Combined PET and MRI Radiomics with Breast Cancer Outcomes

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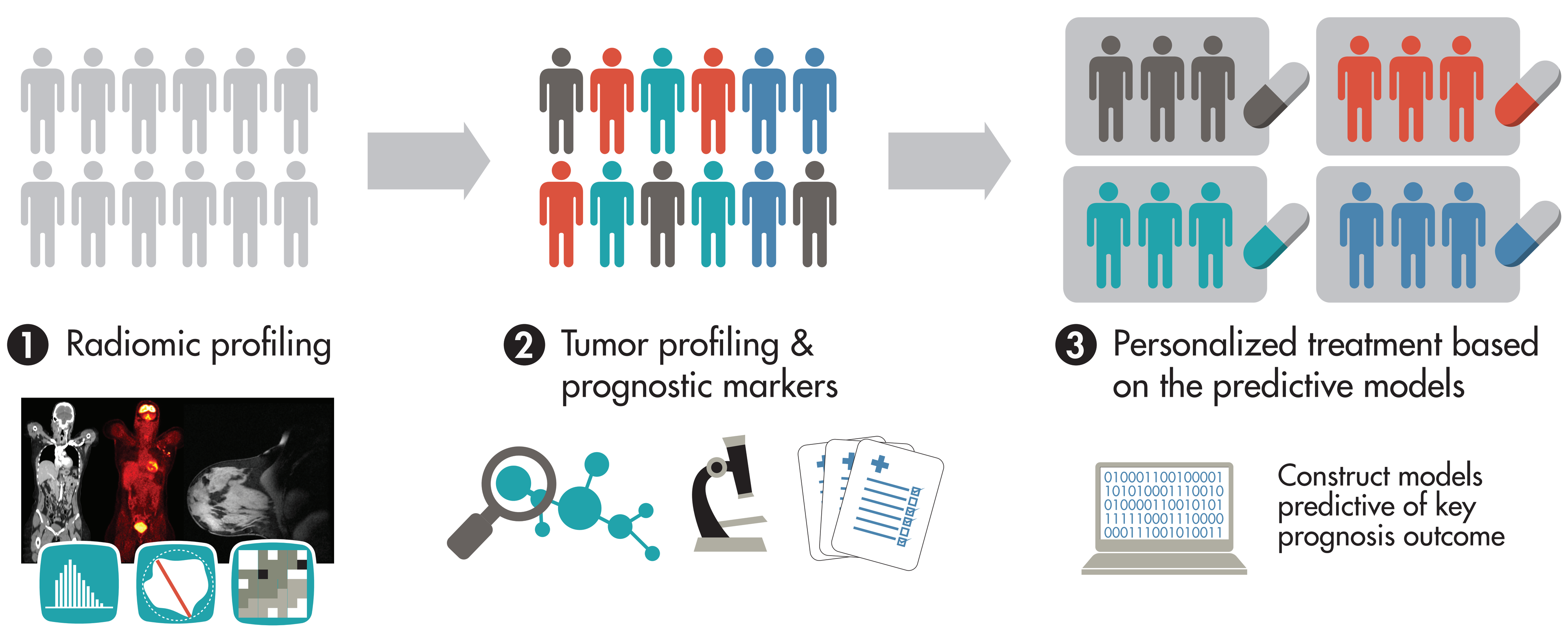
Why Radiomics?

- Improve cancer treatment with more precise and personalized disease management
- Radiomics from 3D imaging modalities has been shown useful for discovering imaging biomarkers[1]



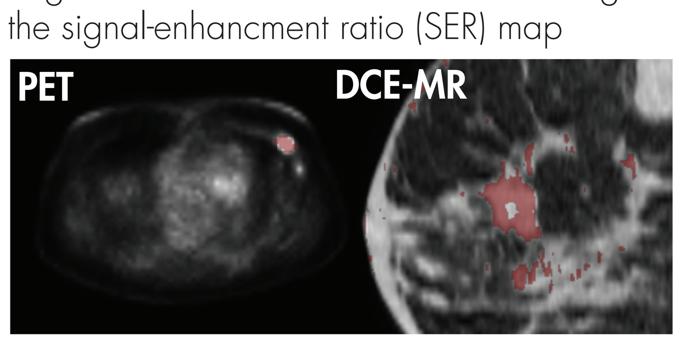
Radiomics Workflow

1 Data Collection

- PET and dynamic-contrast-enhanced MR (DCE-MRI) images from patients diagnosed with invasive breast cancer in 2003 - 2005
- All images were acquired ***prior*** to any surgery/treatment
- Gathered clinical data from the medical records and cancer registry including:
  - tumor histology, grade, T/N/overall stages
  - estrogen receptor (ER), progesterone receptor (PR), human epidermal growth factor receptor 2 (HER2) status
  - recurrence site, status, and duration until recurrence/death since diagnosis

