Revolutionizing Gastric Cancer Diagnosis: AI-Powered Image Analysis for Pathologists

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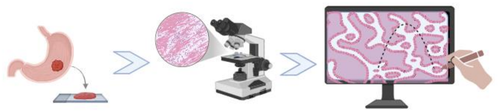
Introduction

Gastric carcinoma continues to pose a substantial global health challenge, despite advancements in treatment. Consequently, accurate and timely pathological evaluation remains paramount. Artificial Intelligence (AI), particularly in image analysis, holds significant potential to revolutionize histopathological workflows by augmenting accuracy and efficiency [1].

The aim of the study was to develop an application capable of delivering an assisted diagnosis, enhancing the efficiency of the pathologist's workflow.

Methods



Four experienced pathologists manually annotated the slides according to Lauren's classification of gastric cancer, into five classes using QuPath v0.4.4.

Image analysis was conducted following a three-step process:

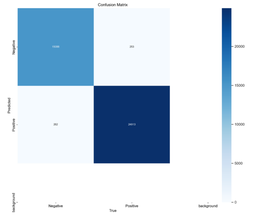
I. Classify all patches in 2 classes, positive and negative, selecting only those that have confidence over 90%.

II. Classify all positive patches in 2 classes, intestinal and diffuse, selecting only those that have confidence over 90%.

III. Reconstruct the full image taking into consideration negative, diffuse and intestinal patches from the above

Results

I. Metrics model 1

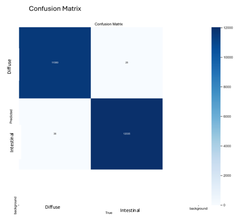


Classification Report:

	precision	recall	f1-score	support
Negative	0.98	0.98	0.98	15350
Positive	0.99	0.99	0.99	25166
accuracy			0.99	40516
macro avg	0.99	0.99	0.99	40516
weighted avg	0.99	0.99	0.99	40516

Figure 1: The confusion matrix illustrates the performance of the classification model in distinguishing between the two categories of tiles: positive and negative.

II. Metrics model 2

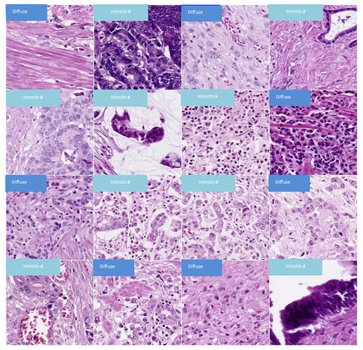


Classification Report:

	precision	recall	f1-score	support
Diffuse	1.00	1.00	1.00	11618
Intestinal	1.00	1.00	1.00	12063
accuracy			1.00	23681
macro avg	1.00	1.00	1.00	23681
weighted avg	1.00	1.00	1.00	23681

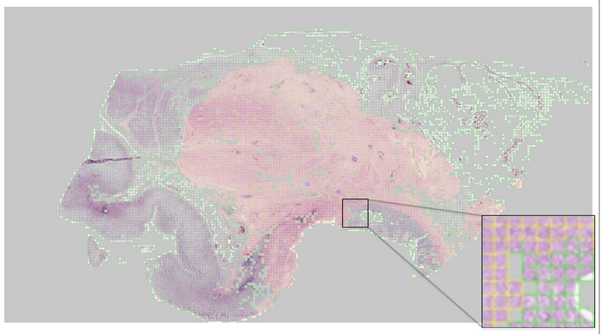
Figure 2: The confusion matrix illustrates the performance of the classification model in distinguishing between the two subtypes of gastric cancer, showing excellent performance with minimal misclassified tiles.

Figure 3: Illustration of validation batches with identical labels and predictions for model II



III. Image reconstruction and patch classification

Reconstructed (yellow = diffuse; green = negative)



Original annotation (red and green = negative; yellow = diffuse; blue = intestinal)

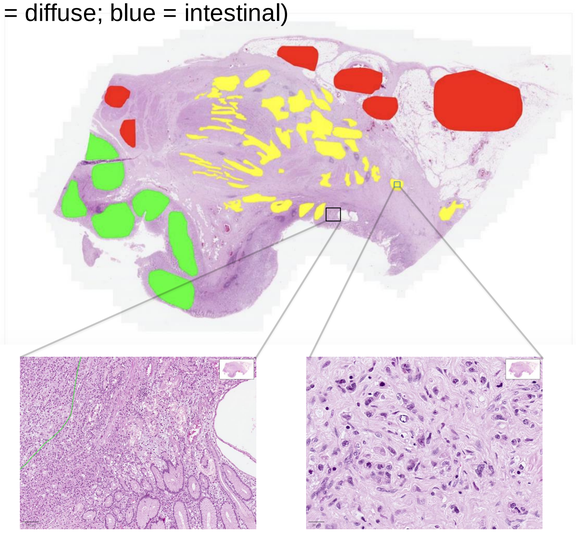


Figure 4: Image reconstruction including the unknown patches

Conclusions

This study explores the potential of artificial intelligence (AI) in revolutionizing histopathological workflows by automating tumor classification. By employing a pipeline inferencing approach using a supervised model to classify and map tumor regions in gastric carcinoma, the research emphasizes the applicability of AI in achieving precision and efficiency in pathology.

Future directions: Expanding on this model, our future research will explore automation of biomarker interpretation, predictive scoring for disease progression, and detection of visual indicators for treatment resistance.

References & Acknowledgements

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[1] Veldhuizen GP, Röcken C, Behrens HM, Cifci D, Muti HS, Yoshikawa T, Arai T, Oshima T, Tan P, Ebert MP, Pearson AT, Calderaro J, Grabsch HI, Kather JN. Deep learning-based subtyping of gastric cancer histology predicts clinical outcome: a multi-institutional retrospective study. Gastric Cancer. 2023 Sep;26(5):708-720. doi: 10.1007/s10120-023-01398-x. Epub 2023 Jun 3. PMID: 37269416; PMCID: PMC10361890.