



Stanford
MEDICINE

PViT-AIR

Puzzling Vision Transformer-based Affine
Image Registration for Multi Histopathology
and Faxitron Images of Breast

Negar Golestani

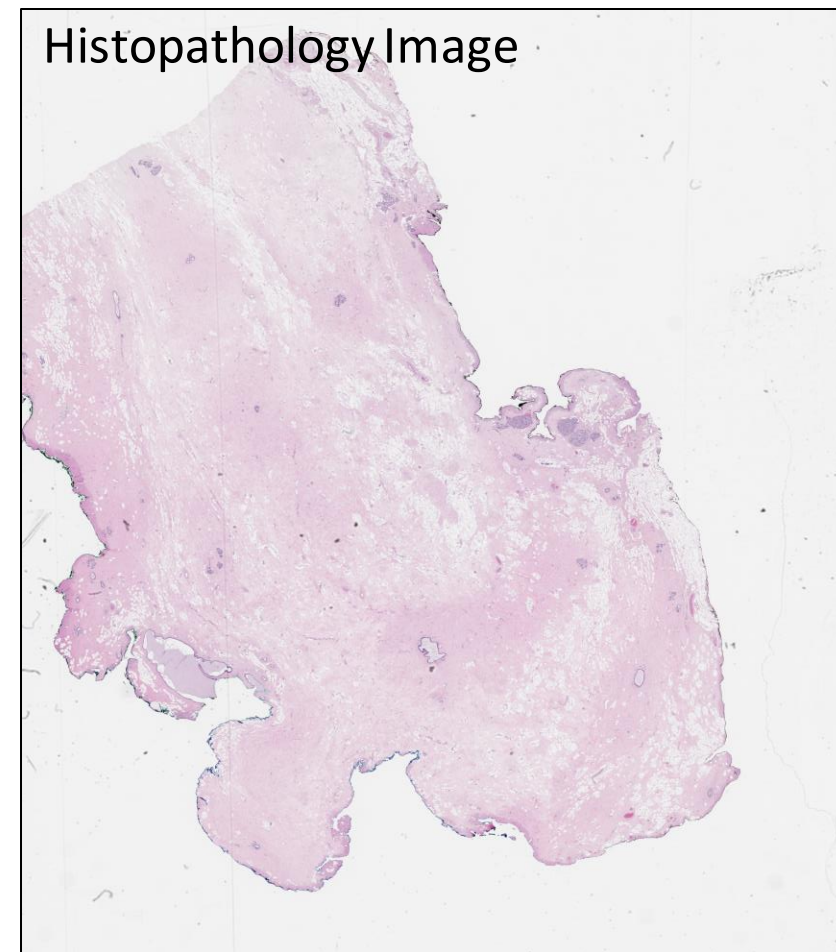
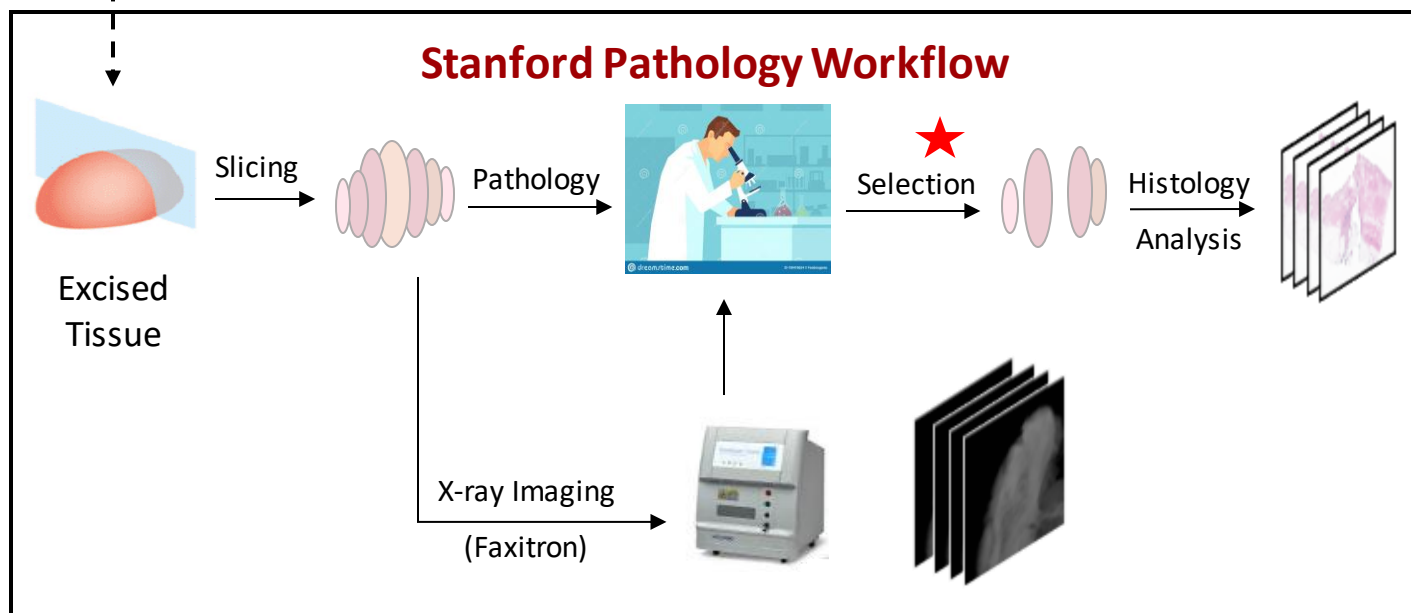
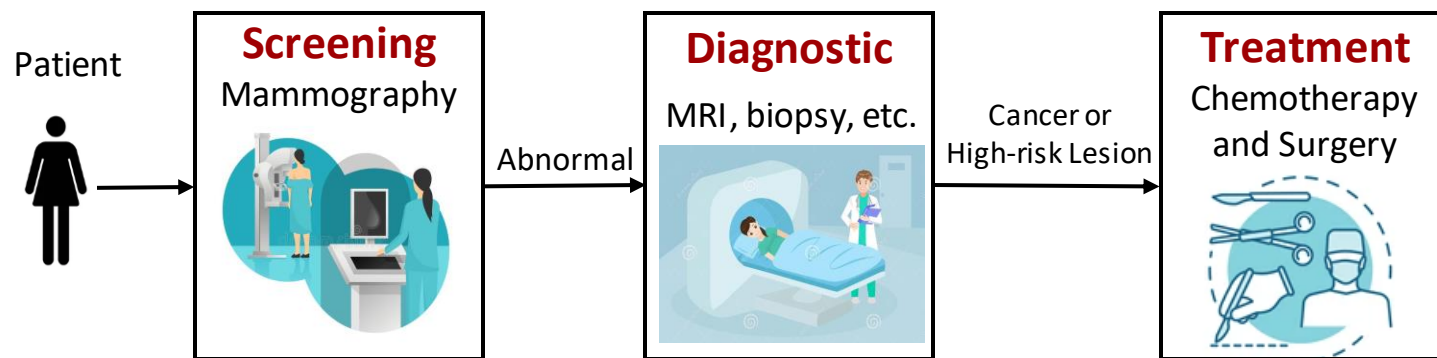
July 2023

Introduction

- **One woman in eight** with invasive **breast cancer** over her lifetime
 - In 2022, estimated 287,850 new cases and 43,250 deaths among women in the US*
- **Neoadjuvant chemotherapy** for treatment before surgical excision
 - helps reduce recurrence risk, extent of surgery, and post-operative complications
- After surgery, **study excised tissue to assess treatment**
 - **Presence and extent** of residual invasive cancer is a strong **prognostic factor** for risk recurrence

