DATA RESEARCH

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2nd EDITION

Prediction of Rectal Cancer Complete Response to Chemoradiotherapy by Multiscale Imaging and Deep Learning Analyses (PRECORMIDEL)

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THE CLINICAL PROBLEM

- Rectal cancer (RC) is a major contributor to colorectal cancer burden. For patients with locally advanced RC, neoadjuvant chemoradiotherapy (nCRT) is standard, yet only ~15% achieve a sustained clinical response [1].
- Response to nCRT varies greatly between individuals, biomarkers have shown limited reliability due to tumor heterogeneity [2], and predictions still rely mainly on stage and grade.
- Accurate response prediction is essential to safely implement watch-and-wait strategies and reduce the risk of undertreatment and tumor regrowth [3].

PROJECT HYPOTHESIS

This project explores the novel hypothesis that predictive information on nCRT response is embedded in pre-treatment biopsies and can be revealed using AI, enabling more accurate treatment decisions and improved clinical outcomes in rectal cancer

PREDICTIVE MODELING PIPELINE

Study Population

120 patients treated with nCRT between January 2012 and December 2021

- 40 patients with sustained clinical response
- 80 patients who did not achieve clinical complete response and underwent surgery

Current Pilot Study

20 patients (10 responder and 10 non-responders)

Image Acquisition

- Tissues were scanned at 40x/0.95 NA (~240 nm lateral, ~1000 nm axial resolution).
- Z-stack imaging captured multiple focal planes, processed into sharp 2D images.

Image Preprocessing

- Slides are divided into 512×512 patches.
- Patches containing less than 30% tissue are discarded

Models

- We used pretrained ResNet18 and VGG19 models on ImageNet.
- ResNet18 offers depth and efficiency
- VGG19 captures fine textures

KEY FINDINGS & FUTURE WORK

- VGG19 showed strong performance. Explainable AI indicates possible tissue differences between responders and non-responders, though their biological relevance is still unclear.
- Future work will integrate additional biomarkers (CDX-2, Ki-67, PHH3, Cleaved Caspase-3, and p27) to better interpret which tissue regions drive AI predictions and enhance model explainability.
- We also aim to explore multiple instance learning, attention mechanisms, and super-resolution microscopy to enhance prediction accuracy and feature localization.

REFERENCES

[1] J. Garcia-Aguilar et al., "Organ Preservation in Patients With Rectal Adenocarcinoma Treated With Total Neoadjuvant Therapy," J Clin Oncol, vol. 40, no. 23, pp. 2546–2556, Aug. 2022, doi: 10.1200/JCO.22.00032.

[2] M. Li et al., "Predicting response to neoadjuvant chemoradiotherapy in rectal cancer: from biomarkers to tumor models," Ther Adv Med Oncol, vol. 14, p. 17588359221077972, Feb. 2022, doi: 10.1177/17588359221077972.

[3] I. M. Slavu et al., "A Review of Neoadjuvant Therapy and the Watch-and-Wait Protocol in Rectal Cancer: Current Evidence and Future Directions," Cureus, vol. 16, no. 9, p. e68461, doi: 10.7759/cureus.68461.h