2 Tumor Segmentation

- Manually segmented tumors from the SUV-converted PET images using MeVisLab©
- Segmented tumors from the DCE-MR images by the signal-enhancement ratio (SER) map



3 Radiomic Feature Extraction

- 8 First-order statistics
- 9 Shape and size features
- 25 3D Gray level co-occurrence matrix (GLCM) texture features

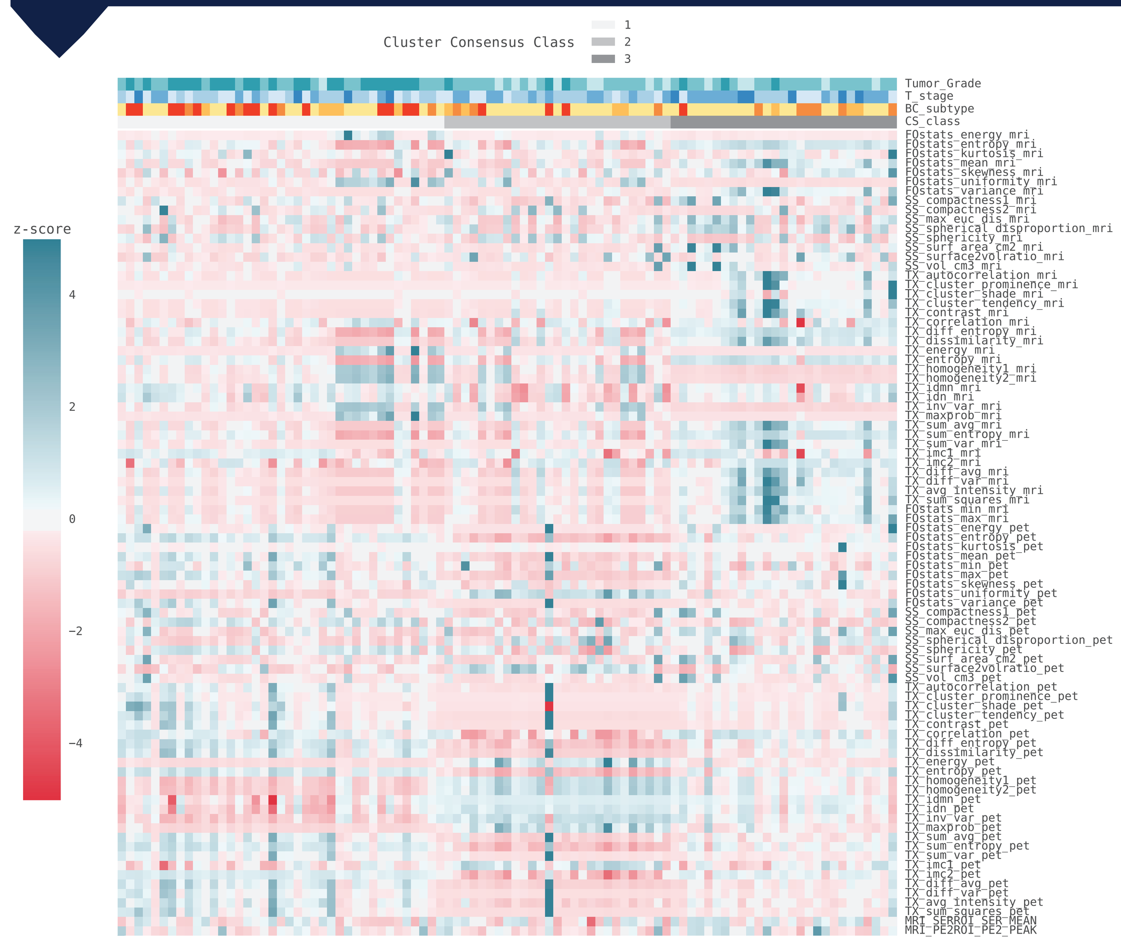
- Images were re-sampled to isotropic voxel size
  GLCM matrices were created with fixed bin width
- Computed with in-house Python-ITK[2] software and validated with pyradiomics open-source software[3]

