RadxTools for assessing tumor treatment response on imaging

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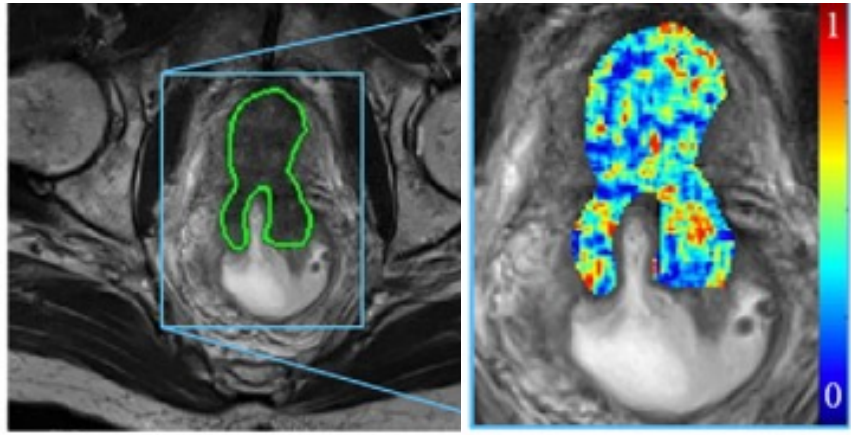
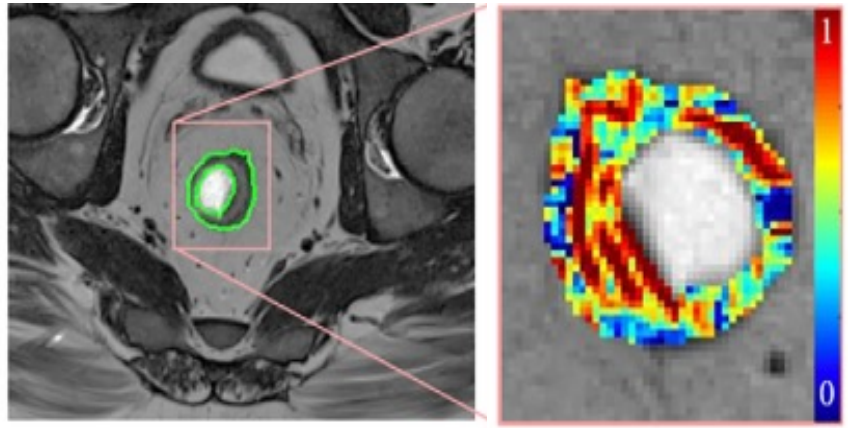
The Challenge: Identifying Treatment Response

- 1.6 million patients in U.S. undergo chemotherapy or radiation as first-line cancer treatment
- Expert identification of responder vs. non-responder on post-treatment imaging is challenging
- Unmet need for image analytics tools to quantify treatment response in oncology via routine imaging



Responder



Non-responder

Adapted from Antunes et al. JMRI 2020

RadxTools

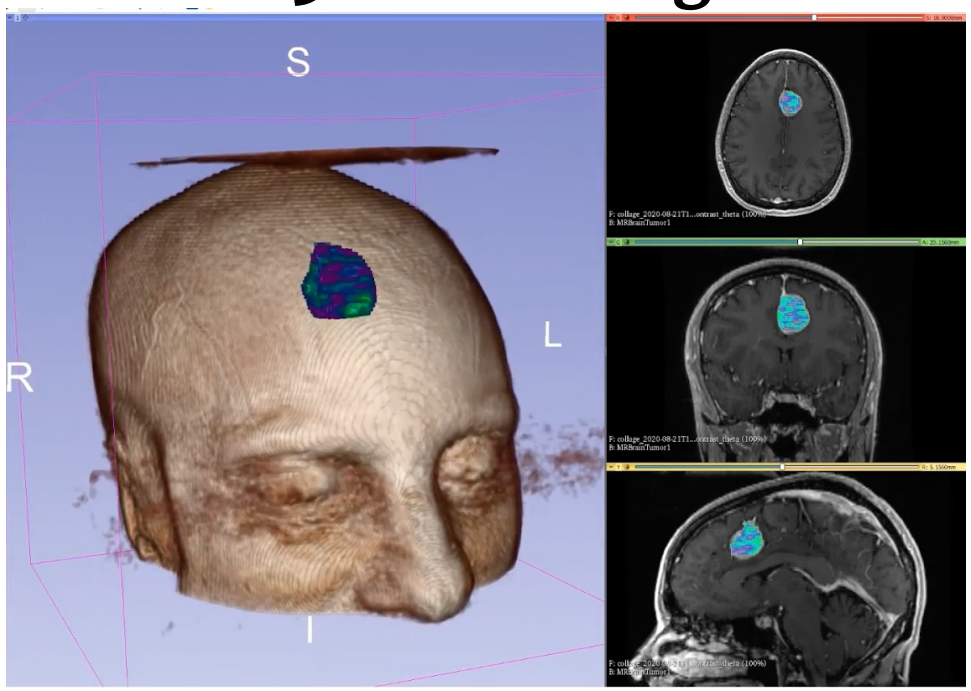
- Suite of 3 open-source tools to characterize tumor treatment response on standard-of-care MR/CT imaging