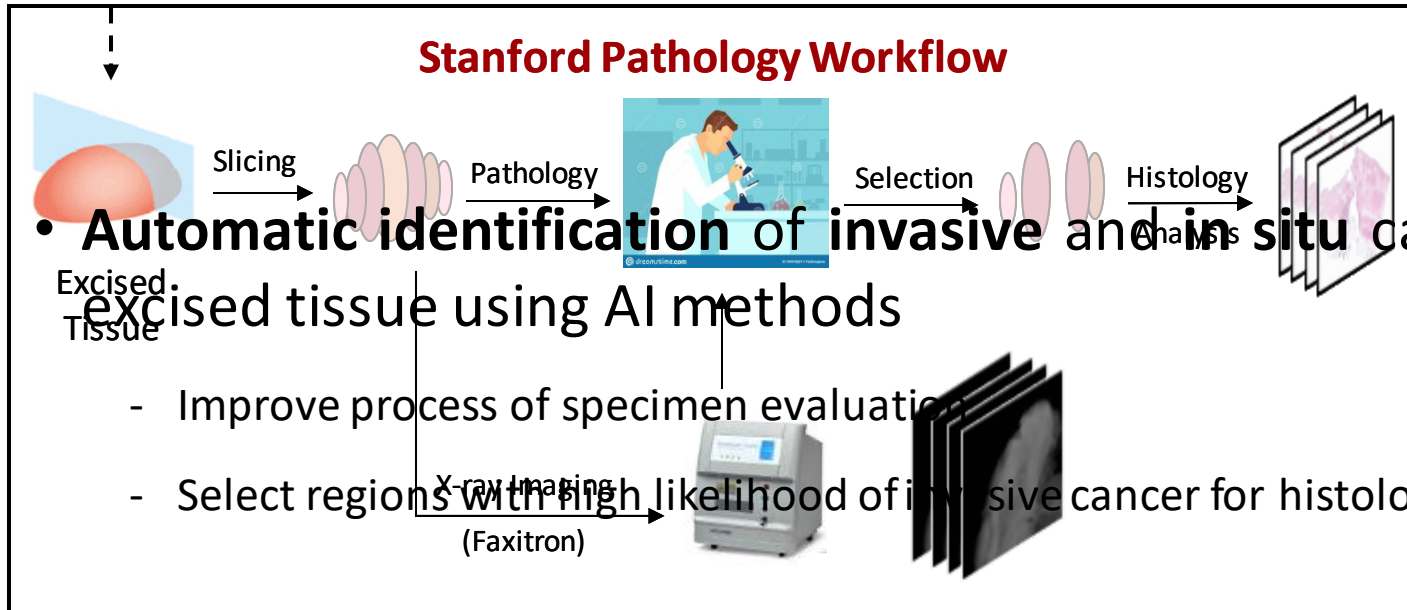
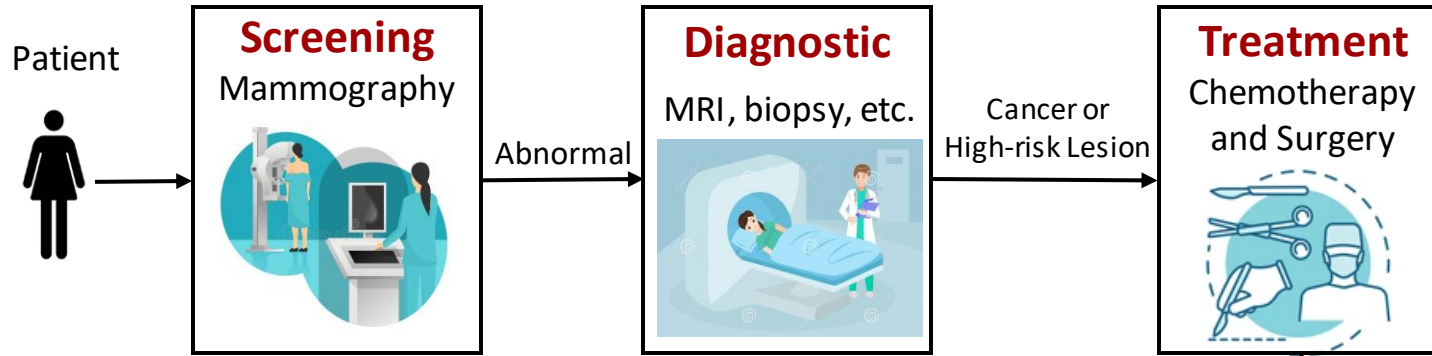


Pathology Workflow



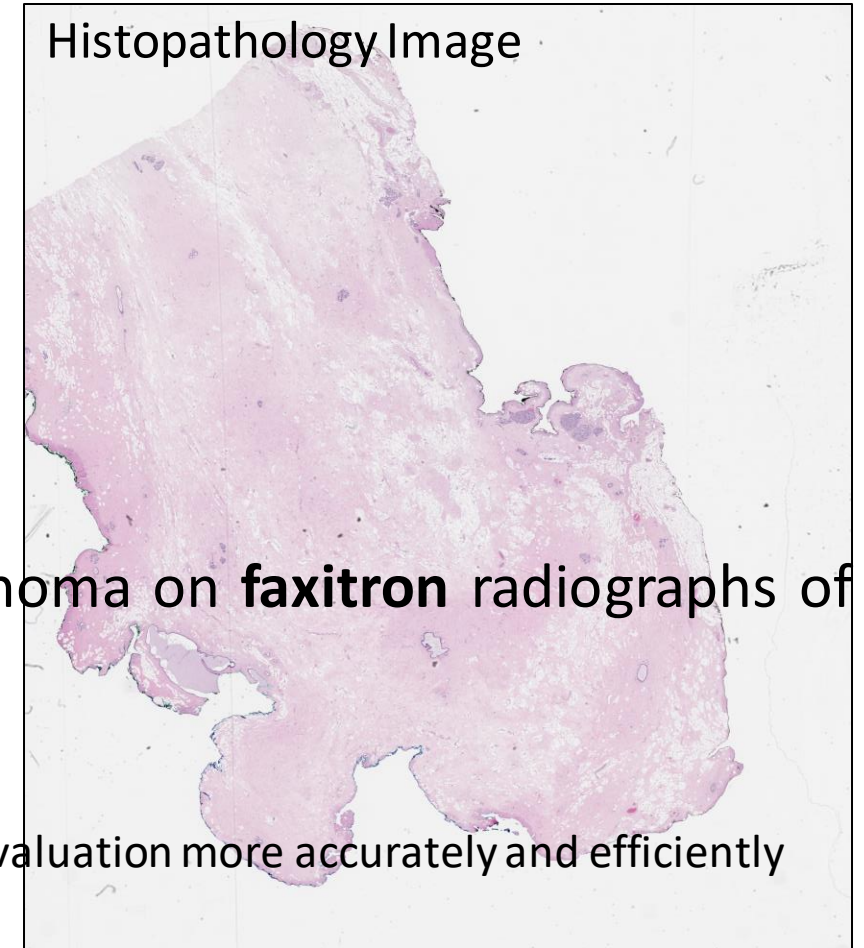
• Photos: <https://www.vectorstock.com>, <https://www.dreamstime.com>

Motivations



• **Automatic identification of invasive and in situ carcinoma on faxitron radiographs of excised tissue using AI methods**

