Multimodal Deep Learning for Breast Cancer Neoadjuvant Therapy Outcomes

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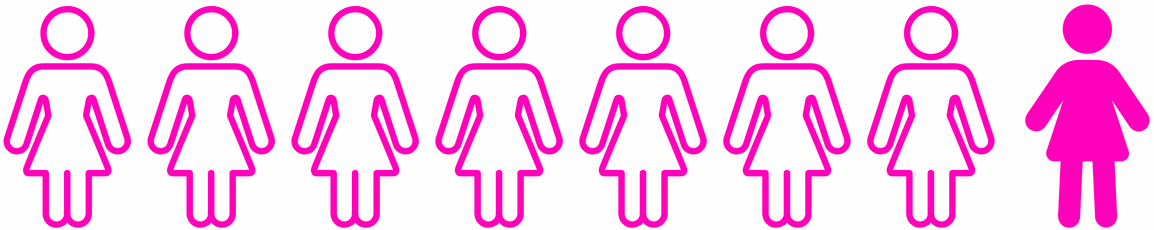
Disclosures

Leila Abdelrahman is an M1 student at the Charles E Schmidt College of Medicine has no disclosures to report.

Significance

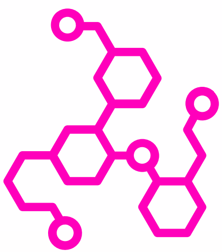
Nearly 1 in 8 Women are Diagnosed with Breast Cancer Each Year

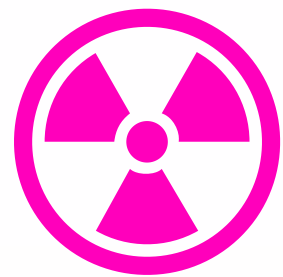


This is very personal because my own family members have breast cancer

Neoadjuvant Therapy

Therapy given prior to reduce/stop tumor growth priro to main treatments (usually invasive surgery).





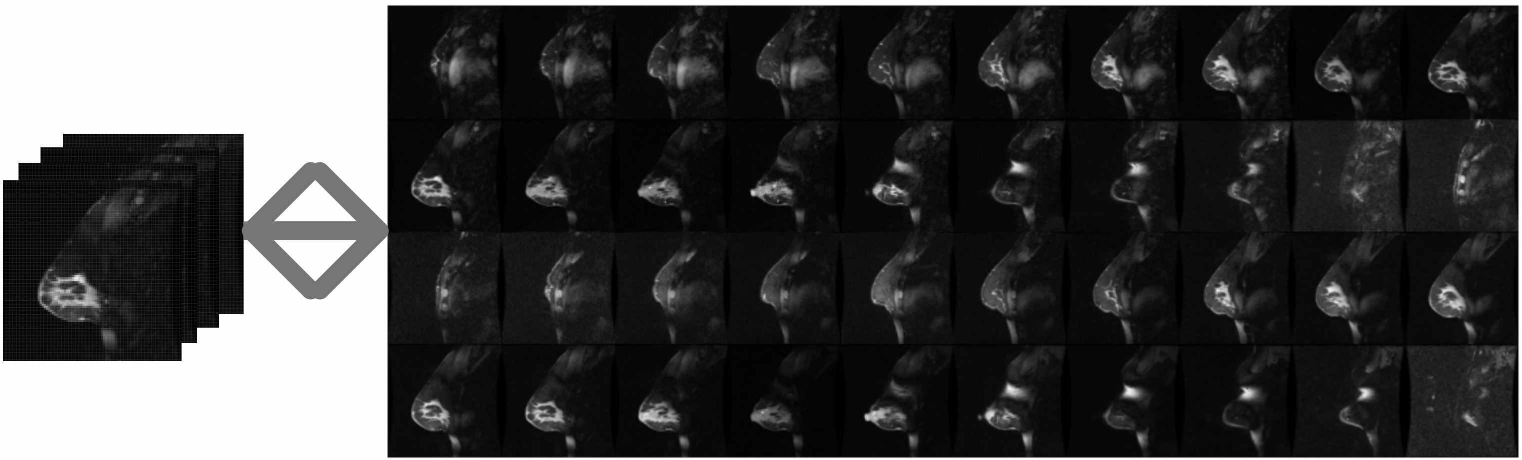
Current Challenges

- Balancing treatment efficacy with toxicity
- **Idenitfying early treatment resistance**
- Creating optimal, patient-centered treatment combinations

