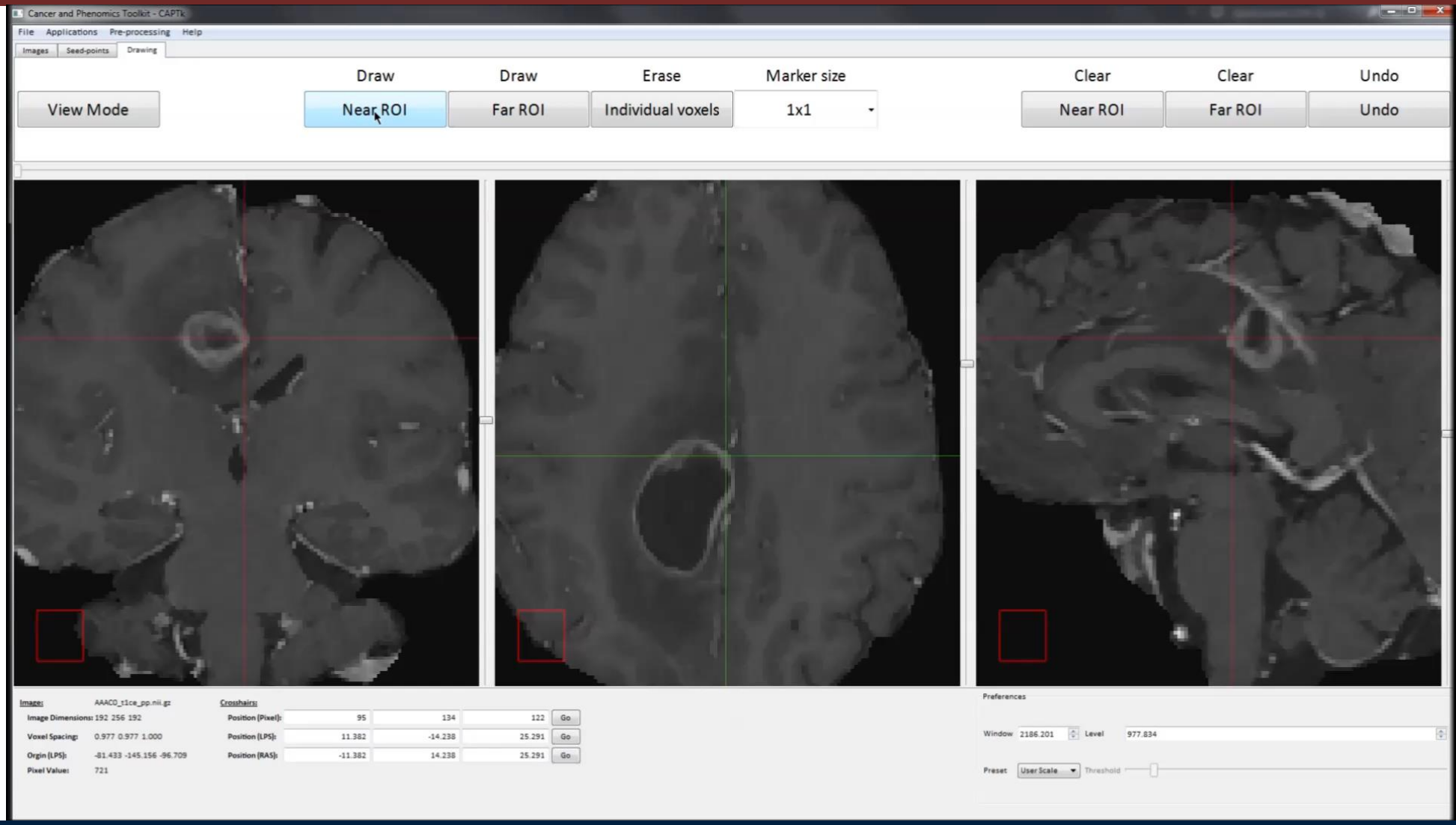
Graphical Layer & GLISTR



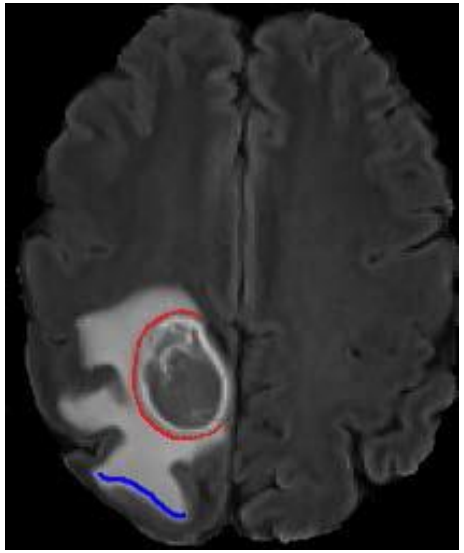


Graphical Layer & EGFR

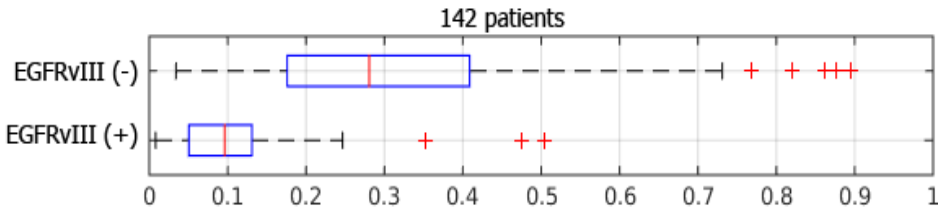