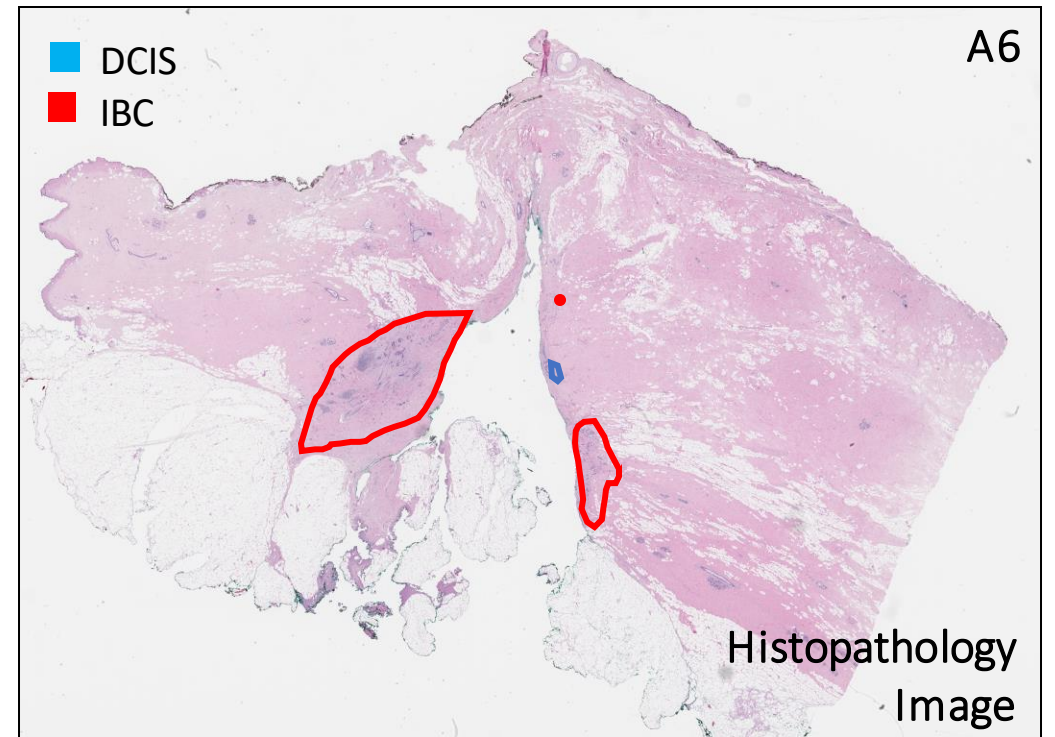
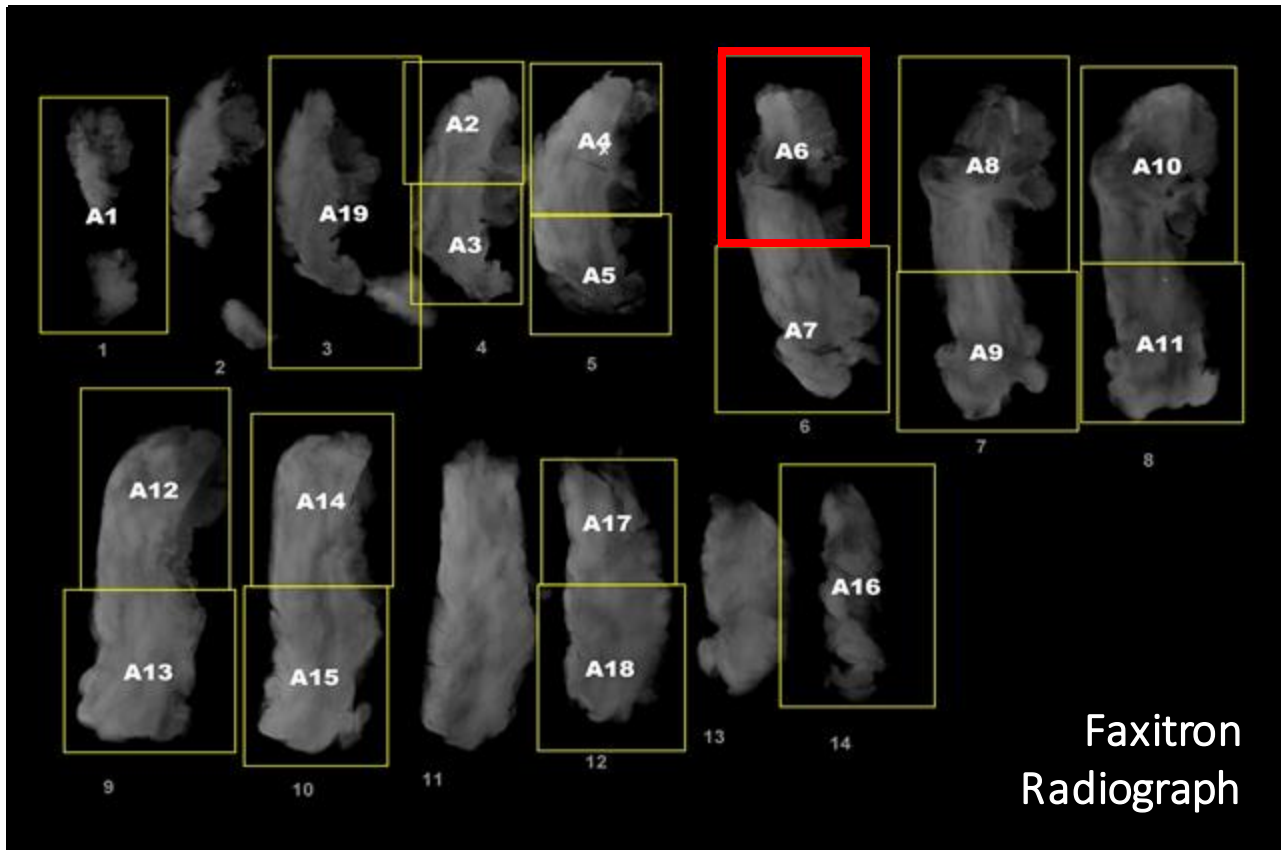
- Improve process of specimen evaluation
- Select regions with high likelihood of invasive cancer for histologic evaluation more accurately and efficiently



