VIS2CELL-BENCH: A SYSTEMATIC BENCHMARK OF SPATIAL TRANSCRIPTOMICS SUPER-RESOLUTION

Anonymous authors
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ABSTRACT

Spatial transcriptomics super-resolution aims to infer cell-level gene expression from spatial measurements that aggregate signals across multiple cells, enabling downstream analyses of cell types and states. However, agreement with coarse observations does not establish whether reconstructed profiles preserve the cell-specific transcriptomic variation required for such analyses. We introduce **Vis2Cell-Bench**, a benchmark built from measured Xenium data for direct evaluation of cell-level recovery. Measured cellular profiles are spatially aggregated into controlled pseudo-Visium observations while being retained as ground truth. Across 87 datasets spanning 13 tissue and organ categories, four spatial partitions and three spatial offsets yield 1,044 benchmark instances for comparing seven methods under a common evaluation protocol. We evaluate two complementary aspects of recovery: gene-expression reconstruction and preservation of cell-specific information across gene panels and spatial partitions. These capabilities are not necessarily aligned: strong gene-wise reconstruction does not consistently translate into faithful recovery of cellular organization, and relative method performance varies across panels and partitions. In an annotated breast cancer dataset, high gene-wise correlation can coexist with limited cell-type separation. To quantify cellular recovery more directly, we introduce the **Cellular Recovery Score (CRS)**, which combines matched-cell expression fidelity with preservation of within-spot transcriptomic relationships without requiring cell-type labels. Vis2Cell-Bench thus provides a unified framework for distinguishing expression reconstruction from preservation of cell-specific information in spatial transcriptomics super-resolution.

1 INTRODUCTION

Spatial transcriptomics links gene expression to tissue architecture, enabling the study of cellular heterogeneity in its spatial context. In assays with multicellular capture spots, each measurement aggregates expression from several cells (Maynard et al., 2021). Computational super-resolution methods use histological morphology, spatial context or single-cell references to infer expression at subspot or cellular scales (Li et al., 2026; Zhao et al., 2026; Chadoutaud et al., 2026; Xue et al., 2025; Huang et al., 2025; Nonchev et al., 2025; He et al., 2026). For these predictions to support analyses of cell types and states, they need to preserve biologically relevant expression patterns in individual cells and differences among them. As methods target cell-level outputs, evaluation must therefore assess how faithfully they recover the expression profiles of the corresponding cells.

Reliable evaluation of cellular recovery presents two challenges. First, different allocations of expression among cells can produce the same spot-level aggregate. Agreement after re-aggregation therefore cannot establish whether expression has been recovered for the correct cells. Direct evaluation of cellular recovery requires measured expression profiles matched to the constituent cells. Second, even with such references, gene-wise correlation alone does not fully characterize cellular recovery. It summarizes agreement for each gene across cells and can remain high while expression differences among cells within the same spot are attenuated. Complementary criteria are therefore needed to assess expression fidelity in matched cells and preservation of within-spot transcriptomic relationships alongside gene-wise reconstruction.

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We introduce Vis2Cell-Bench to support direct evaluation of cellular recovery. Measured Xenium cell-level expression profiles are spatially aggregated into controlled pseudo-Visium observations, while the identity, coordinates and measured expression of each constituent cell are retained as matched evaluation references (Janesick et al., 2023). To compare heterogeneous output representations, cell-level predictions are evaluated against the corresponding cells, whereas dense or subspot predictions are mapped by spatial position to the same cellular evaluation coordinates. The benchmark comprises 87 datasets spanning 13 tissue and organ categories. Four spatial grids and three spatial offsets yield 1,044 benchmark instances for comparing seven methods across gene-panel definitions and sizes under a common evaluation protocol.

Across seven super-resolution methods, we find that higher gene-wise correlation does not consistently correspond to better preservation of expression-derived cellular structure. For example, on SVG100, FineST achieves a higher gene-wise Pearson correlation coefficient (PCC) than Hist2SR but lower normalized mutual information (NMI) between clusters derived from predicted and measured expression. A spatial example further illustrates that high gene-wise correlation can coexist with reduced expression differences among cells within the same spot. Absolute performance and relative method rankings also vary across gene panels and spatial evaluation settings. These findings support evaluating gene-wise reconstruction and preservation of cell-specific information as complementary dimensions of recovery.

To complement gene-wise correlation, we introduce the Cellular Recovery Score (CRS), which combines matched-cell expression fidelity with preservation of relative within-spot transcriptomic relationships without requiring cell-type labels. On the independently annotated breast cancer dataset NCBI785 using SVG100, CRS shows a stronger Spearman correlation with annotation-based NMI than gene-wise PCC does. This result provides initial support for CRS as a complementary measure of cellular recovery; its consistency across datasets and evaluation settings remains to be established.