1. **RadTx** – capture subtle lesion perturbations in response to therapy
   - CoLlAGe
   - Topology
2. **RadPathFuse** – MRI-histopathology co-registration
3. **RadQC** – quality control of radiomic features

- Integrated into informatics platforms for widespread use by the radiomics/imaging community and oncology working groups

RadTx: CoLlAGe Module

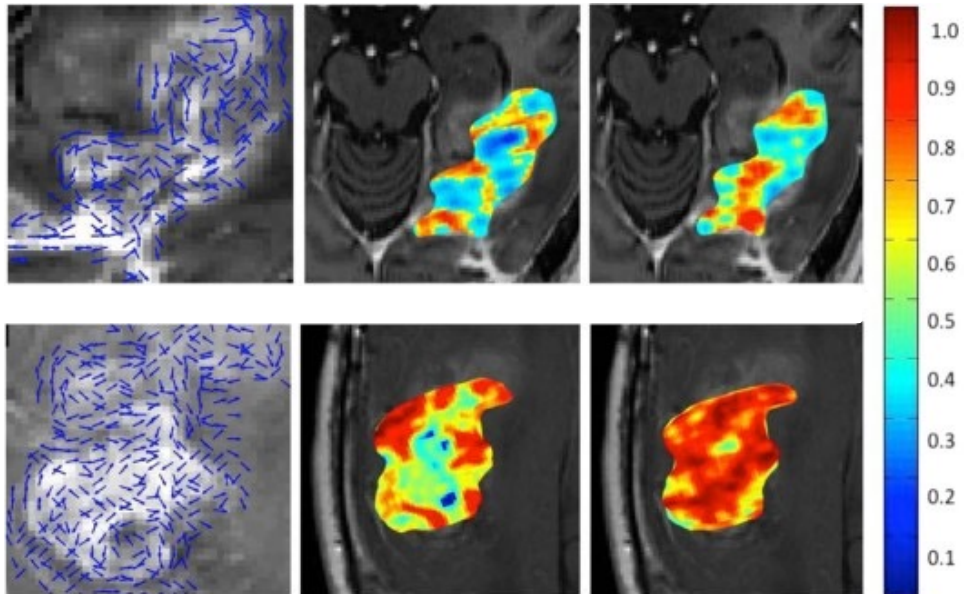
3D Slicer Plugin



Use Case: Brain Tumors

Entropy for radiation necrosis

Entropy for tumor recurrence



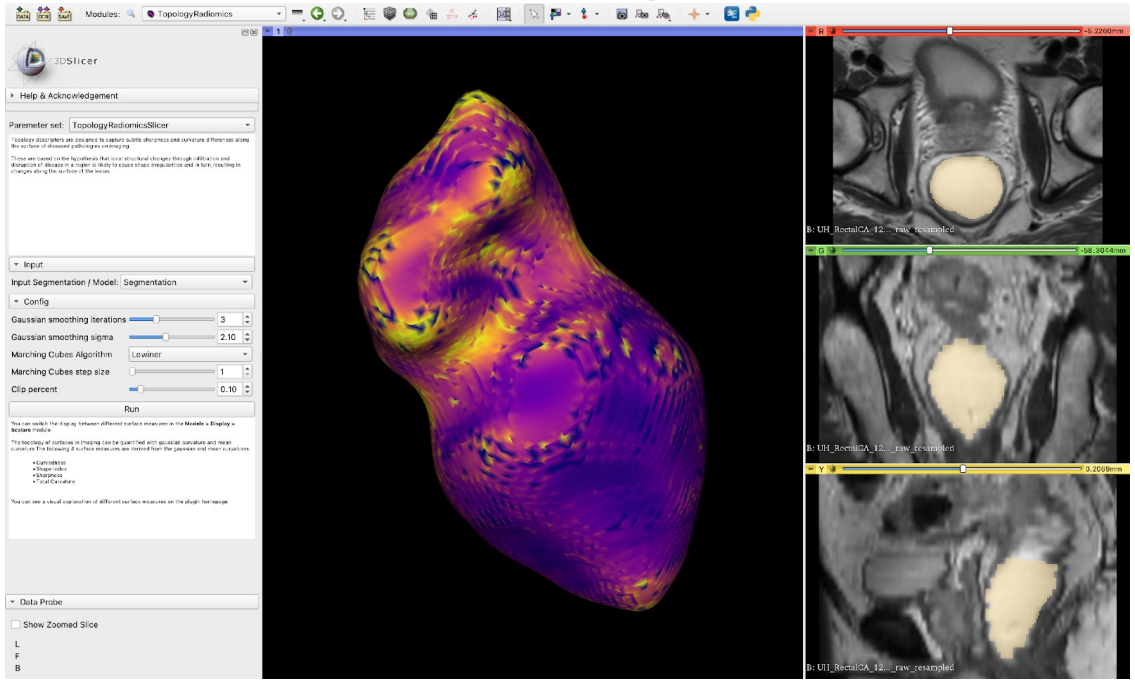
CoLlAGe features shown to distinguish radiation effects from recurrent tumor on post-treatment T1w MRI with an accuracy of 88.5% [1].