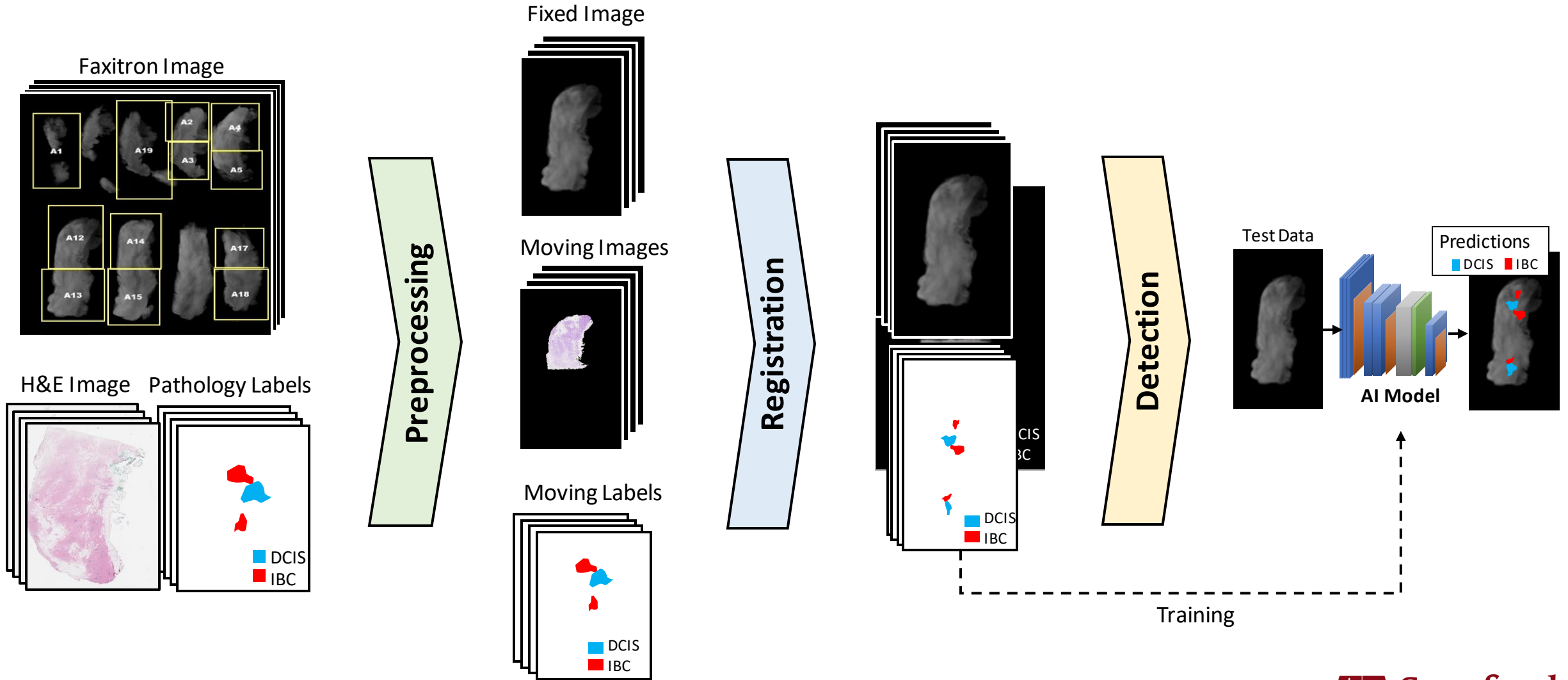
• Photos: <https://www.vectorstock.com>, <https://www.dreamstime.com>

Data

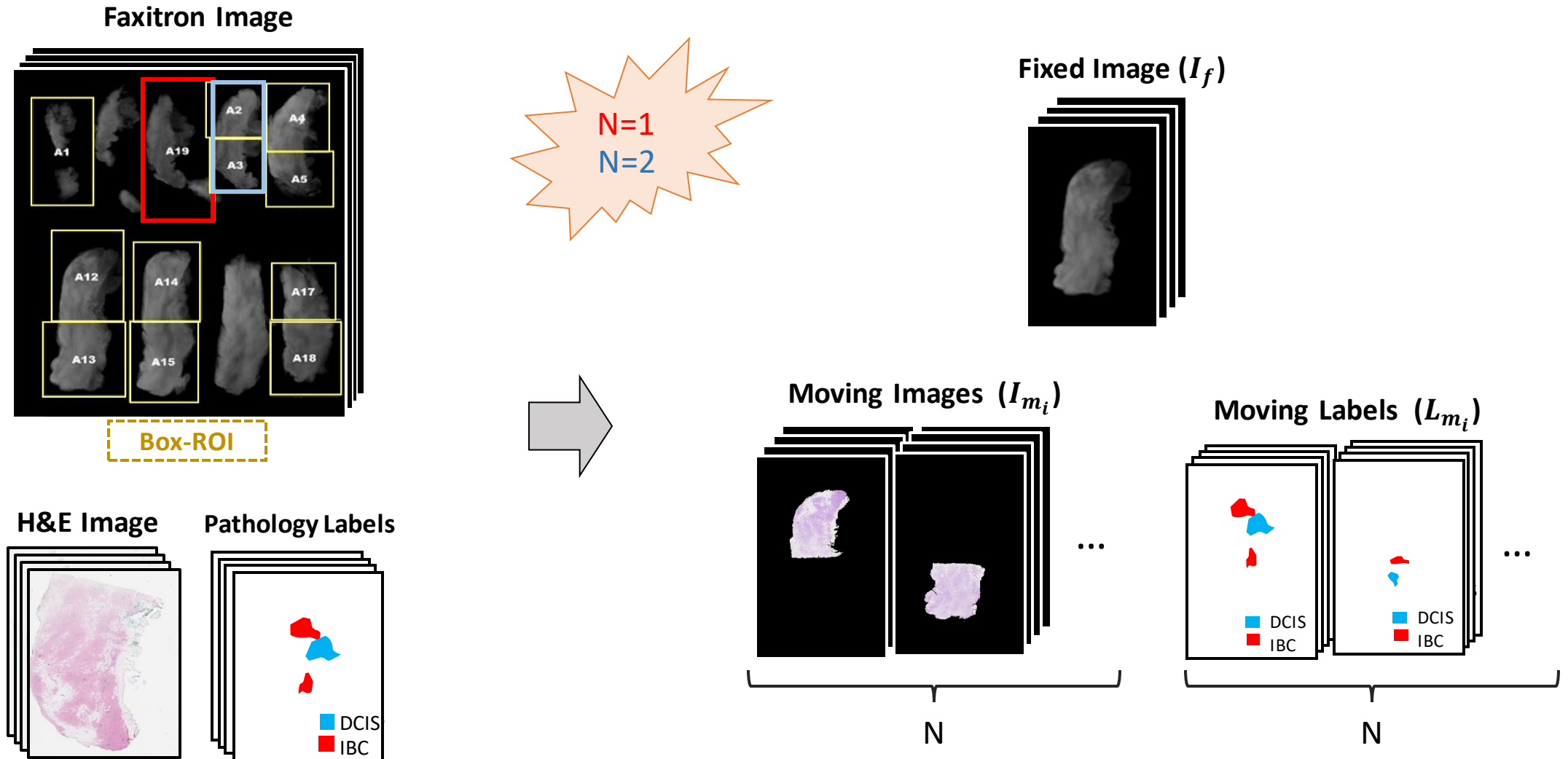
- Data of 100 women, including Faxitron radiographs and Histopathology slides