Our contributions are threefold:

- **A benchmark with matched cellular references.** Vis2Cell-Bench pairs controlled pseudo-Visium observations with measured constituent cells and aligns heterogeneous model outputs to a common cellular evaluation target across 87 datasets and 1,044 benchmark instances.
- **A systematic comparison of recovery objectives.** Across seven methods, we show that gene-wise correlation and agreement with expression-derived cellular structure do not consistently favor the same methods, and characterize performance variation across gene panels and spatial evaluation settings.
- **A complementary metric for cellular recovery.** CRS combines matched-cell expression fidelity with preservation of relative within-spot transcriptomic relationships without requiring cell-type labels. In preliminary validation on NCBI785 using SVG100, CRS shows a stronger association with annotation-based NMI than gene-wise PCC does.

2 Related Work

Histology-guided expression inference. ST-Net, HisToGene and Hist2ST predict spatial gene expression from histological morphology using different mechanisms to incorporate image features and spatial context (He et al., 2020; Pang et al., 2021; Zeng et al., 2022). More recent methods extend prediction beyond measured spot locations toward subspot or cell-associated expression. FineST supports subspot and nucleus-resolved inference, HISTEX integrates histological and transcriptomic information to produce fine-grained spatial expression, and sCellST, DeepSpot2Cell (DS2Cell) and Hist2SR use spot-level supervision to learn cell-associated predictions (Li et al., 2026; Xue et al., 2025; Chadoutaud et al., 2026; Nonchev et al., 2025; Huang et al., 2025). These methods highlight an important distinction between the spatial resolution of an output and the resolution at which recovery has been empirically demonstrated.

Reference-guided cellular inference. Tangram aligns single-cell profiles with spatial measurements, whereas cell2location and RCTD estimate cellular composition within measured locations (Biancalani et al., 2021; Kleshchevnikov et al., 2022; Cable et al., 2022). Such reference information can constrain fine-grained inference, but mapped reference profiles or estimated cellular compositions are not equivalent to measured transcriptomes of individual physical cells. PanoSpace and

STARS further combine histology with single-cell reference information for fine-grained or cell-associated spatial reconstruction (He et al., 2026; Zhao et al., 2026). Reference-guided inference should therefore be distinguished from recovery of expression in matched physical cells.

Benchmarking spatial transcriptomics. Existing benchmarks systematically evaluate spatial clustering, cellular deconvolution, and cross-dataset alignment or integration (Yuan et al., 2024; Li et al., 2023; Hu et al., 2024). Their endpoints include spatial domains, cell-type composition and correspondence across samples, but they do not directly test whether expression assigned after spatial aggregation is recovered for matched physical cells. Vis2Cell-Bench addresses this gap by pairing pseudo-Visium observations with their measured constituent cells under controlled spatial aggregation.

Evaluating cellular recovery. Multi-objective evaluation frameworks such as scIB assess complementary properties rather than relying on a single numerical criterion (Luecken et al., 2022). In spatial transcriptomics super-resolution, gene-wise correlations and clustering comparisons characterize gene-expression agreement and transcriptomic relationships among cells, respectively. Clusters derived from measured expression and reference cell-type annotations further address distinct evaluation questions and should not be treated as interchangeable targets. We therefore evaluate expression reconstruction and cellular structure separately and use CRS to complement these analyses by quantifying matched-cell expression fidelity and within-spot transcriptomic relationships without requiring cell-type labels.

3 VIS2CELL-BENCH: A CELL-GROUNDED BENCHMARK

Cell-grounded benchmark construction. Vis2Cell-Bench constructs controlled coarse-grained spatial observations from measured Xenium cell-level expression while retaining the constituent cells as direct evaluation references. For each Xenium cell with measured expression vector $\mathbf{x}_i$ and spatial coordinates, we assign the cell to a pseudo-spot by its centroid and sum the complete expression profiles within each spot. The observed expression for spot s is therefore defined as $\mathbf{y}_s = \sum_{i \in \mathcal{C}_s} \mathbf{x}_i$, where $\mathcal{C}_s$ denotes the set of cells assigned to that spot. Rather than retaining only the aggregate observation, we preserve the identity, coordinates and measured expression of every constituent cell, establishing an explicit correspondence between each coarse observation and its cell-level ground truth (Figure 1). This design enables controlled evaluation of recovery under spatial aggregation and is not intended to reproduce Visium assay chemistry, capture efficiency or measurement noise.

Benchmark instances and spatial evaluation. A benchmark instance is defined by a dataset–grid–seed combination, giving 1,044 instances from 87 datasets, four spatial grids and three spatial offset seeds. Here, the seed indexes the spatial offset used to construct the pseudo-spot grid and therefore changes the resulting cell-to-spot assignments; it does not refer to model initialization or training randomness. Within observed spot regions, predictions are evaluated on the spatial grid used to construct the input pseudo-spots. For cross-grid evaluation, each grid serves in turn as the observed input, and recovery is evaluated over regions defined by the remaining three grids, yielding four cross-grid evaluation settings for each dataset and seed. Each observed grid contributes one instance-level score for a given method, gene panel and metric; grid–seed instances from the same dataset share the underlying cellular measurements and are therefore not independent biological samples.