Purpose: Measure anisotropic differences in disease pathologies via local entropy of voxel-level gradient orientations

Available Platforms: Python PIP, 3D Slicer, CapTK

RadTx: Topology Module

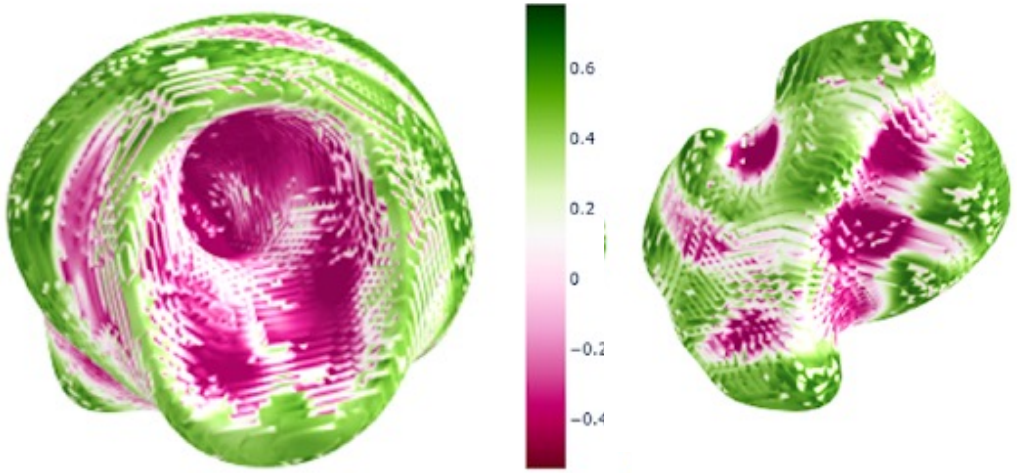
3D Slicer Plugin



Use Case: Rectal Cancer

Surface for complete response

Surface for non-response



Tumor topology features predict pathologic complete response to neoadjuvant CRT on pre-treatment T2w MRI with an AUC of 0.95 [2].

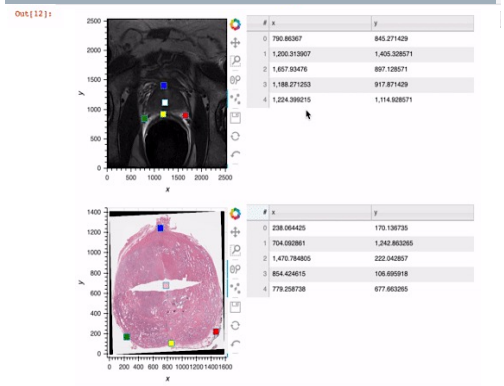
Purpose: Quantify morphometric sharpness and surface curvature differences between responders vs. non-responders to treatment

