Cell-level staining quantification framework for HER2 prediction

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Background and objectives

HER2 immunohistochemistry (IHC) underpins therapy selection, yet antibody-drug conjugates (ADCs) demand richer readouts than categorical scores. We present **an end-to-end pipeline for cell-level segmentation and membrane quantification** on IHC slides, enabling continuous and spatially aware HER2 metrics pertinent to ADC response. The pipeline adheres to current ASCO/CAP criteria and is readily adaptable to future revisions.

⭐ More information on our IHC foundation model at **poster 33P**

Results

Our framework distinguished cancer cells vs. non-cancer cells with 88.8% balanced accuracy (BAcc) compared to 82.3% for the Virchow2-based architecture [3], and achieved a BAcc of 66.7% in correctly classifying cell-level staining intensities (62.6% for Virchow2).

	Negative (model)	Faint Stain (model)	Moderate Stain (model)	Strong Stain (model)
Negative (Experts)	**91.6%**	8.4%	0.0%	0.0%
Faint Stain (Experts)	12.3%	**68.9%**	18.3%	0.5%
Moderate Stain (Experts)	0.7%	21.7%	**55.3%**	22.3%
Strong Stain (Experts)	0.1%	7.5%	41.4%	**51.0%**

Table: Comparison of expert vs. model cell-level staining quantification.

Method & Data

1. A first model based on CellViT [1] was trained to detect and segment tumor cells from 41,146 annotated cell nuclei using a lightweight IHC FM (86M parameters) pre-trained with iBOT [2] on 10,000 slides covering 100+ markers.

2. A deconvolution algorithm extracting DAB channel was used to derive "Negative", "Faint", "Moderate" and "Strong" classes using thresholding.

3. Cell-level scoring can be aggregated following ASCO/CAP guidelines to generate HER2 status.

Our framework was applied on an independent validation cohort (N=110 WSIs) to identify tumor cells. A subset of WSIs was used to compare cell-level staining predictions against 7,106 annotations (N=96 patches) provided by 3 expert pathologists.
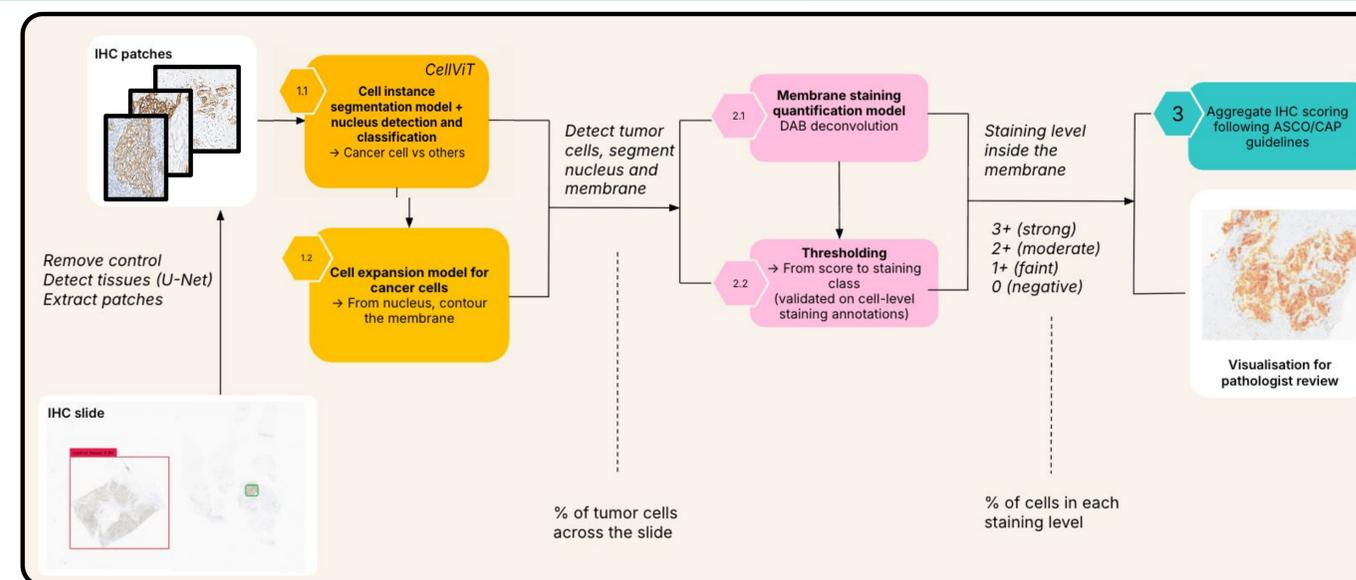
References

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[2] Zhou, J., et al. (2022). iBOT: Image BERT Pre-Training with Online Tokenizer. arXiv preprint arXiv:2111.07832.
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Affiliations & Acknowledgements

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Conclusions

Efficiency: Our cell-level staining quantification framework **achieves state-of-art accuracy while providing quantitative, ADC-relevant HER2 metrics** in compliance with ASCO/CAP guidelines.

Scalability: It is readily adaptable to future scoring systems, with native support for **spatial feature integration**, ensuring robustness and **scalability for evolving clinical and research needs.**