A common cellular evaluation target. The compared methods differ in their supervision, inference pipelines and native output representations, and the benchmark does not require identical model architectures, native resolutions or auxiliary inputs. Methods that produce cell-level expression are matched directly to the corresponding Xenium cells, whereas dense or subspot outputs are mapped by spatial position to the same Xenium cell evaluation coordinates. Methods therefore retain their native inference formulations and method-specific auxiliary inputs where required, while being evaluated from the same benchmark-generated pseudo-Visium observations, target genes and measured cell-level references. This design separates the spatial resolution of an output from the resolution at which recovery accuracy is established, enabling heterogeneous native outputs to be compared against a common cellular target.

Complementary recovery objectives. Vis2Cell-Bench separates cellular recovery into complementary evaluation objectives rather than relying on a single metric to rank methods. Gene-wise

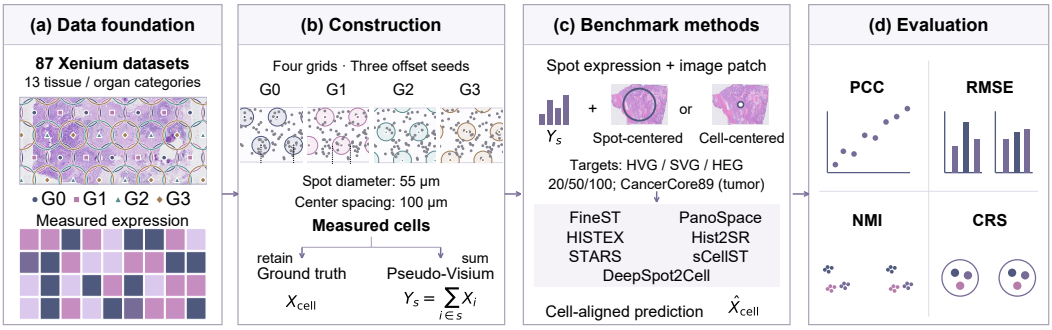


Figure 1: **Overview of Vis2Cell-Bench. (a)** Measured Xenium cell-level expression, spatial coordinates and paired histology provide the benchmark data foundation. **(b)** Measured cellular expression is retained as cell-level ground truth and aggregated into pseudo-Visium spot-level observations under four spatial grids. **(c)** Seven spatial transcriptomics super-resolution methods are evaluated under a common protocol, with their native outputs mapped by spatial position to the common Xenium cell evaluation coordinates. **(d)** Multi-level evaluation includes gene-wise PCC, RMSE, clustering agreement measured by NMI, and cellular recovery measured by CRS.

PCC and RMSE measure reconstruction agreement and error for individual genes across matched cells, whereas clustering NMI measures agreement between cluster structures derived separately from predicted and measured expression. These criteria address different questions: recovering variation of individual genes across matched cells does not necessarily imply recovery of transcriptomic distinctions among cells contributing to the same spot. To assess this cell-specific information directly, we define the Cellular Recovery Score (CRS), which combines matched-cell expression fidelity with preservation of relative within-spot transcriptomic relationships without using cell-type labels.

Cellular Recovery Score. For the N_s matched cells in spot s, let r_{si} denote the Pearson correlation across genes between the measured and predicted expression profiles of cell i. For each unordered cell pair $i < j$, we define correlation distances $d_{s,ij}^{\text{true}}$ and $d_{s,ij}^{\text{pred}}$ as one minus the corresponding across-gene cell–cell correlations in measured and predicted expression, respectively. With the measured and predicted distances ordered over the same cell pairs, we define Cell Fidelity (CF), Heterogeneity Preservation (HP) and their harmonic-mean combination CRS as

$$\mathrm{CF}_s = \frac{1}{N_s}\sum_{i=1}^{N_s}\frac{r_{si}+1}{2}, \qquad \mathrm{HP}_s = \frac{1+\mathrm{corr}(\mathbf{d}_s^{\text{true}}, \mathbf{d}_s^{\text{pred}})}{2}, \qquad \mathrm{CRS}_s = \frac{2\,\mathrm{CF}_s\,\mathrm{HP}_s}{\mathrm{CF}_s + \mathrm{HP}_s + 10^{-8}}. \tag{1}$$

When defined, both CF and HP lie in $[0, 1]$, and their harmonic mean requires both matched-cell fidelity and within-spot relationship preservation to contribute to a high CRS. The 10^{-8} term provides numerical stability and does not make otherwise undefined correlations valid. Spots for which the correlations required to compute CF or HP are undefined, for example because of constant expression profiles, constant distance vectors, non-finite values or insufficient cell pairs, are excluded from CRS computation. In particular, a spot with only two matched cells contains a single cell pair and therefore has undefined HP. CRS does not use cell-type labels; complete definitions and exclusion criteria are provided in Appendix B.