Defining the Problem

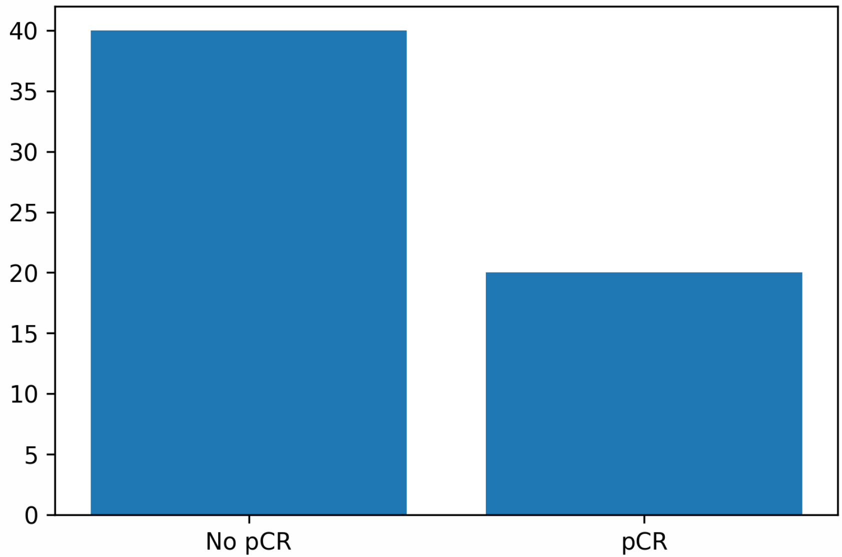
Can we combine MRI imaging data before treatment along with clinical biomarkers ranging from age, race, and HER2 status to predict if a patient can respond to neoadjuvant systemic therapy (NST) using the pathologic Complete Response (pCR) as a response metric?

ISPY-1 Dataset: MRI



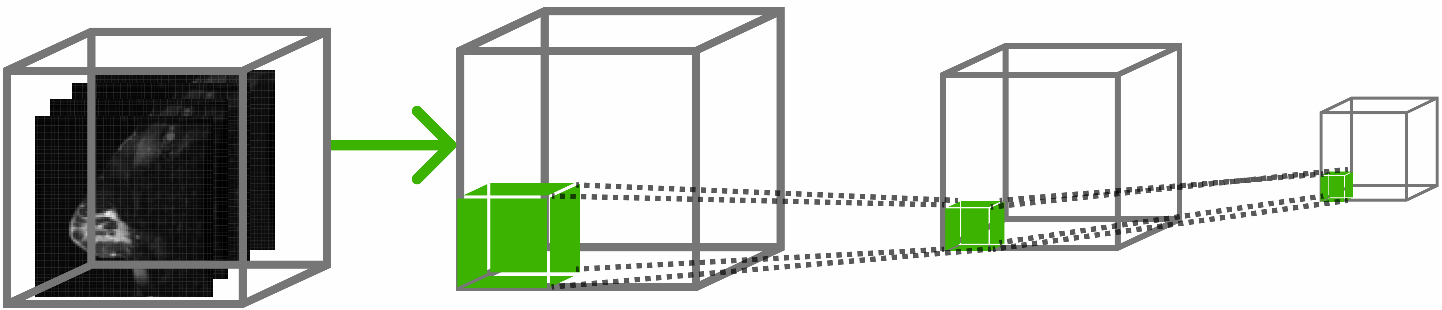
The MRI images were interpolated along the z axis to yield 60 slides in total.