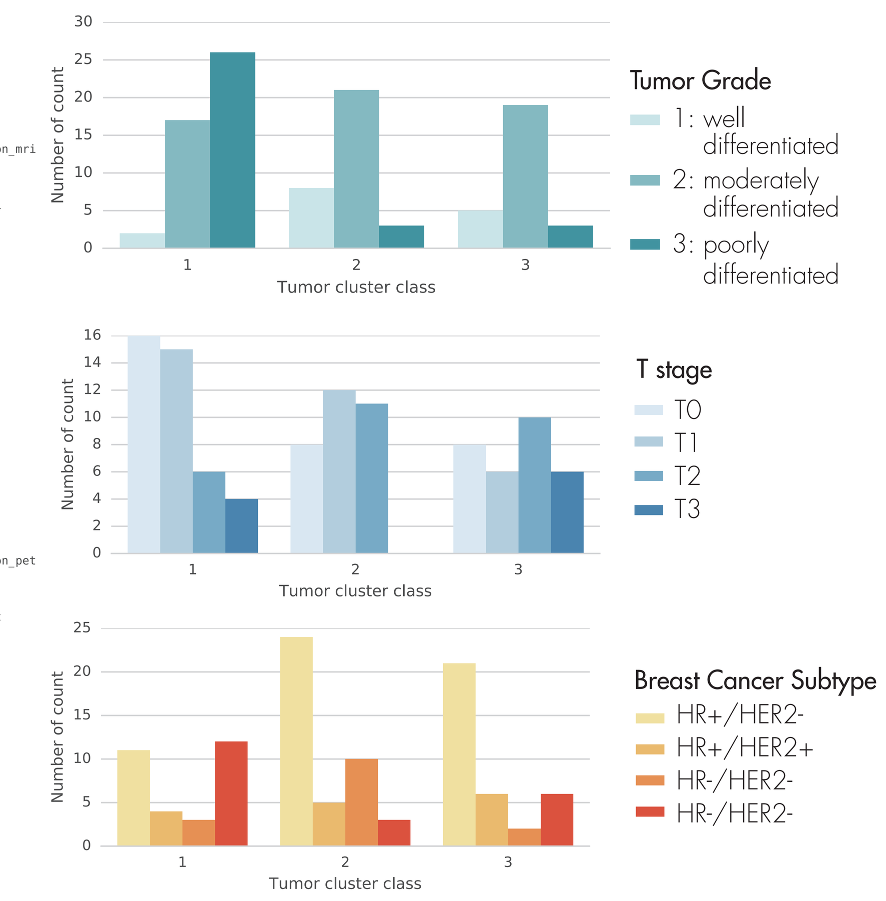
4 Clustering and Statistical Analysis

- Performed unsupervised clustering using concensus clustering implemented in R[4]
- χ^2 test for significant association between the tumor clusters and tumor profiling variables
- Computed correlation coefficients for any inference between each radiomic feature to the outcome
  - Ordered variables: Spearman's rank correlation coefficients
  - Un-ordered variables: multiple-regression correlation coefficients

What Did We Find?

- Observed PET and MR radiomics pattern among the tumor clusters
- Higher grade tumors found in **tumor cluster 3** (χ^2 test P-value = 7.9×10^{-6})
- Lower T-stage tumors found in **tumor cluster 2** (χ^2 test P-value = 4.0×10^{-2})
- Triple-negative tumors found in **tumor cluster 1** (χ^2 test P-value = 8.9×10^{-3})