4 Experiments

4.1 Experimental Setup

We compare FineST (Li et al., 2026), PanoSpace (He et al., 2026), HISTEX (Xue et al., 2025), Hist2SR (Huang et al., 2025), DeepSpot2Cell (Nonchev et al., 2025), sCellST (Chadoutaud et al., 2026) and STARS (Zhao et al., 2026) using their official implementations. Each method retains

its native training and inference formulation; harmonization of heterogeneous native outputs to the common Xenium cell evaluation coordinates is defined in Section 3, with implementation details and method-specific configurations provided in the appendix.

HEG, HVG and SVG panels of 20, 50 or 100 genes are selected separately for each dataset–grid–seed benchmark instance and define the target genes used for model training and prediction rather than post hoc evaluation subsets. CancerCore89 is a fixed, literature-curated set of 89 tumor-associated genes informed by established cancer-gene resources and pan-cancer studies (Sondka et al., 2018; Bailey et al., 2018; Chakravarty et al., 2017). For each eligible cancer dataset, this set is intersected with the genes measured in the corresponding Xenium dataset; consequently, the effective CancerCore89 panel can vary across datasets and contains at most 89 genes. PCC and RMSE are computed for each gene across matched cells and then averaged over genes within each panel. Results are summarized descriptively as mean $\pm$ standard deviation across benchmark instances; grid–seed instances from the same dataset share the underlying cellular measurements and therefore do not represent independent biological replicates.

For clustering-based evaluation, measured and predicted expression are processed separately using the same pipeline comprising normalization, log1p transformation, 15-component PCA and Leiden clustering at resolution 0.1 (Traag et al., 2019). NMI and HS quantify agreement between clusters derived separately from predicted and measured expression (Vinh et al., 2010; Rosenberg & Hirschberg, 2007). For NCBI785, which provides four-class cell-type annotations, we additionally use NMI to compare expression-derived clusters with the annotations and assess agreement between expression-derived and annotated cellular structure. Complete preprocessing and evaluation protocols are provided in Appendix A.

4.2 Dataset Landscape

Vis2Cell-Bench comprises 87 Xenium datasets spanning 13 tissue and organ categories, including 48 tumor and 39 non-tumor datasets, with lung (28 datasets) and breast (22 datasets) most represented. The datasets vary substantially in cell count, pseudo-spot count and the number of cells contributing to each spot. To avoid treating multiple grid–seed instances derived from the same biological dataset as independent observations, grid–seed-dependent statistics in the dataset-level landscape are first summarized within each dataset, such that each dataset contributes a single point. Full distributions of tissue coverage, dataset scale and spot occupancy are provided in Appendix C, with per-dataset statistics reported in Appendix D. This variation broadens the conditions under which methods are evaluated, while the unequal tissue representation limits conclusions about generalization to unrepresented tissues.

4.3 Gene-level Reconstruction

For each dataset–grid–seed benchmark instance in Figure 2a,b, PCC is computed separately for each gene across matched cells and then averaged over genes within the corresponding panel. The HVG, SVG and HEG panels each comprise 1,044 benchmark instances from 87 datasets, four spatial grids and three spatial offset seeds, whereas CancerCore89 is evaluated on 576 instances from 48 tumor datasets. The same gene-level aggregation is used for evaluation within and outside observed spot regions.

Recovery within observed spot regions. Relative performance depends strongly on the training target panel (Figure 2a; Table 1). FineST, for example, has a higher mean PCC than PanoSpace on SVG50 (0.390 versus 0.349), whereas their order reverses on HVG50 (0.242 versus 0.271). In a descriptive, equally weighted average of the seven method means, SVG20 and SVG50 yield relatively high PCC in both spatial evaluation settings. The effect of increasing panel size is also method dependent: within observed spot regions, FineST decreases from 0.390 on SVG50 to 0.374 on SVG100, whereas HISTEX increases from 0.337 to 0.348. Because different panels define different training target gene sets, these comparisons reflect recovery under different target definitions rather than repeated evaluation of an identical set of genes.