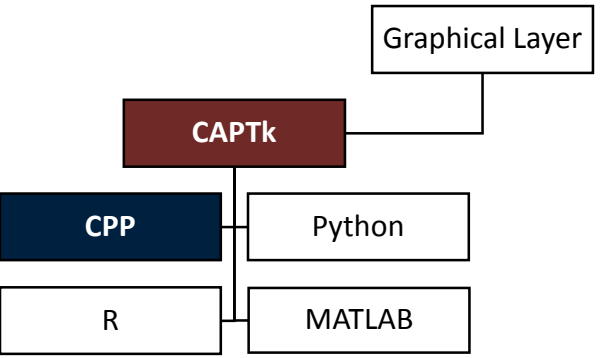
EGFR Results



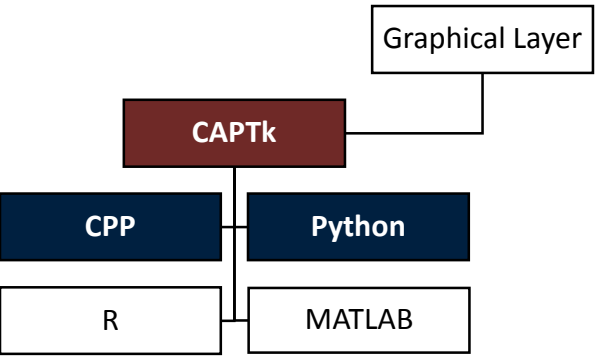
Bakas et al., SNO 2015

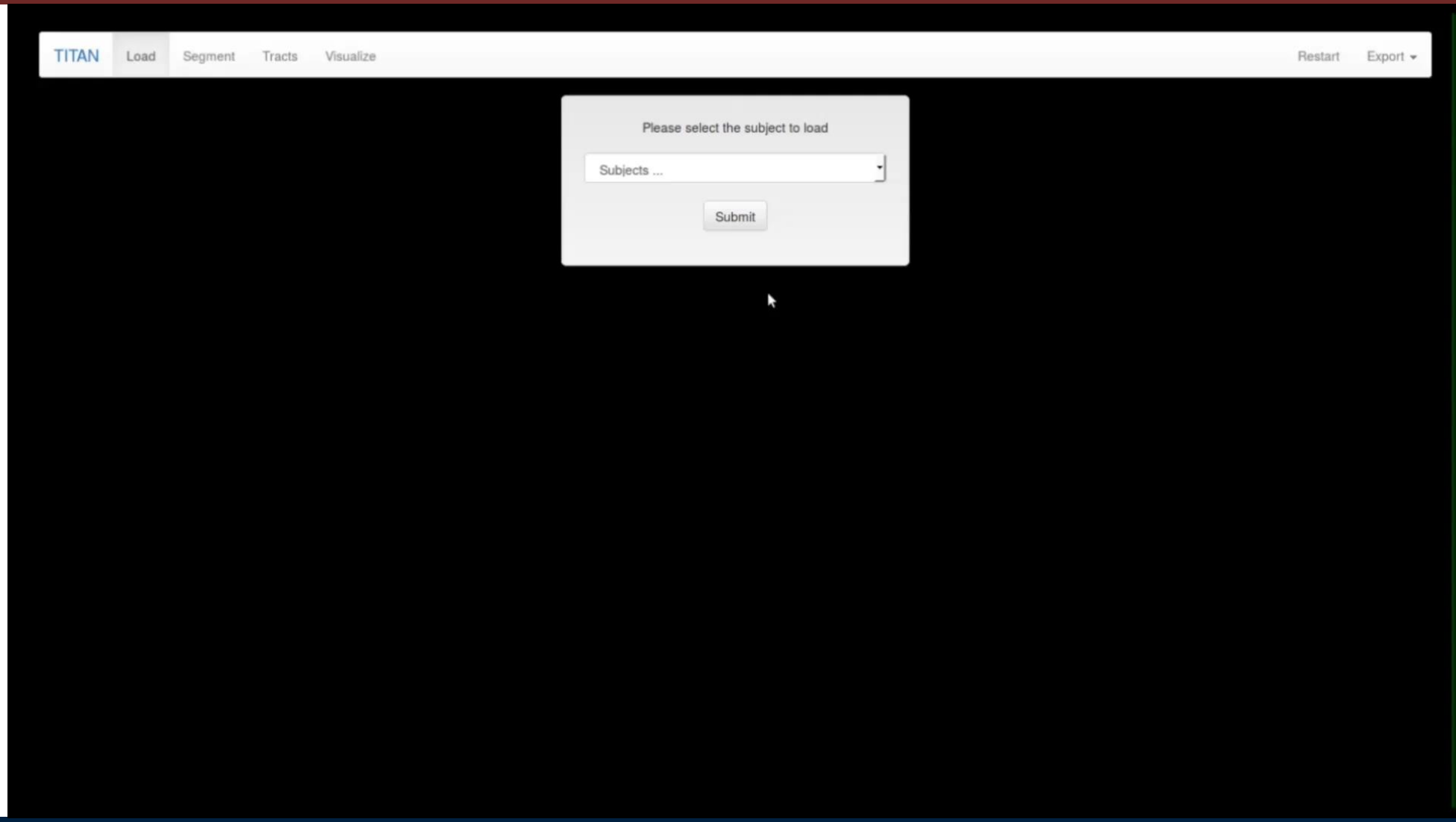