Available Platforms: Python PIP, 3D Slicer, Jupyter Notebook

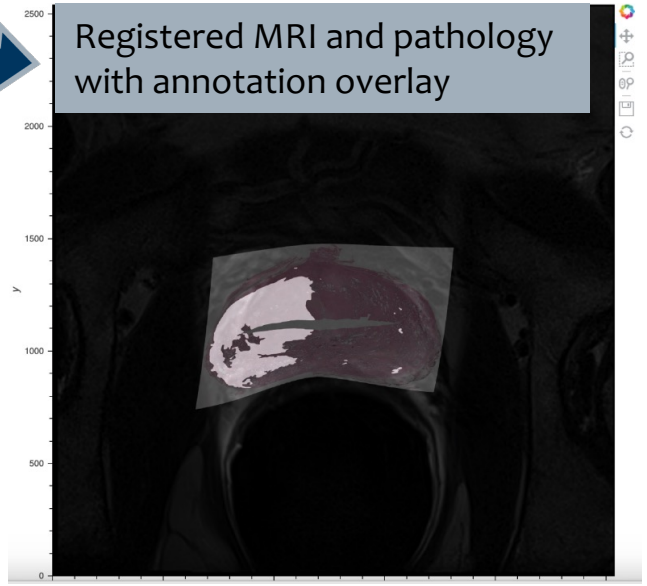
RadPathFuse

Jupyter Notebook

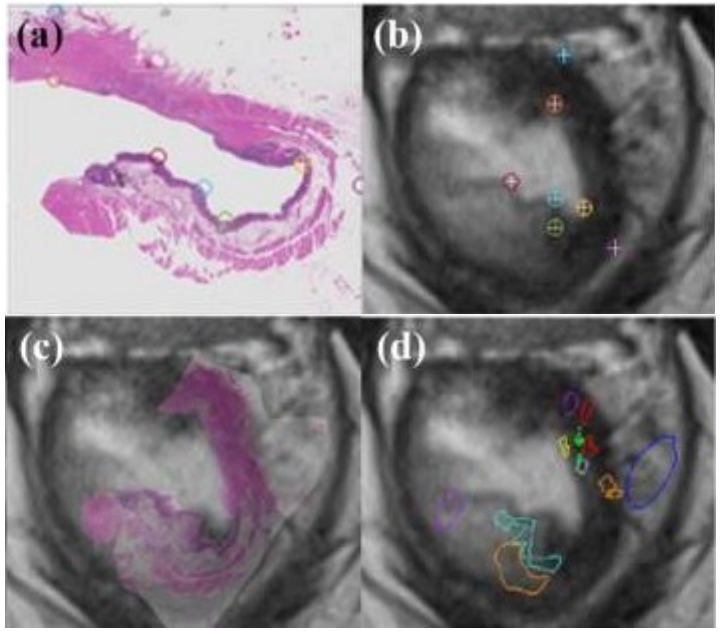
Interactive landmark selection



Registered MRI and pathology with annotation overlay



Use Case: Rectal Cancer



Co-registered pathology and MRI sections (c-d) reveal excellent structural alignment, with a registration error of 2-3 pixels [3]. Landmarks used for registration displayed in different colors on the pathology slide (a) and MR slice (b).

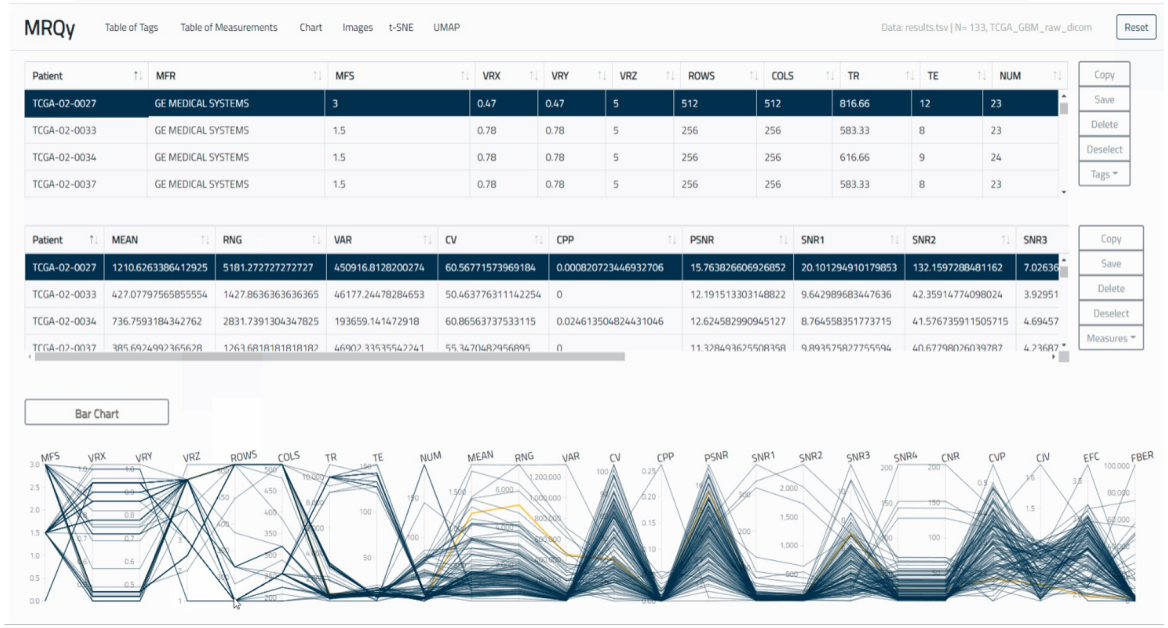
Purpose: Interactive workflow to generate deeply annotated pathology-validated radiographic datasets via rigorous co-registration of MRI/CT and histopathology specimens