Cross-grid evaluation. Gene-level reconstruction decreases outside observed spot regions in 69 of 70 method–panel comparisons, and the magnitude of this decrease varies across methods (Figure 2a,b; Tables 1 and 2). On HVG100, FineST decreases from 0.274 to 0.117 and PanoSpace from

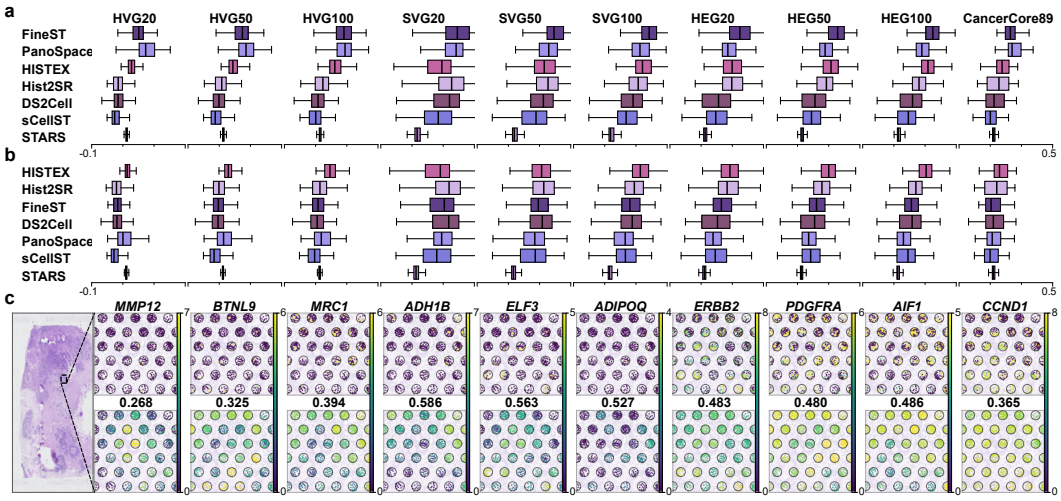


Figure 2: **Gene-level reconstruction across gene panels and spatial settings. (a)** Gene-level PCC within observed spot regions across seven methods and gene panels. **(b)** Gene-level PCC outside observed spot regions under cross-grid evaluation. **(c)** Cell-level expression in a randomly sampled $500 \times 500\,\mu$m ROI from NCBI784 (grid 0, seed 0). The ROI is indicated in the H&E image on the left; for each gene panel, measured expression and the corresponding FineST prediction are shown for the gene with the highest gene-wise PCC. PCC values are reported above the predictions.

Table 1: Gene-level reconstruction within observed spots. Values are mean ± s.d. across dataset–grid–seed instances. Bold denotes the best method for each panel and metric (PCC ↑; RMSE ↓).

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.197±0.047	**0.249±0.071**	0.157±0.027	0.070±0.034	0.074±0.038	0.054±0.029	0.125±0.007
	RMSE ↓	3.832±0.513	3.268±0.474	3.676±0.598	4.684±0.532	4.105±1.045	**3.114±0.682**	4.181±0.468
HVG50	PCC ↑	0.242±0.062	**0.271±0.072**	0.190±0.040	0.113±0.050	0.099±0.051	0.079±0.040	0.127±0.007
	RMSE ↓	2.946±0.448	2.552±0.358	2.895±0.417	3.331±0.593	3.242±0.836	**2.363±0.515**	3.212±0.445
HVG100	PCC ↑	0.274±0.073	**0.277±0.070**	0.226±0.055	0.140±0.065	0.113±0.059	0.099±0.051	0.130±0.009
	RMSE ↓	2.221±0.416	2.162±0.313	2.140±0.378	2.355±0.620	2.585±0.773	**1.838±0.397**	2.415±0.414
SVG20	PCC ↑	**0.382±0.105**	0.370±0.099	0.278±0.118	0.353±0.124	0.326±0.128	0.267±0.120	0.138±0.026
	RMSE ↓	3.816±0.548	**3.336±0.482**	3.832±0.506	3.513±0.644	3.818±0.656	3.558±0.510	4.182±0.491
SVG50	PCC ↑	**0.390±0.090**	0.349±0.093	0.337±0.097	0.342±0.111	0.310±0.117	0.262±0.110	0.143±0.025
	RMSE ↓	3.208±0.407	**2.862±0.362**	3.117±0.387	2.984±0.505	3.306±0.519	3.030±0.389	3.527±0.367
SVG100	PCC ↑	**0.374±0.081**	0.321±0.086	0.348±0.084	0.304±0.097	0.270±0.109	0.234±0.100	0.143±0.022
	RMSE ↓	2.799±0.335	**2.547±0.299**	2.664±0.316	2.643±0.414	2.997±0.439	2.673±0.330	3.041±0.301
HEG20	PCC ↑	**0.346±0.084**	0.277±0.081	0.300±0.080	0.294±0.089	0.206±0.117	0.199±0.092	0.128±0.017
	RMSE ↓	3.384±0.726	3.296±0.612	**3.134±0.616**	3.210±0.684	3.455±0.710	3.349±0.672	3.409±0.725
HEG50	PCC ↑	**0.346±0.073**	0.278±0.078	0.315±0.073	0.276±0.078	0.210±0.106	0.192±0.086	0.132±0.015
	RMSE ↓	3.186±0.495	3.067±0.422	**2.919±0.423**	3.053±0.482	3.295±0.499	3.152±0.450	3.248±0.497
HEG100	PCC ↑	**0.340±0.068**	0.278±0.076	0.318±0.069	0.258±0.075	0.205±0.106	0.185±0.086	0.135±0.018
	RMSE ↓	2.939±0.355	2.786±0.313	**2.696±0.317**	2.824±0.364	3.092±0.384	2.890±0.326	3.010±0.351
CancerCore89	PCC ↑	0.229±0.057	**0.244±0.064**	0.177±0.050	0.154±0.076	0.125±0.076	0.101±0.052	0.123±0.015
	RMSE ↓	4.470±0.777	**3.999±0.646**	4.129±0.719	4.410±0.765	4.413±0.675	4.136±0.672	4.404±0.784

