HISTOPATHOLOGICAL H&E-BASED EVALUATION OF HER2 STATUS IN BREAST CANCER THROUGH A NOVEL MACHINE LEARNING APPROACH

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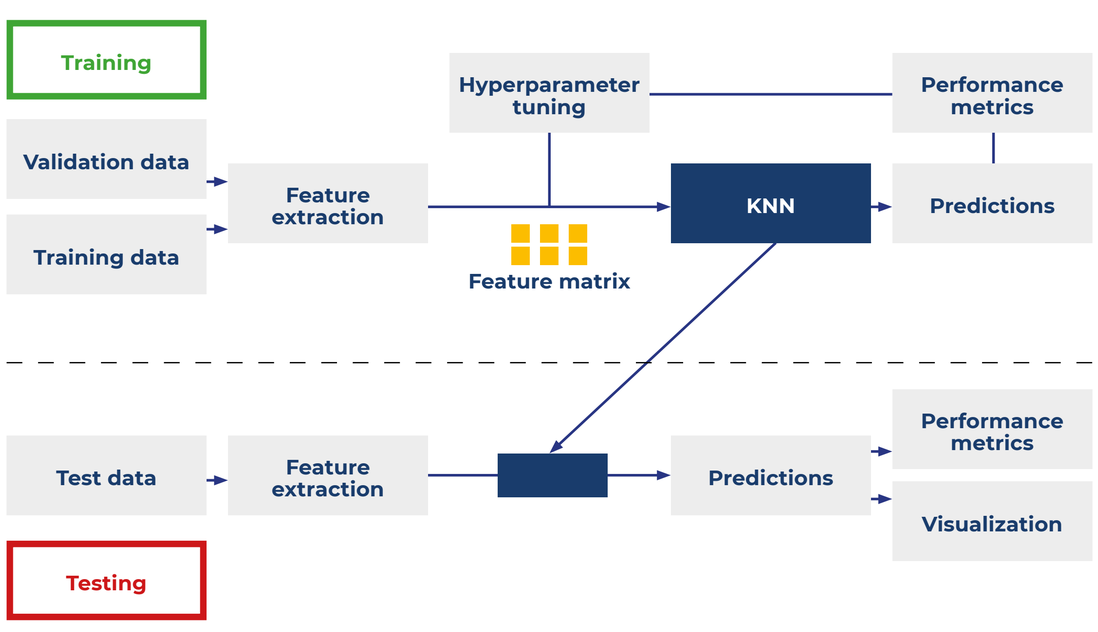
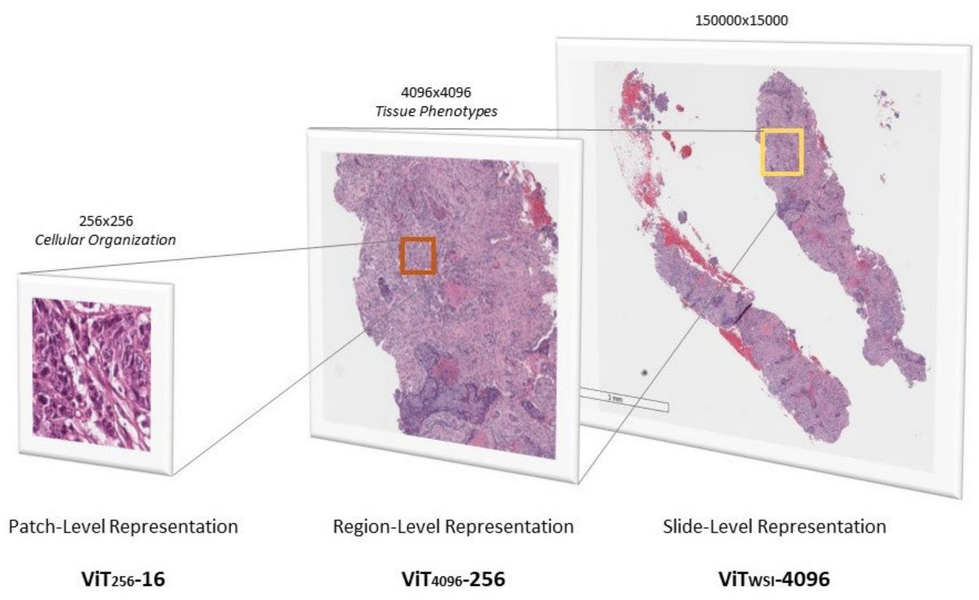
Background & objectives