ISPY-1 Dataset: Distribution



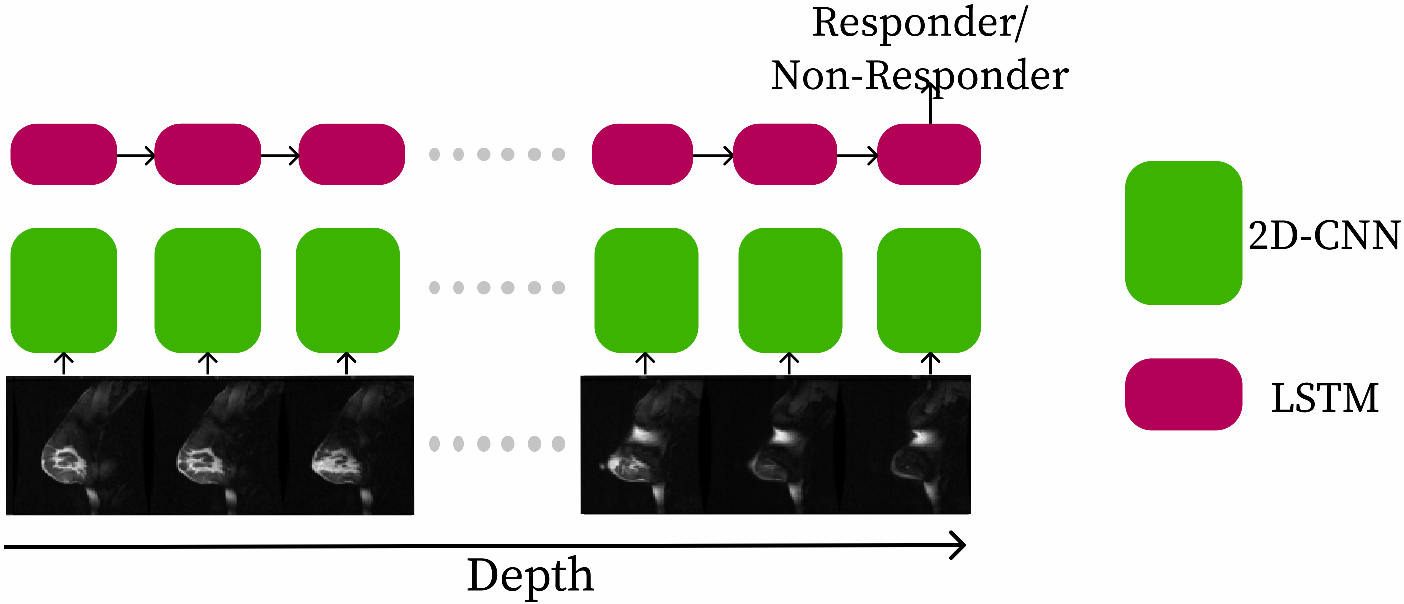
There was significant class imbalance, with the dataset containing more non-responders than responders.