0.277 to 0.140, whereas HISTEX decreases from 0.226 to 0.194. These unequal decreases change their relative ordering across the two spatial evaluation settings, showing that performance within observed pseudo-spot mixtures does not necessarily carry over to regions defined by the remaining grids.

High PCC can coexist with within-spot smoothing. FineST provides an illustrative case in which strong gene-wise reconstruction coexists with smoothing of cell-level expression differences. In the randomly sampled $500 \times 500\,\mu$m ROI from NCBI784 (grid 0, seed 0), we visualize, for each

Table 2: Gene-level reconstruction outside observed spot regions. Values are mean ± s.d. across dataset–grid–seed instances. Bold denotes the best method for each panel and metric (PCC ↑; RMSE ↓).

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.067±0.029	0.109±0.055	**0.131±0.017**	0.061±0.035	0.067±0.038	0.050±0.029	0.123±0.006
	RMSE ↓	4.034±0.506	3.484±0.463	3.691±0.600	4.689±0.529	4.107±1.046	**3.116±0.682**	4.188±0.470
HVG50	PCC ↑	0.096±0.043	0.133±0.065	**0.160±0.033**	0.099±0.051	0.093±0.051	0.074±0.040	0.125±0.006
	RMSE ↓	3.155±0.436	2.697±0.360	2.912±0.417	3.349±0.587	3.244±0.836	**2.368±0.514**	3.221±0.443
HVG100	PCC ↑	0.117±0.053	0.140±0.069	**0.194±0.050**	0.126±0.064	0.109±0.059	0.092±0.051	0.126±0.007
	RMSE ↓	2.390±0.418	2.294±0.327	2.156±0.377	2.374±0.614	2.586±0.772	**1.843±0.396**	2.424±0.416
SVG20	PCC ↑	0.302±0.112	0.292±0.109	0.265±0.117	**0.334±0.127**	0.319±0.128	0.261±0.120	0.127±0.024
	RMSE ↓	3.965±0.541	**3.497±0.498**	3.850±0.504	3.548±0.636	3.825±0.654	3.566±0.509	4.193±0.492
SVG50	PCC ↑	0.293±0.095	0.263±0.102	0.320±0.097	**0.322±0.113**	0.304±0.117	0.256±0.111	0.135±0.023
	RMSE ↓	3.370±0.398	**3.006±0.371**	3.139±0.382	3.017±0.496	3.312±0.517	3.037±0.387	3.534±0.368
SVG100	PCC ↑	0.261±0.085	0.223±0.091	**0.329±0.086**	0.284±0.099	0.265±0.109	0.228±0.100	0.135±0.019
	RMSE ↓	2.956±0.326	2.680±0.302	2.685±0.311	**2.670±0.408**	3.001±0.438	2.680±0.328	3.049±0.301
HEG20	PCC ↑	0.239±0.085	0.183±0.085	**0.288±0.081**	0.270±0.091	0.201±0.117	0.195±0.093	0.121±0.016
	RMSE ↓	3.482±0.755	3.417±0.652	**3.153±0.613**	3.244±0.680	3.459±0.711	3.353±0.672	3.419±0.728
HEG50	PCC ↑	0.226±0.073	0.175±0.077	**0.300±0.076**	0.253±0.083	0.206±0.106	0.188±0.086	0.127±0.013
	RMSE ↓	3.303±0.519	3.197±0.442	**2.940±0.421**	3.082±0.478	3.299±0.499	3.156±0.451	3.252±0.498
HEG100	PCC ↑	0.211±0.068	0.165±0.073	**0.302±0.074**	0.236±0.080	0.201±0.106	0.181±0.086	0.129±0.017
	RMSE ↓	3.068±0.371	2.923±0.318	**2.716±0.315**	2.850±0.361	3.095±0.383	2.894±0.325	3.016±0.351
CancerCore89	PCC ↑	0.119±0.059	0.124±0.061	**0.165±0.052**	0.136±0.078	0.122±0.075	0.104±0.054	0.121±0.015
	RMSE ↓	4.599±0.800	4.165±0.627	4.141±0.719	4.424±0.764	4.416±0.675	**4.117±0.668**	4.401±0.781

gene panel, the gene with the highest gene-wise PCC for FineST, thereby focusing on cases with strong gene-wise reconstruction (Figure 2c). Despite these relatively high correlations, predicted expression within some spots is more uniform than the measured reference, with reduced cell-to-cell contrast. Strong gene-wise agreement can therefore coexist with smoothing of cellular differences within the same spot and does not necessarily imply equivalent preservation of within-spot transcriptomic relationships.