Framework

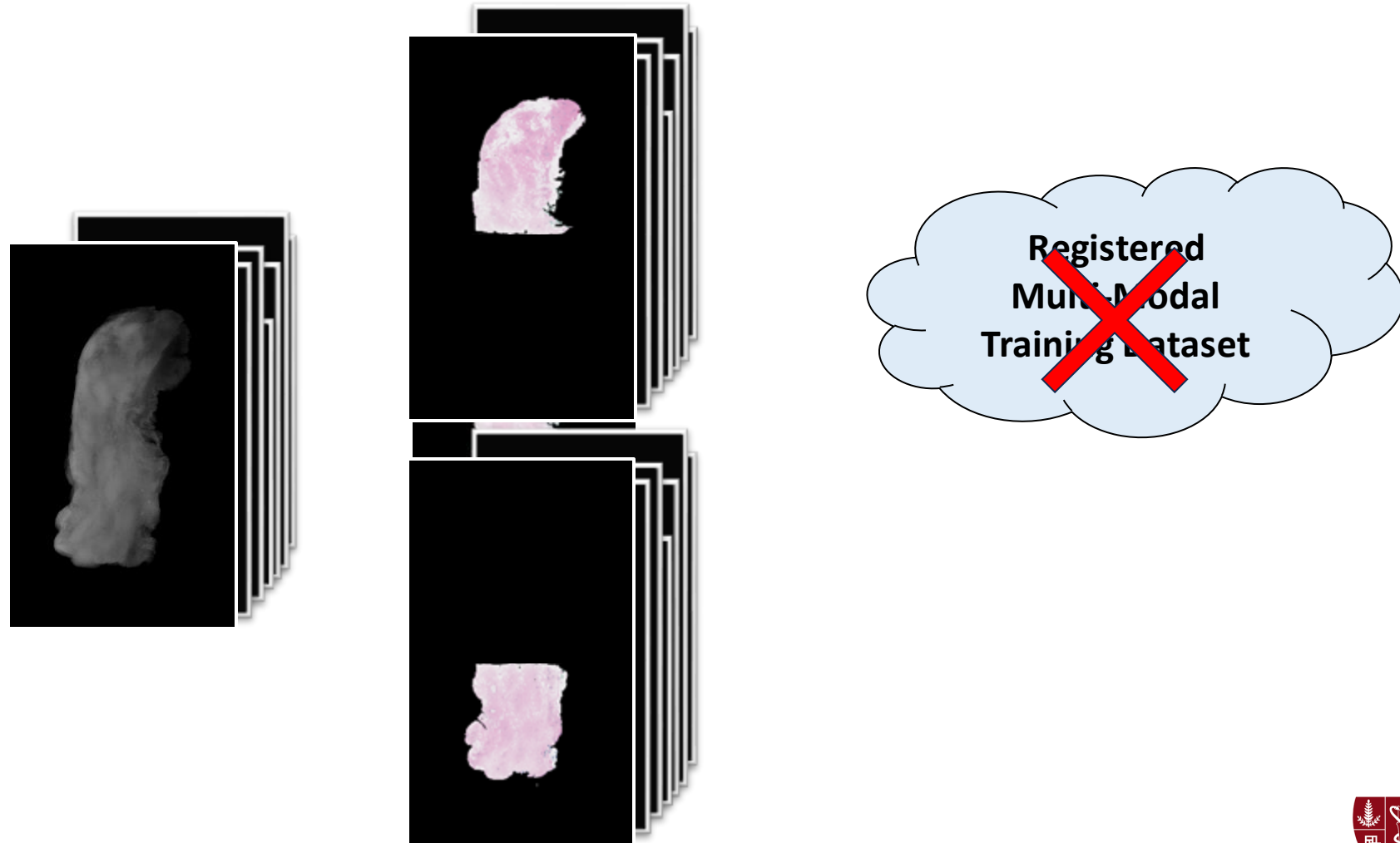


Data Preprocessing



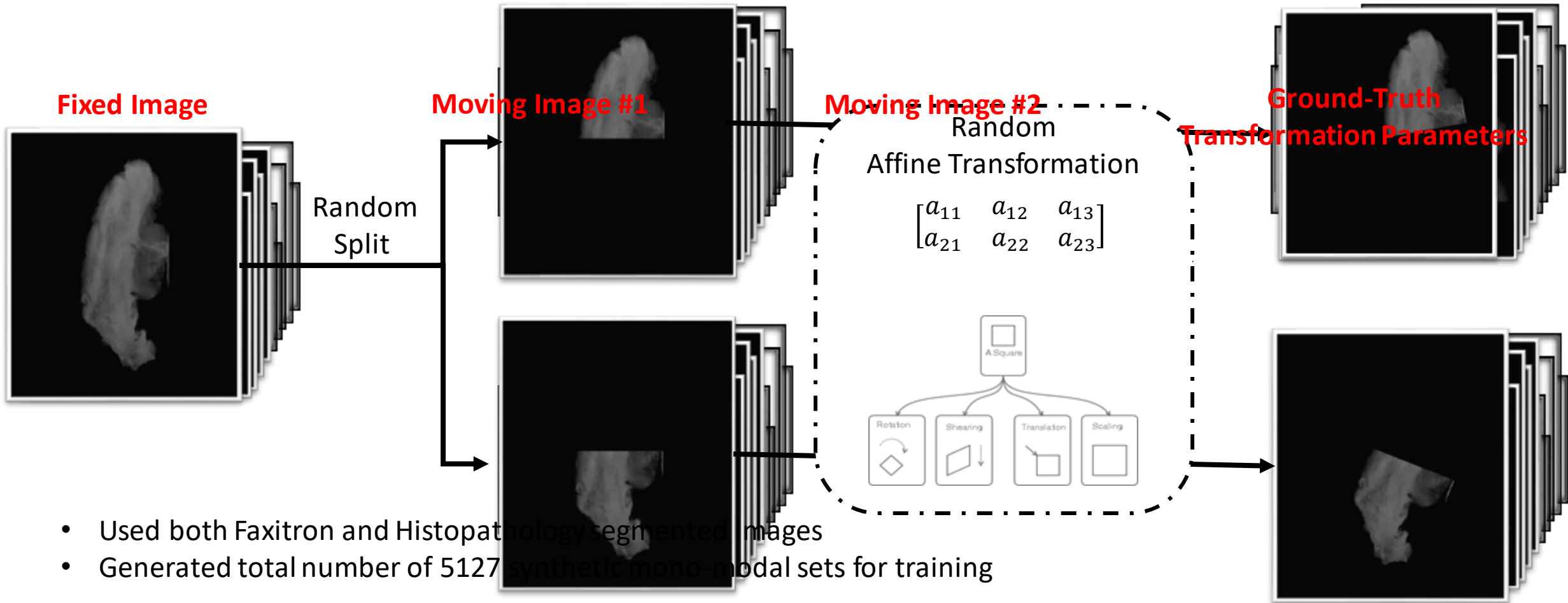
Training Dataset

Registered Multi-Modal



Training Dataset

Synthetic Mono-Modal



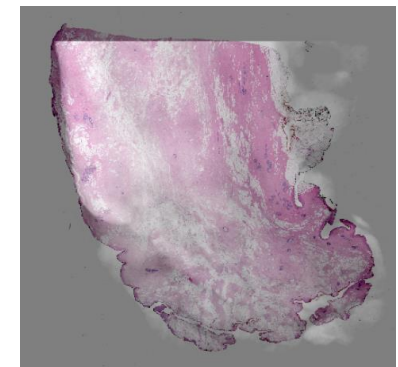
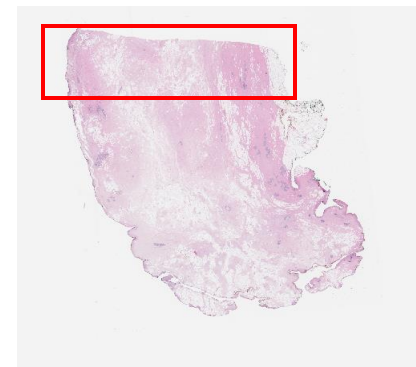
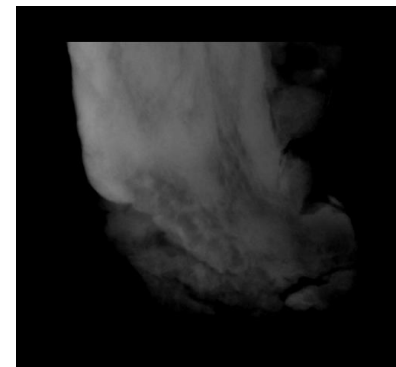
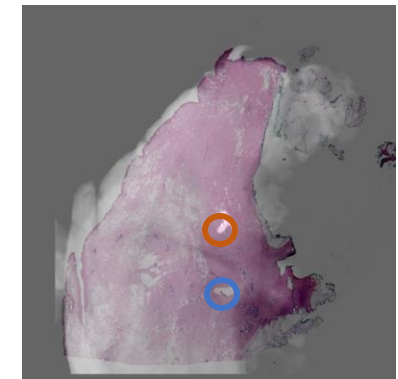