Recent evidences introduced a new 'HER2-low' expression in breast cancer (BC) clinical practice[1]. The accurate definition of the HER2 profile is thus showing the need for more sensitive diagnostic tools to ensure that eligible patients are not deprived of effective therapies.



Methods

In computational pathology, self-supervised learning is a new paradigm for learning feature representations without fully labeled data. In particular, Vision Transformers (ViTs), relying on self-attention mechanisms to process image data, were used as the base for the patchwise classification of different histopathological datasets. The model aimed at classification of HER2 biomarker expression on H&E slides of BC.

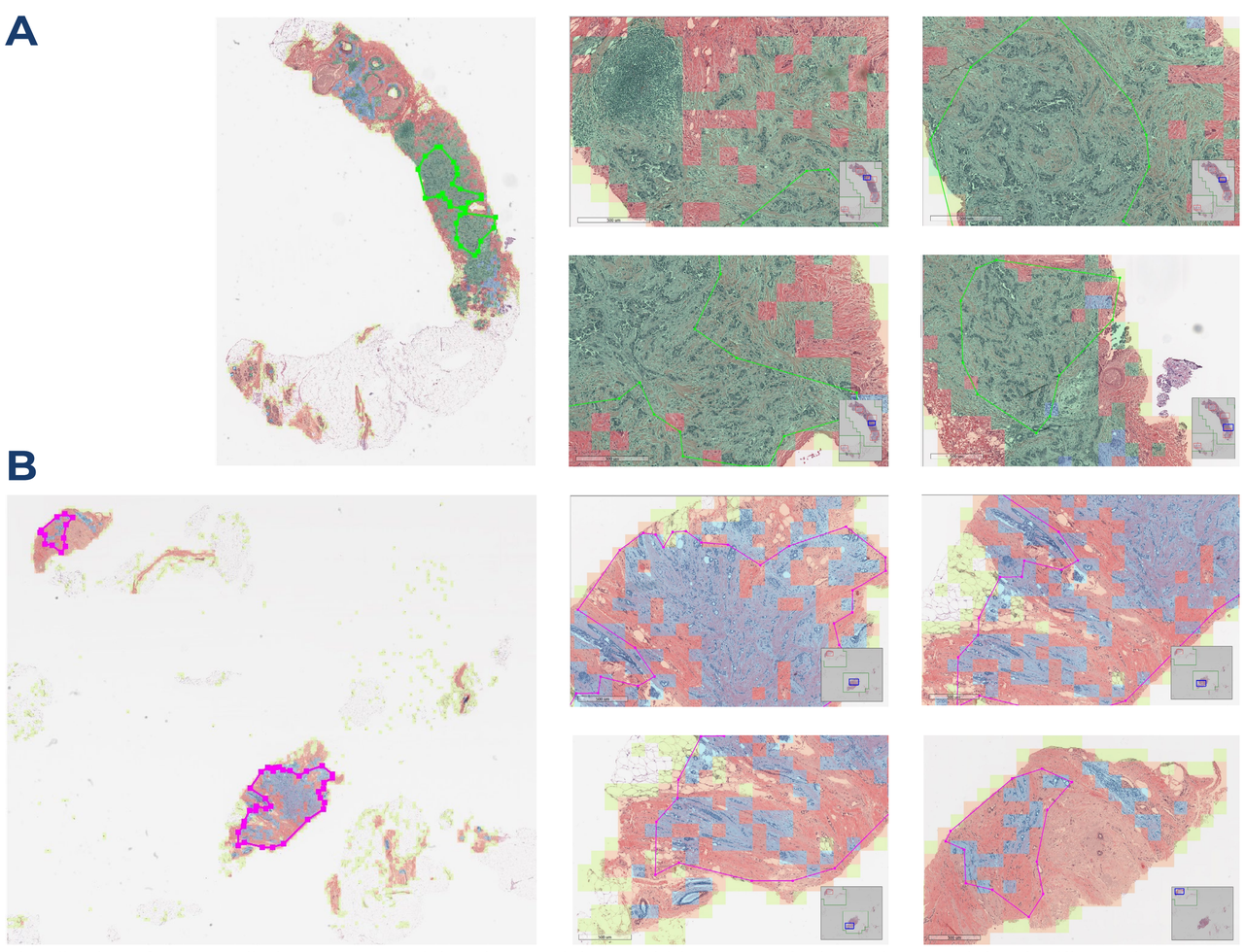


Results

Through a successful collaboration and the shared knowledge of different expert teams, a model was developed. It properly defines areas interested by the presence of HER2 in WSI of BC samples on the basis of H&E slides. As ultimate goal of the project, the system will be trained not only to quantify HER2 expression but also to discriminate HER2-low cases on H&E WSI. The preliminary results of the model were further validated outside the training environment on real cases provided by a reference center: 500 H&E WSI from different patients were used to train and test a network to get a WSI-level classification for IHC HER2 status. We obtained a F1 score of 0,64, without using any additional model to distinguish tumor vs non-tumor patches. This value is among the best reported within the European HEROHE Challenge[2], launched for promoting the development of computer-aided diagnostic tools to predict the HER2 status in invasive BC samples.

Conclusion and future perspectives