4.4 Cellular Structure and Cell-type Preservation

For Figure 3a, predicted and measured expression are clustered separately using the same pipeline for each dataset–grid–seed benchmark instance, and NMI is computed between the resulting cluster assignments. Each boxplot summarizes 1,044 benchmark instances from 87 datasets, four spatial grids and three spatial offset seeds. Figure 3b uses the annotated NCBI785 dataset with SVG100. The spatial maps, UMAPs and zoomed views correspond to grid 0 and seed 0, whereas the NMI reported for each method is mean ± s.d. across 12 grid–seed instances and is computed against four reference annotations—tumor, myoepithelial, immune and stromal. Hybrid/unannotated cells are shown in gray.

Expression-derived cluster structure. Relative performance changes when evaluation shifts from gene-wise reconstruction to cluster structure derived from cell-level expression. On SVG100, FineST has a higher mean PCC within observed spot regions than Hist2SR (0.374 versus 0.304), but a lower NMI between predicted- and measured-expression clusters (0.187 ± 0.059 versus 0.225 ± 0.084; Figure 3a and Table 3). This reversal on the same gene panel shows that stronger gene-wise reconstruction does not necessarily correspond to stronger recovery of expression-derived cellular structure. Gene-panel choice also affects clustering agreement: SVG20 yields higher mean NMI than HEG20 for all seven methods, yet its NMI values range only from 0.054 to 0.246. Gene-wise reconstruction and expression-derived cluster agreement therefore capture distinct aspects of cellular recovery.

Annotation-based cell-type preservation. We further assess whether reconstructed expression preserves annotation-aligned cell-type structure on NCBI785 (GSM7780153; Sample 1, Replicate 1) from Janesick et al. (2023), using SVG100 as the target gene panel. Here, NMI compares clus-

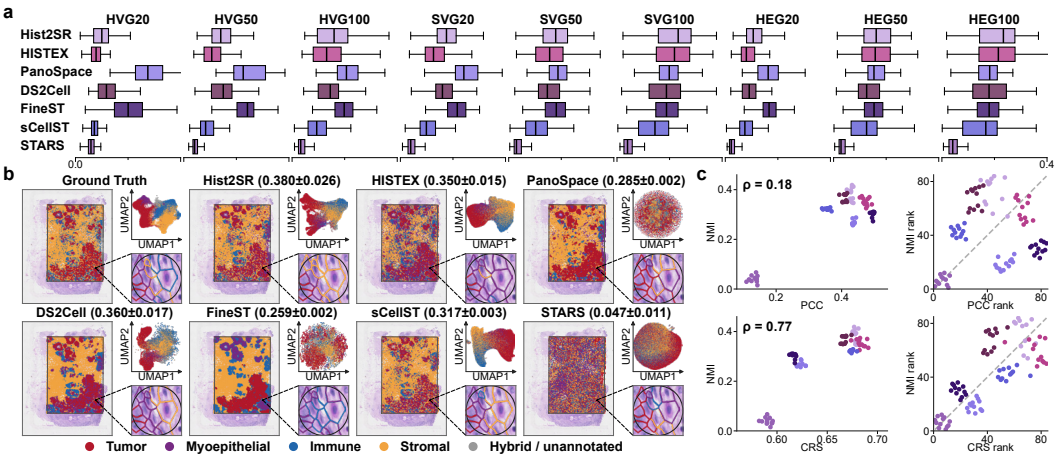


Figure 3: **Cellular structure, cell-type preservation and metric alignment.** **(a)** NMI between clusters derived separately from predicted and measured expression across nine gene panels and seven methods. **(b)** Cell-type structure in the annotated breast cancer sample NCBI785 using SVG100, shown as spatial cell-type maps, UMAPs and zoomed views of the same 55 μm spot region. **(c)** Alignment of PCC and CRS with annotation-based NMI, shown for raw scores and their corresponding ranks. Spearman correlations are indicated in the plots.

ters derived from predicted expression with the four reference cell-type annotations rather than with clusters derived from measured expression. In the displayed grid 0, seed 0 UMAPs, FineST and PanoSpace show more intermixed cell-type structure than the measured reference (Figure 3b). Across the 12 grid–seed instances, their NMI values (0.259 ± 0.002 and 0.285 ± 0.002, respectively) are lower than those of Hist2SR (0.380 ± 0.026) and DeepSpot2Cell (0.360 ± 0.017). This result further shows that strong gene-wise PCC across the broader benchmark does not necessarily coincide with stronger annotation-aligned cell-type structure in an individual sample.