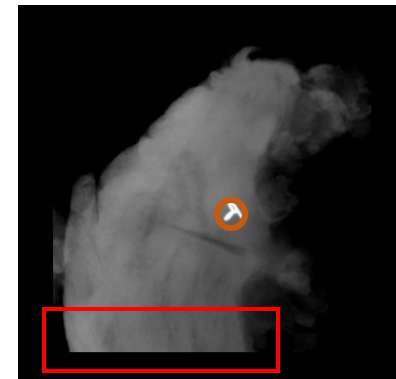
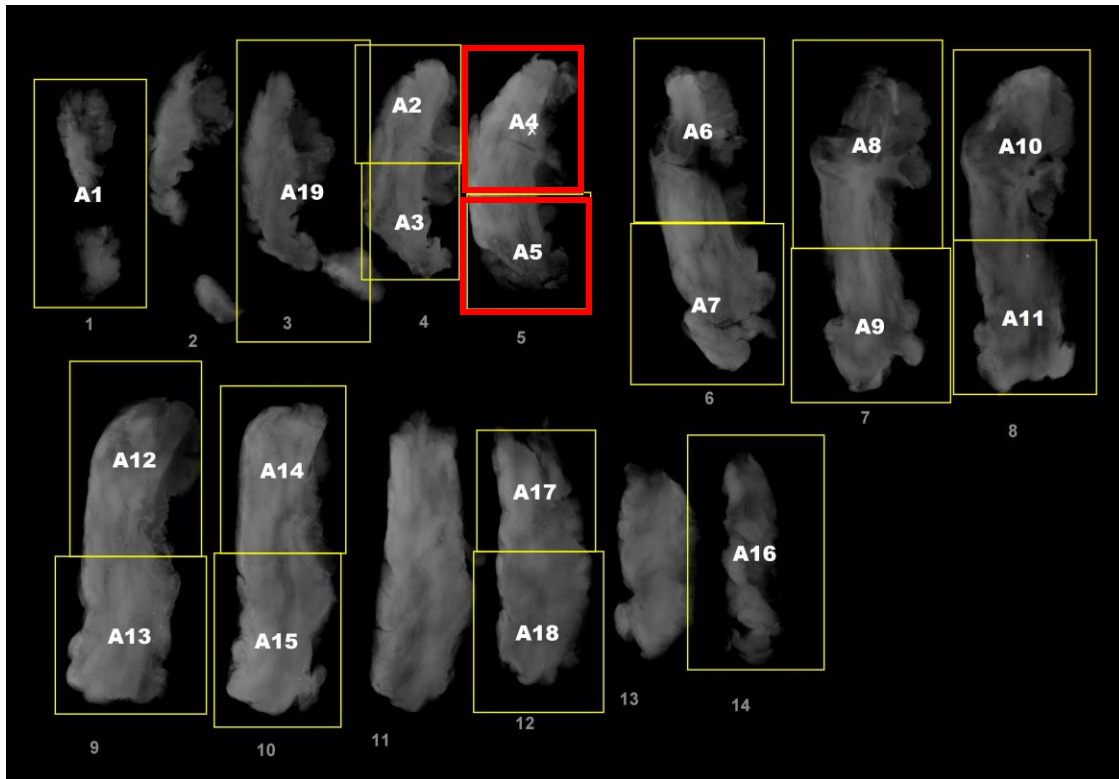
- Used both Faxitron and Histopathology segmented images
- Generated total number of 5127 synthetic mono-modal sets for training

Baseline Methods

Segment to Segment Registration

Traditional Iterative Method (SimpleITK): iterative process makes them computationally intensive.