Geodesic Segmentation using CaPTk

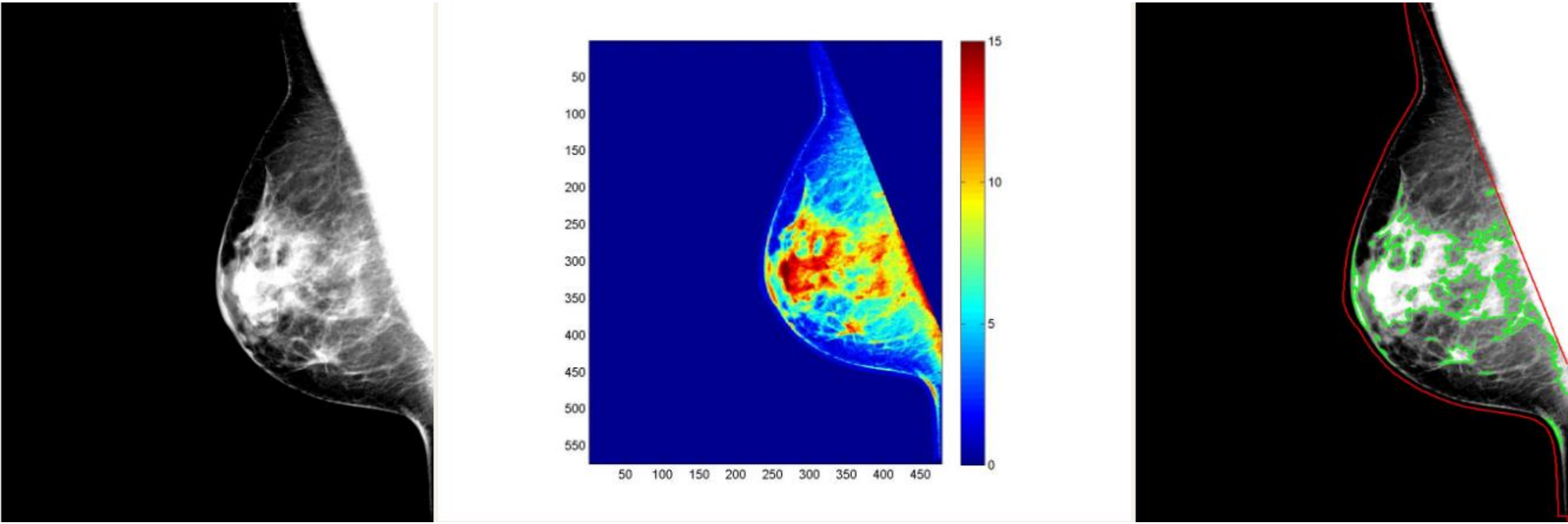


TITAN – Edema Invariant Tractography



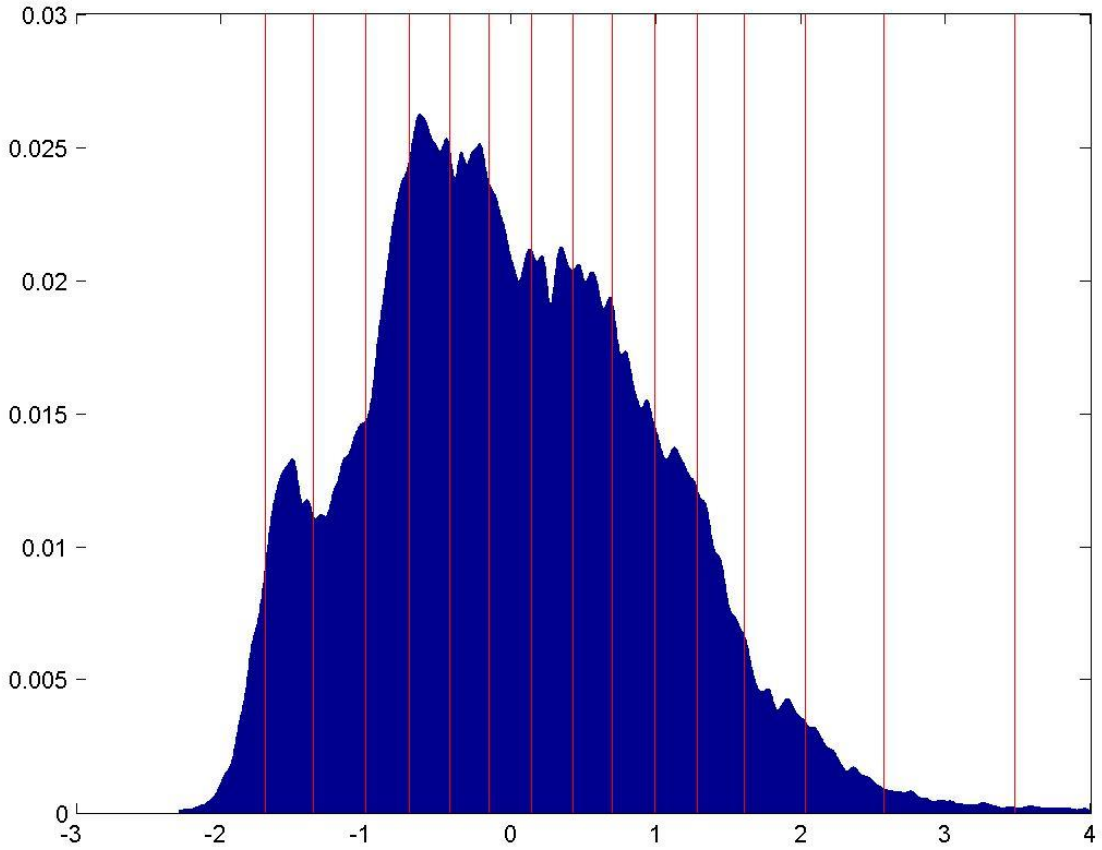


LIBRA: Fully-automated Breast Density Estimation



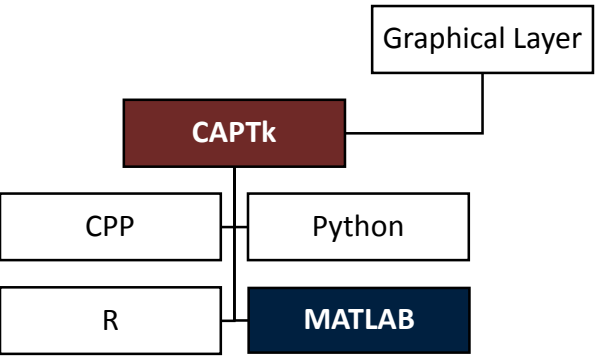
The breast density maps using an adaptive multi-class fuzzy c-means segmentation with SVM classification