3D CNN



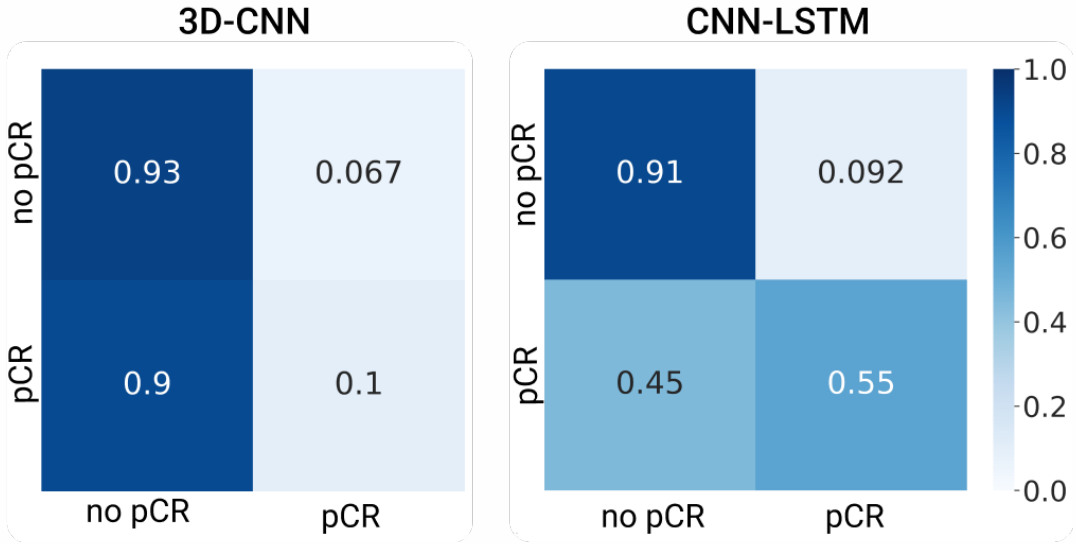
The 3D-CNN uses sequential convolutions to learn image features and generate 3D feature maps in an end-to-end manner.

3D CNN - LSTM



The CNN-LSTM generates feature maps for each image slice and uses the prior slice's features to inform the next slice.

Imaging Unimodal Results



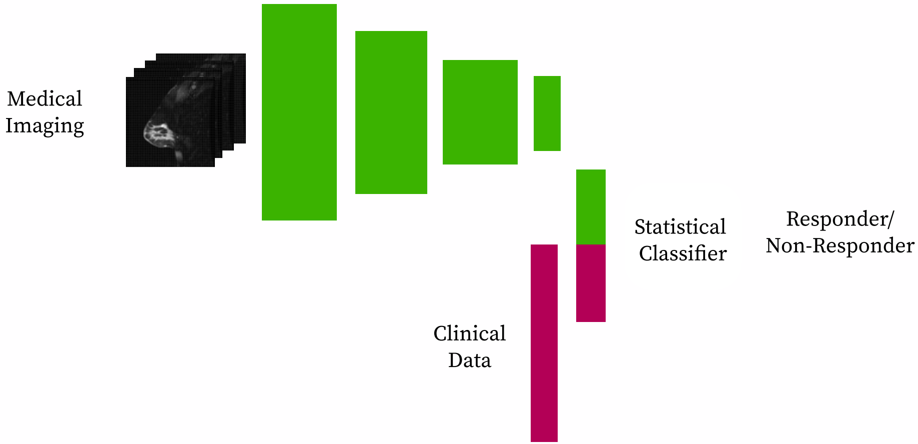
Confusion matrices for the predictive models using only images. The CNN-LSTM had better performance and we userd that as part of our fusion model.

Clinical Unimodal Results

Model Type	Accuracy
SVM	0.667 %
Random Forest	0.600
Logistic Regression	0.5833
Shallow Neural Network	0.6
Soft Voting Ensemble	0.600
Hard Voting Ensemble	0.566

Accuracy results for the different statistical classifiers on the clinical data (age, race, HER2, etc) alone, without imaging. The SVM had the highest individual performance.

Fusing Images + Clinical Points



Multimodal Fusion Results

Fusion Combination and	Accuracy
CNN-LSTM + Random Forest	0.715
CNN-LSTM + SVM	0.839
CNN-LSTM + Logistic Regression	0.666
CNN-LSTM + Shallow Neural Net	0.613

The CNN-LSTM + SVM had the best overall fusion results.

Conclusion & Discussion

-Data distribution was a limiting factor and developing ways for a more balanced dataset could improve results

-Investigating other fusion methods, including convolutions and earlier fusion is open for investigation

-This work can greatly improve how physicians decide how to prescribe NST for patients.