Deep Learning: CNNGeometric* and BreastRegNet



Fixed image

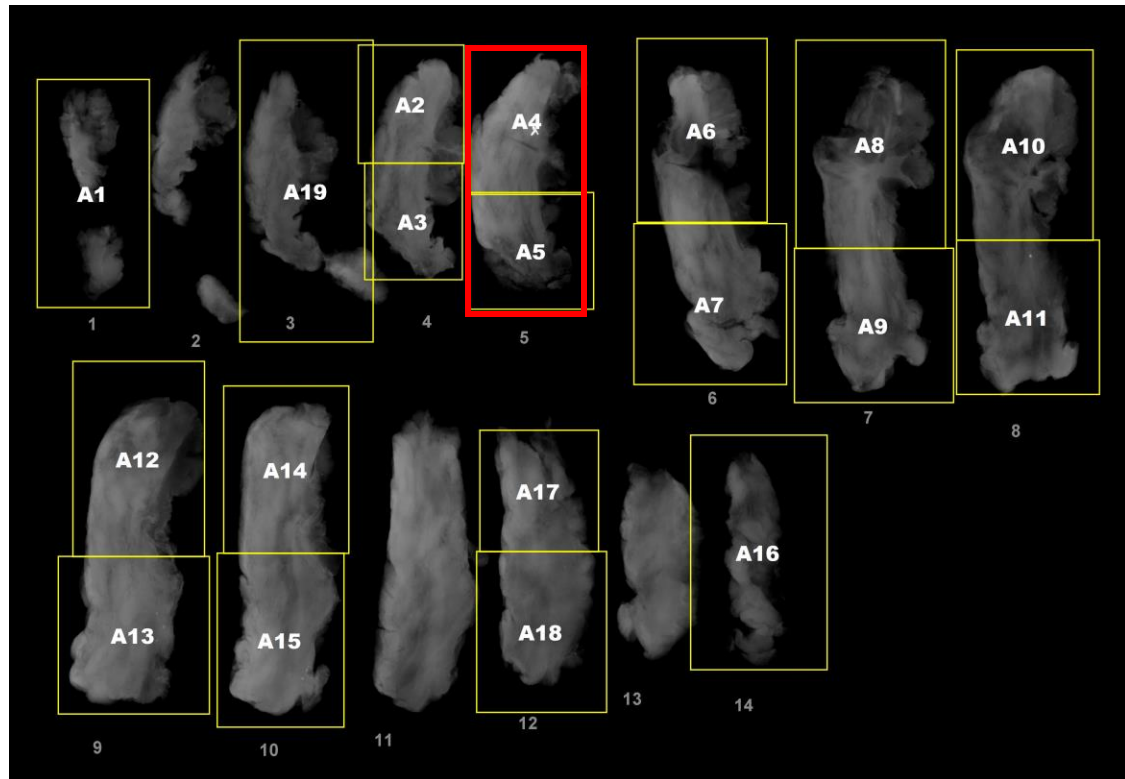
Moving Image

Registration Result

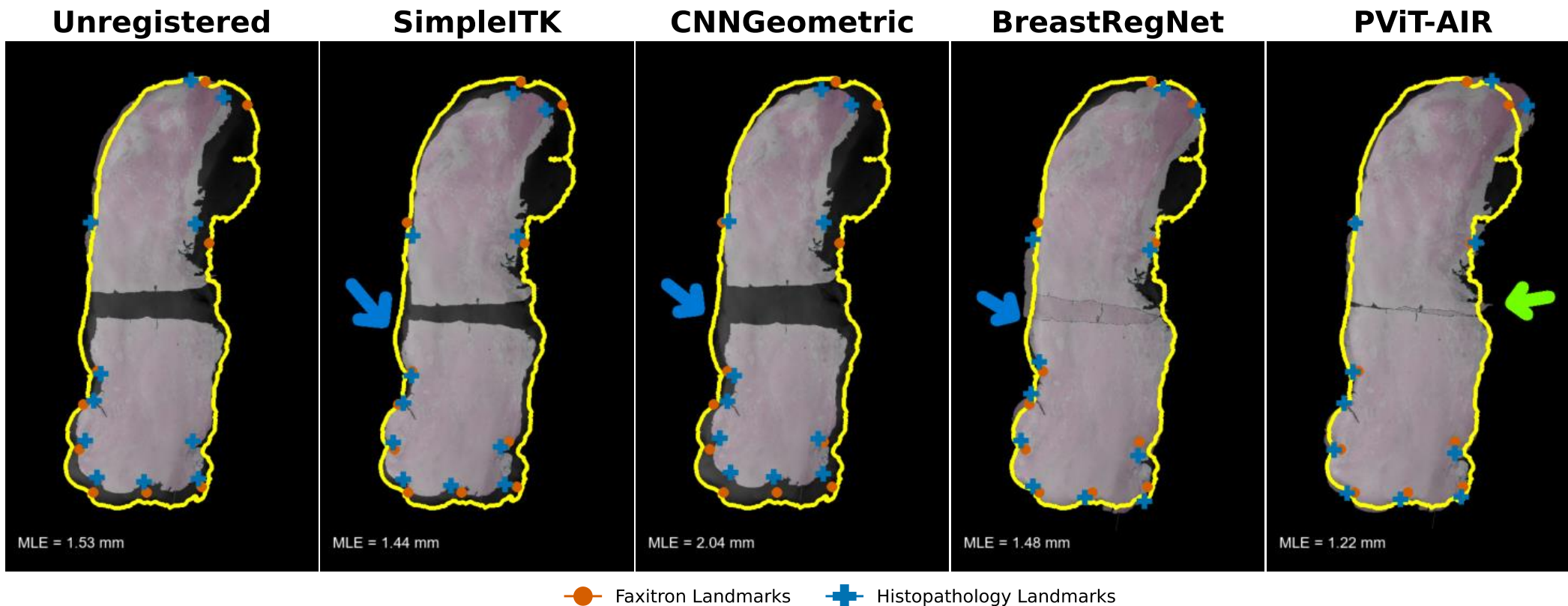
* Rocco, I., et. al, 2017. Convolutional neural network architecture for geometric matching, in: Proceedings of IEEE conference on computer vision and pattern recognition, pp. 6148–6157

PViT-AIR

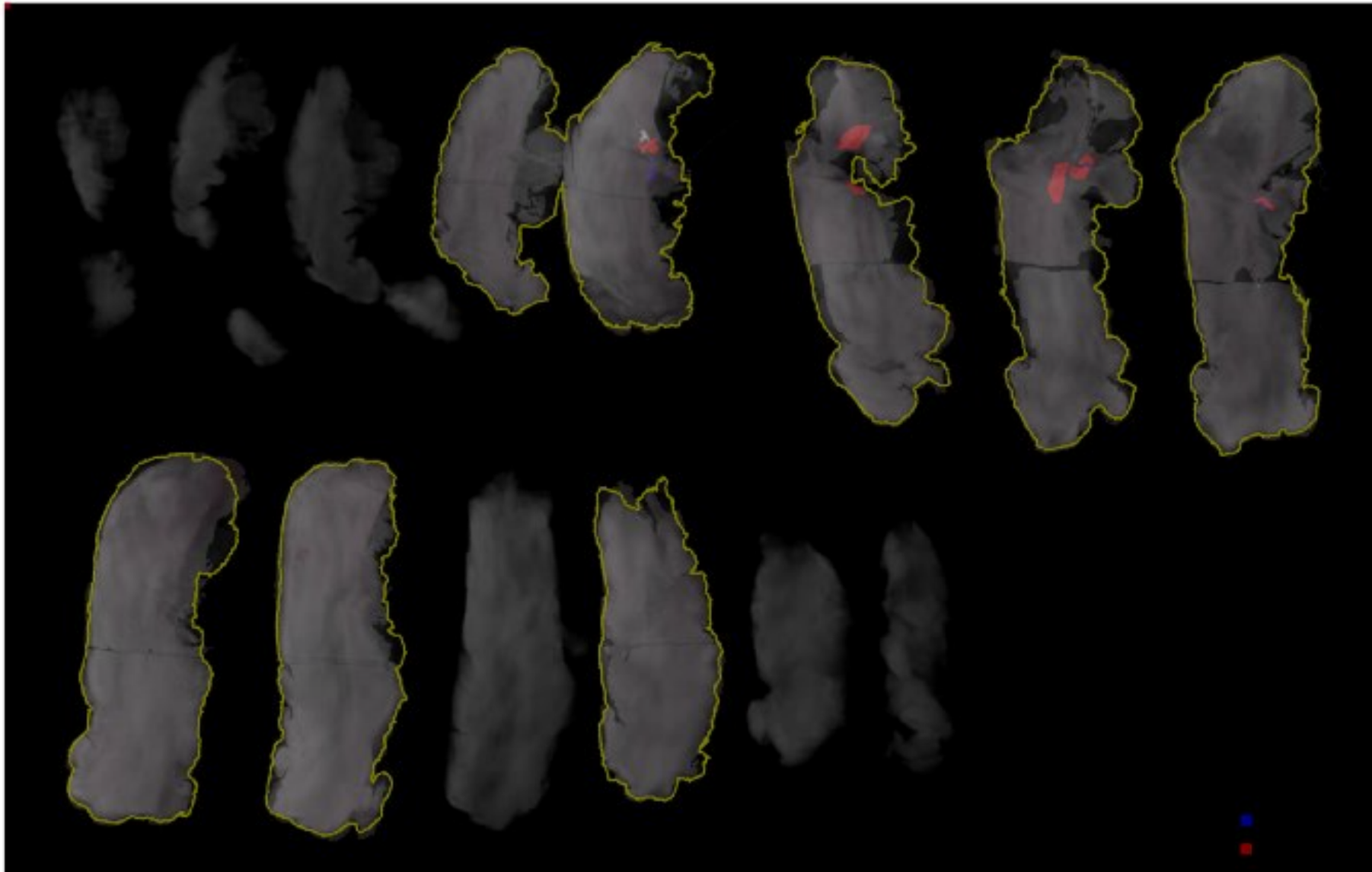
Multi-Segment to Slice Registration



Qualitative Results (1/2)



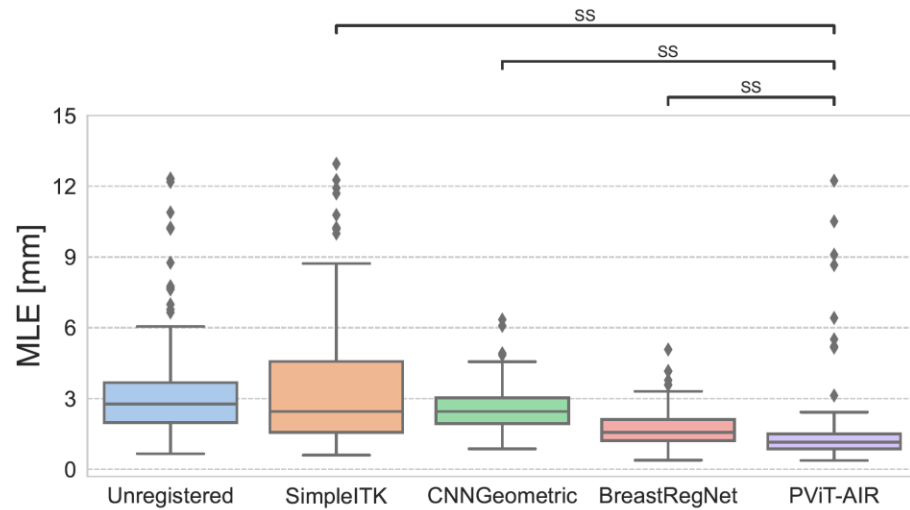
Qualitative Results (2/2)