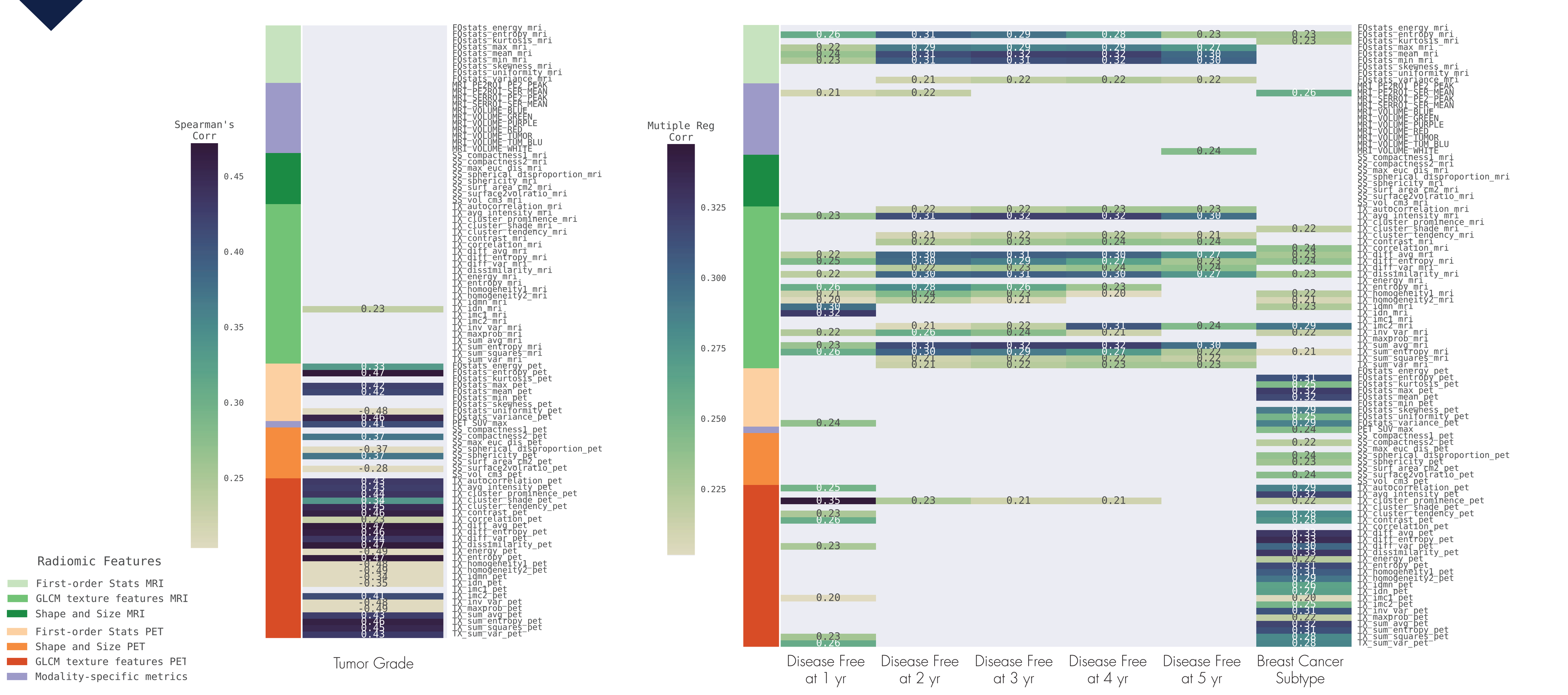


Potential imaging biomarkers

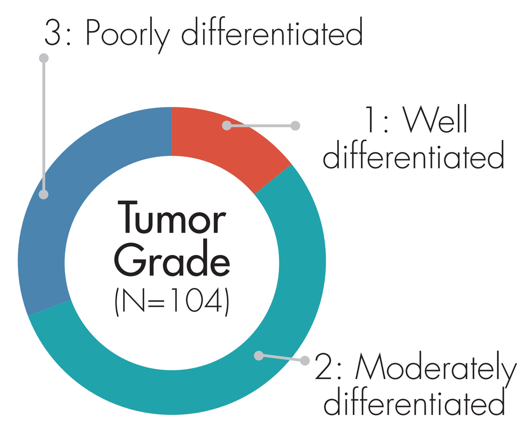
Tumor Grade
- PET image 1st-order entropy and uniformity
- PET image texture difference average and dissimilarity