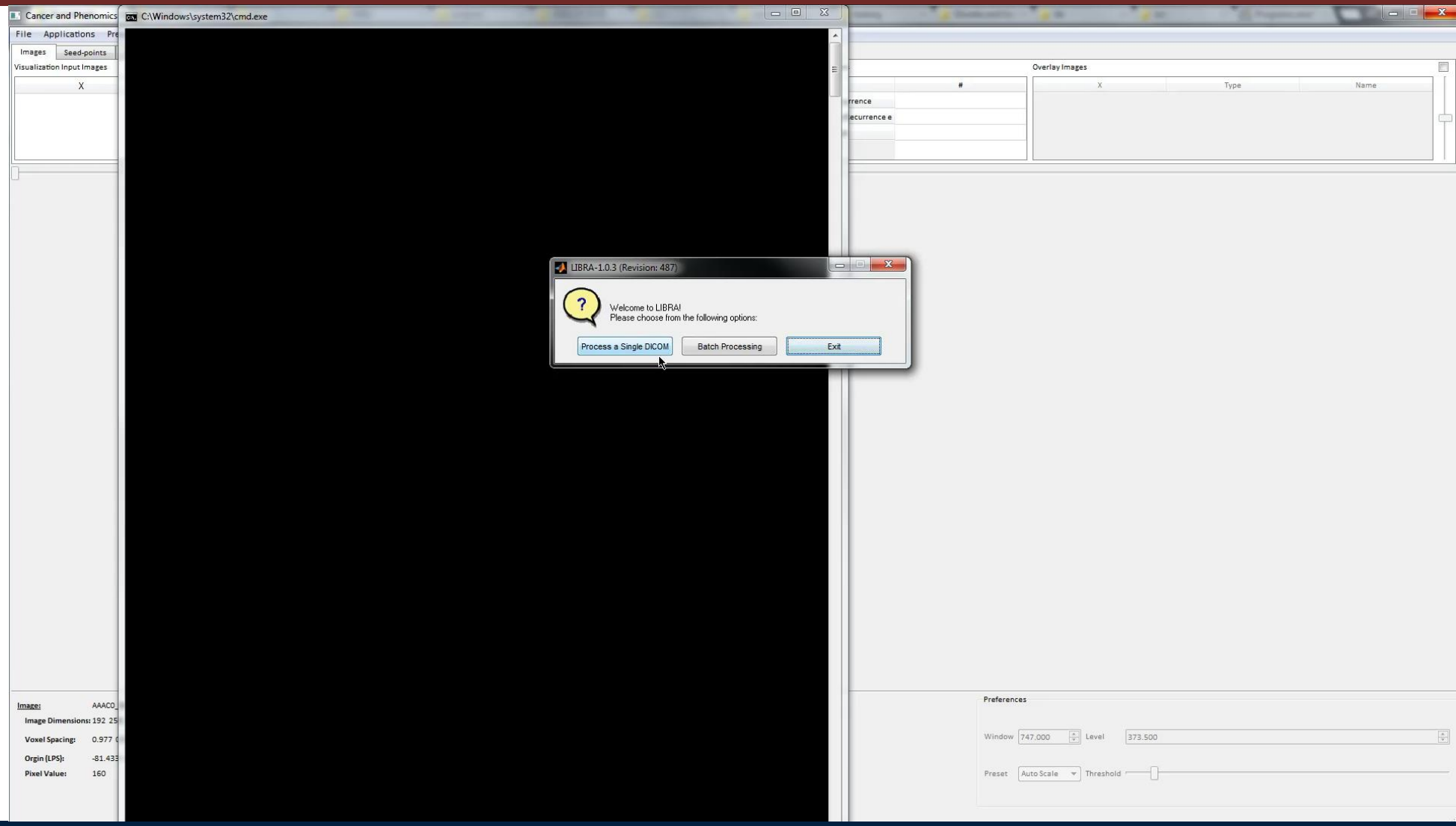
LIBRA: Adaptive Histogram-based Clustering



The breast region gray-level intensity histogram (z-scored) and FCM-cluster centers

LIBRA being called from CAPTk





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