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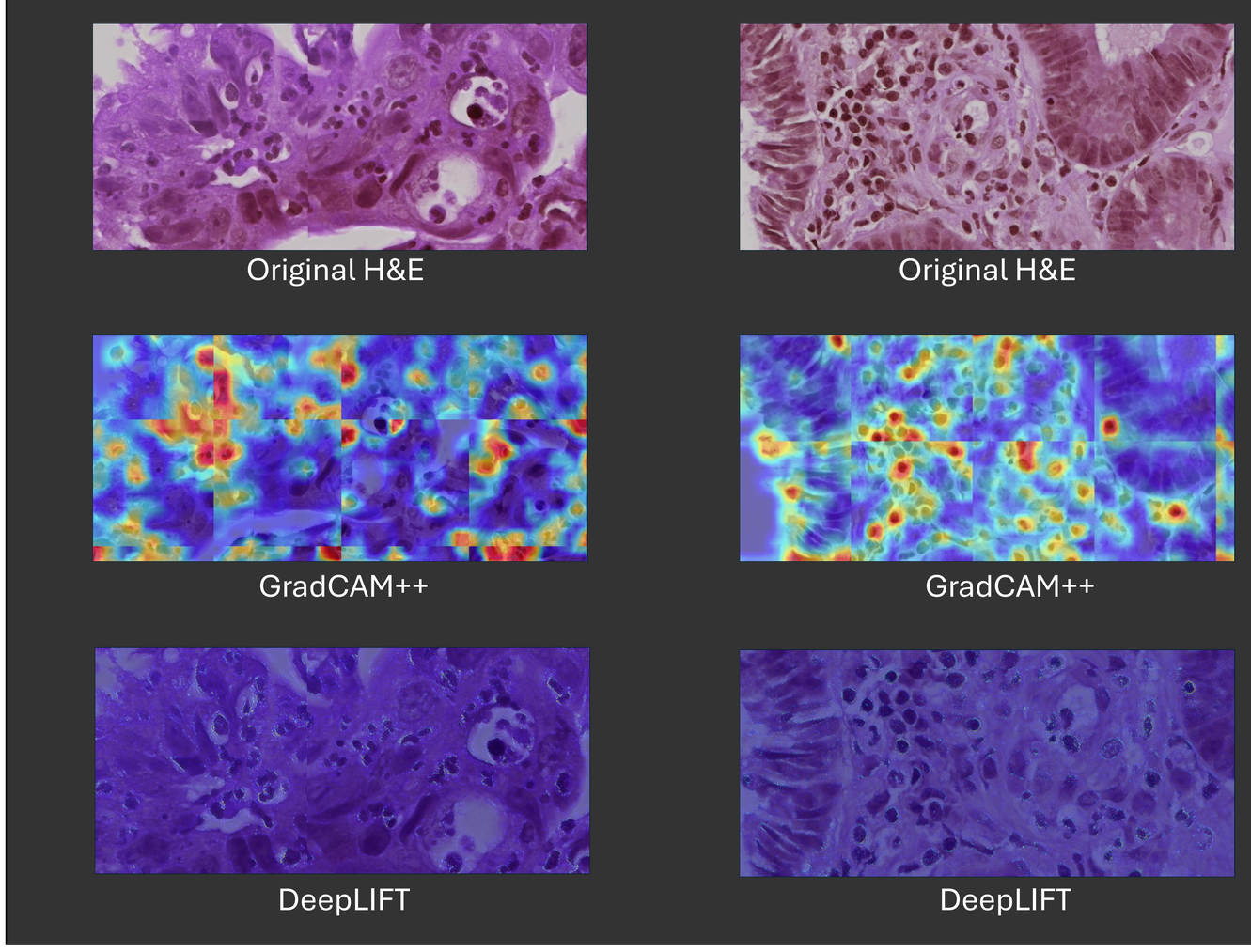
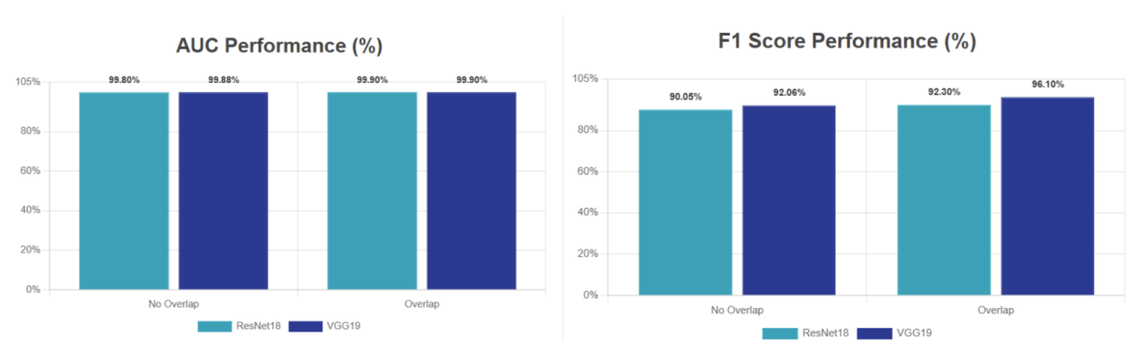
Uncovering tissue signatures of chemotherapy response in rectal cancer through explainable AI



MODEL PERFORMANCE

- Both models achieved outstanding discrimination with AUC values >99.8% across all conditions.
- VGG19 consistently outperformed ResNet18 in predictive accuracy, as reflected in higher F1 scores.
- Overlap patches demonstrated superior performance compared to non-overlap patches for response prediction.



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ONLINE VERSION