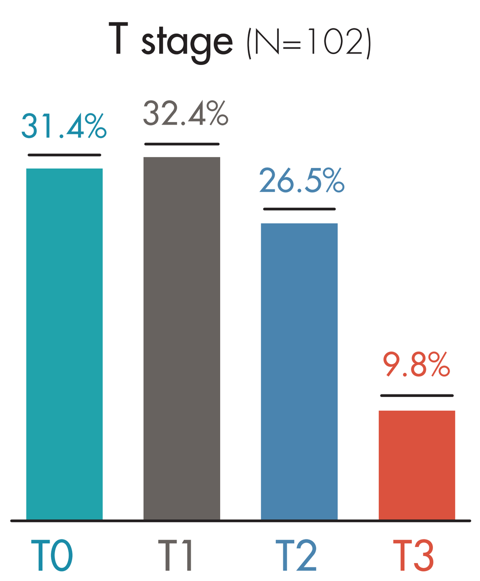
Breast Cancer Subtype
- PET image texture difference average and entropy
- PET image texture sum average
- PET SUV_{max} and SUV_{avg}

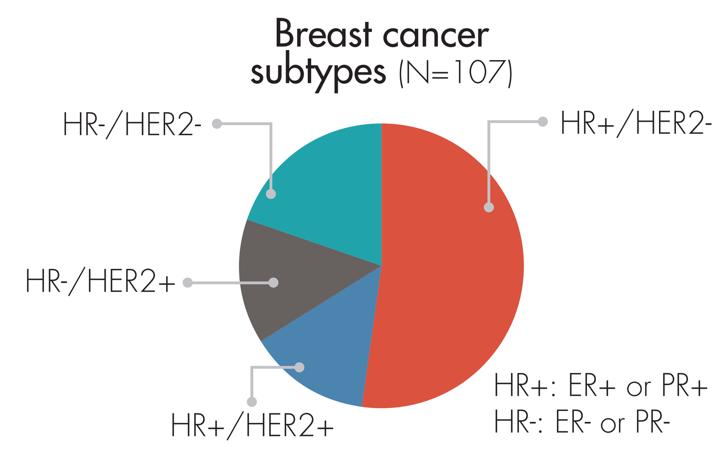
Disease Free Status
- MR image mean and minimum
- MR image texture features average intensity, sum average, difference average, and dissimilarity
- PET image texture cluster prominence

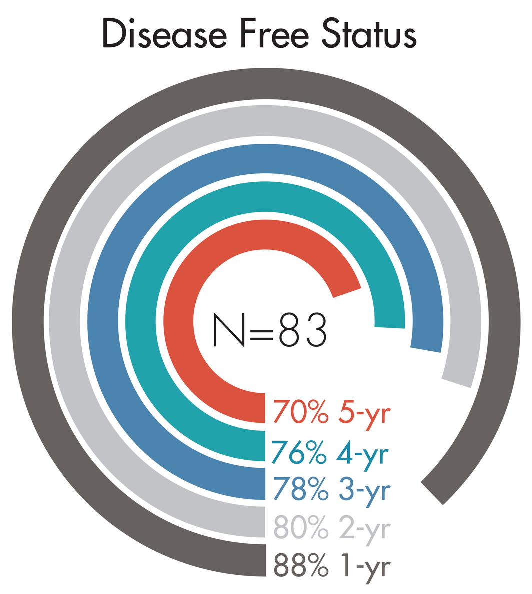


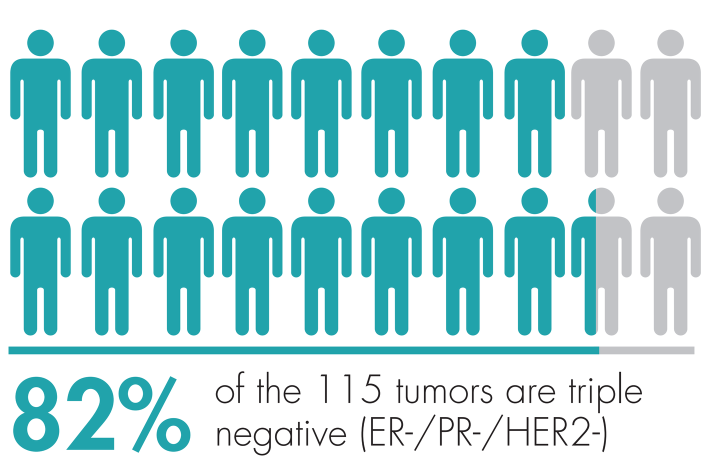
Patient Demographics











Conclusion

- Extracted and validated PET and MR image radiomics
- Unsupervised clustering show radiomic features have potential for predicting tumor profiling
- Texture features of PET and MR images, in addition to first-order image statistics, could be key imaging biomarkers in building a predictive model for breast cancer diagnosis and prognosis

Thank You

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