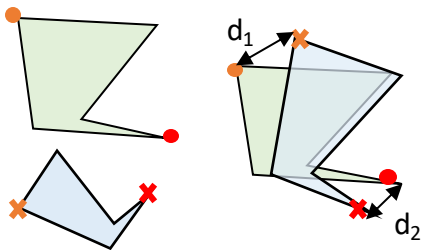
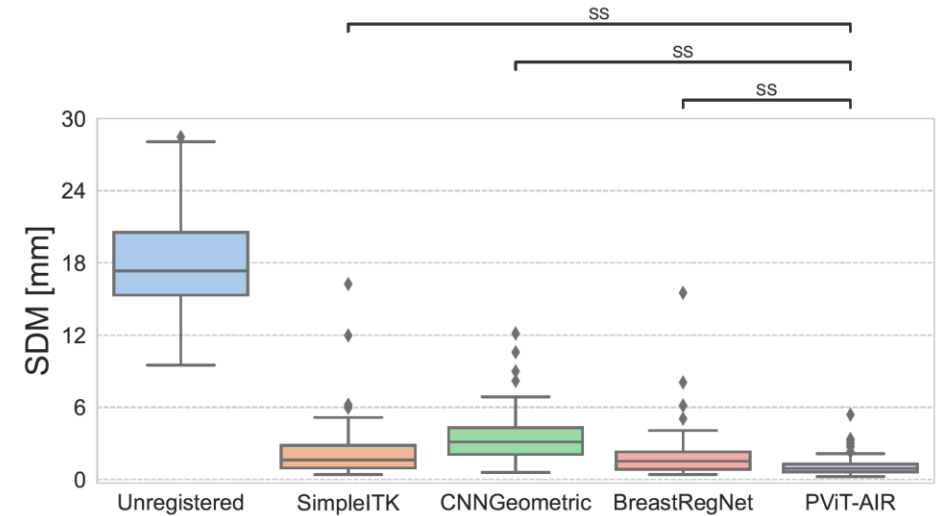
PViT-AIR registration results for all samples of a patient.

Quantitative Results (1/2)

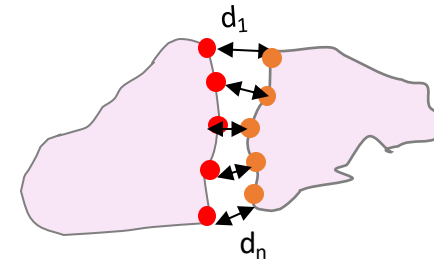
Mean Landmarks Error (MLE)



Stitching Distance Metric (SDM)



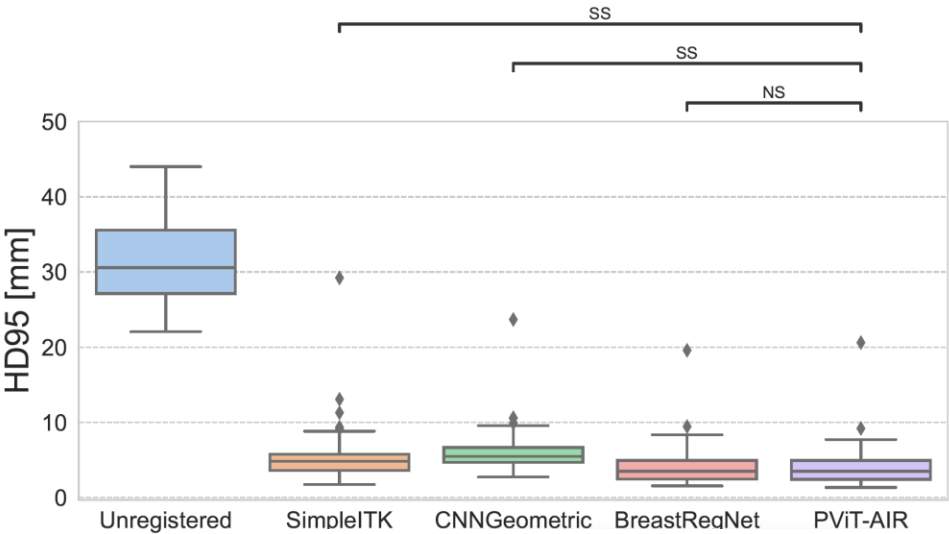
$$MLE = \frac{1}{N} \sum_{i=1}^N d_i$$



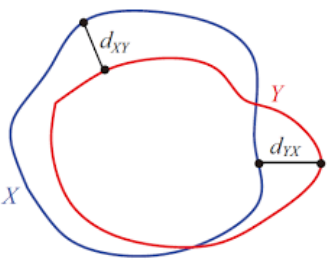
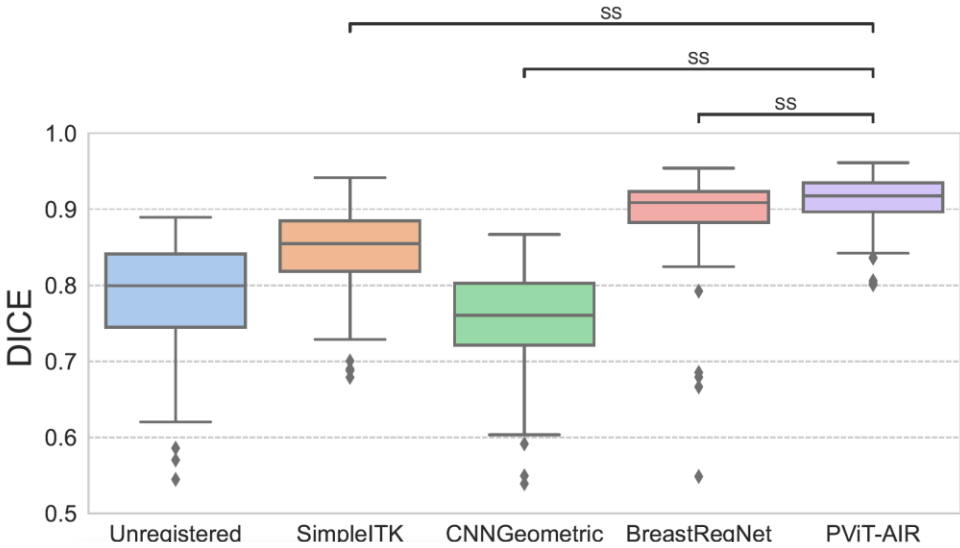
$$SDM = \frac{1}{N} \sum_{i=1}^N d_i$$

Quantitative Results (2/2)

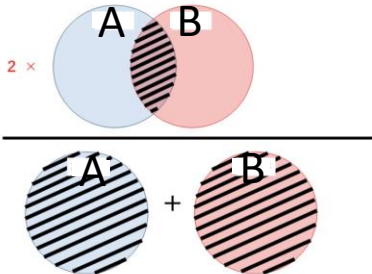
Hausdorff Distance (HD)



Dice Coefficient



$$HD = \max\{d_{XY}, d_{YX}\}$$



$$DICE = \frac{2|A \cap B|}{|A| + |B|}$$

Conclusion

- **Rad-path fusion framework** to improve pathologist workflow
- Alignment of histopathology and Faxitron radiographs for **mapping cancer labels**
- Train **deep learning models** to localize IBC and DCIS on Faxitron

Future work

- Train models to differentiate IBC from DCIS on **pre-surgical MRI**
 - Improves **management** of patients with DCIS
 - helps **guide biopsy toward aggressive** regions
 - facilitates early detection

Thank You!



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M E D I C I N E