Preliminary results show that ViTs have great potential in the development of innovative Machine Learning systems for AI applications in Pathology. This works finally aims at providing an H&E-based algorithm that can predict HER2 status and treatment response in breast cancer at an accuracy that may benefit clinical evaluations, especially for the identification of HER2-low expression patients. AI will soon be able to avoid the execution of IHC tests that recognize the presence or over expression of specific markers, leading to significant savings in terms of time and costs. The Turn Around Time (TAT, or time to diagnosis) will be reduced, offering the patient the possibility of receiving the most appropriate therapy in less time. Laboratories may avoid to be equipped with instrumentations and platforms for perform validated IHC testing nor with specialized personnel to read the appropriate immunoreactivity of the patients' samples. More data are needed to improve the performance of the model, especially to strengthen accuracy and precision in cases scored as 1+ by the IHC test to unequivocally determine the HER2-low class of patients the are eligible to specific therapies according to the most recent official recommendations. Thanks to the optimization of timing in terms of efficiency and diagnostic accuracy, this technological progress sees a great positive social impact in the path of "democratization" of the usability of a timely and correct diagnosis in a capillary manner for individual patients. The developed AI model would also provide a great benefit to clinicians such as oncologists in managing the patient's therapeutic process.



Visualization of KNN predictions on HER2+ (A) and HER2- (B) WSI within ASAP. Left: the entire WSI, right: significant close-ups at 500 µm. The contour line in green (A) and purple (B) marks the region annotated by the pathologist. Light blue: regions predicted as HER2 negative; green: regions predicted as HER2 positive; red: areas predicted as 'Tissue'; yellow: areas predicted as 'Low Tissue'.

REFERENCES

[1] Tarantino P (2023). Annals of Oncology. https://doi.org/10.1016/j.annonc.2023.05.008
[2] Conde-Sousa, E (2022). Journal of Imaging, 8(8). https://doi.org/10.3390/jimaging8080213

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