Available Platforms: Jupyter Notebook

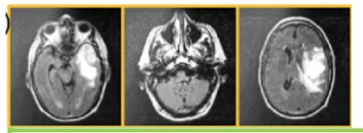
3. S. A. Billings,, John Wiley & Sons, 2013

RadQC: MRQy

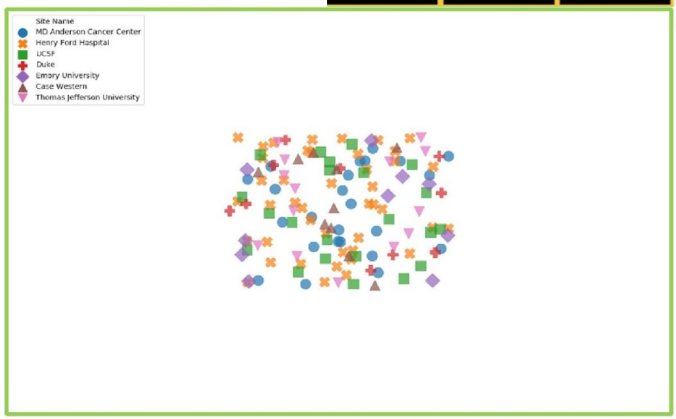
Python PIP



Use Case: TCGA-GBM



Brain MRIs from seven distinct sites



Before processing (L), each site can be distinctively clustered via MRQy measures, revealing potential batch effects. After processing (R), the data fall within a single merged cluster [4].

Purpose: Enables quality control of MRI data to quantify and evaluate impact of imaging and institutional variations (e.g., scanners, protocols)

Available Platforms: Python PIP

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  1U01CA248226-01
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- Emory University
- The Georgia Institute of Technology

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[1] Prasanna, P., Tiwari, P., & Madabhushi, A. (2016). "Co-occurrence of Local Anisotropic Gradient Orientations (CoLlAGe): A new radiomics descriptor". Scientific Reports, 6:37241.

[2] Singh, S, DeSilvio, T, Purysko, A, Paspulati, RM, Friedman, K, Liska, D, Stein S, Kirshnamurthi, SS, Viswanath, SE "Computerized features of tumor diversity on pre-chemoradiation MRI are associated with pathologic complete response in rectal cancers: A multi-institutional study". Journal of Clinical Oncology, 2022, 40:16_suppl, 3608-3608.

[3] Antunes, JT, Viswanath, SE, Brady, JT, Crawshaw, B, Ros, P, Steele, S, Delaney, CP, Paspulati, RM, Willis, JE, Madabhushi, A, "Coregistration of Preoperative MRI with Ex Vivo Mesorectal Pathology Specimens to Spatially Map Post-treatment Changes in Rectal Cancer Onto In Vivo Imaging: Preliminary Findings", Acad Radiol, 2018 Jul;25(7):833-841.

[4] Sadri, AR, Janowczyk, A, Zou, R, Verma, R, Beig, N, Antunes, J, Madabhushi, A, Tiwari, P, Viswanath, SE, "Technical Note: MRQy — An open-source tool for quality control of MR imaging data", Med. Phys., 2020, 47: 6029-6038. https://doi.org/10.1002/mp.14593