Table 3: Clustering agreement within observed spot regions. Values are mean ± s.d. across dataset–grid–seed instances. NMI and HS quantify agreement between clusters derived from super-resolved cell-level expression and those derived from measured cell-level expression. Bold denotes the best method for each panel and metric (NMI ↑; HS ↑).

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	NMI ↑	0.202±0.074	**0.280±0.071**	0.099±0.083	0.120±0.089	0.127±0.054	0.073±0.018	0.073±0.066
	HS ↑	0.188±0.076	**0.285±0.074**	0.086±0.091	0.106±0.100	0.110±0.057	0.056±0.014	0.062±0.070
HVG50	NMI ↑	0.239±0.056	**0.245±0.075**	0.122±0.073	0.153±0.076	0.148±0.049	0.088±0.031	0.058±0.063
	HS ↑	0.246±0.065	**0.275±0.081**	0.108±0.083	0.138±0.089	0.132±0.054	0.070±0.025	0.051±0.069
HVG100	NMI ↑	0.197±0.048	**0.215±0.061**	0.139±0.068	0.163±0.071	0.144±0.055	0.097±0.046	0.046±0.048
	HS ↑	0.230±0.062	**0.278±0.071**	0.129±0.077	0.156±0.084	0.139±0.059	0.085±0.041	0.043±0.056
SVG20	NMI ↑	0.213±0.047	**0.246±0.063**	0.138±0.068	0.179±0.075	0.164±0.054	0.103±0.042	0.054±0.059
	HS ↑	0.224±0.050	**0.279±0.073**	0.124±0.076	0.166±0.088	0.149±0.053	0.086±0.035	0.048±0.066
SVG50	NMI ↑	0.178±0.055	**0.192±0.056**	0.157±0.068	0.178±0.073	0.155±0.066	0.107±0.054	0.043±0.046
	HS ↑	0.230±0.067	**0.256±0.073**	0.153±0.074	0.183±0.086	0.161±0.070	0.100±0.051	0.043±0.053
SVG100	NMI ↑	0.187±0.059	0.193±0.053	0.212±0.082	**0.225±0.084**	0.189±0.080	0.140±0.069	0.048±0.034
	HS ↑	0.283±0.097	**0.296±0.093**	0.221±0.092	0.249±0.103	0.220±0.100	0.148±0.074	0.051±0.042
HEG20	NMI ↑	**0.167±0.038**	0.166±0.057	0.088±0.035	0.113±0.045	0.095±0.041	0.078±0.036	0.030±0.024
	HS ↑	**0.213±0.048**	0.211±0.074	0.087±0.044	0.116±0.061	0.095±0.040	0.071±0.032	0.030±0.035
HEG50	NMI ↑	0.153±0.050	0.159±0.045	0.161±0.068	**0.166±0.063**	0.136±0.062	0.117±0.060	0.034±0.021
	HS ↑	0.247±0.081	**0.253±0.078**	0.174±0.074	0.196±0.081	0.162±0.074	0.126±0.065	0.039±0.032
HEG100	NMI ↑	0.178±0.058	0.176±0.052	0.210±0.087	**0.216±0.082**	0.179±0.082	0.150±0.078	0.046±0.025
	HS ↑	**0.297±0.096**	0.293±0.099	0.228±0.093	0.251±0.098	0.223±0.104	0.168±0.090	0.053±0.036

4.5 CRS Aligns with Annotation-Based Cellular Structure

To test whether CRS captures cellular structure that is not fully reflected by gene-wise reconstruction, we examine its association with annotation-based NMI on the independently annotated NCBI785 dataset. Under the SVG100 setting, seven methods across four spatial grids and three offset seeds yield 84 method–grid–seed observations. CRS shows a Spearman correlation of $\rho = 0.77$ with annotation-based NMI, compared with $\rho = 0.18$ for gene-wise PCC (Figure 3c). This contrast indicates that the two reconstruction metrics differ substantially in how they relate to annotation-aligned cellular structure: stronger gene-wise reconstruction does not consistently correspond to better preservation of cell-type structure, whereas CRS exhibits a substantially more consistent ordering with annotation-based NMI across these observations.

This result also provides an annotation-independent assessment of the CRS design. CRS combines matched-cell fidelity with preservation of relative within-spot transcriptomic relationships, whereas cell-type annotations are used neither in its definition nor in its computation. Its stronger association with annotation-based NMI therefore does not arise from shared label information, but instead reflects agreement between the cellular expression structure captured by CRS and an independently defined annotation structure. Together with the observation that high PCC can coexist with within-spot smoothing, these results indicate that gene-wise accuracy and cellular recovery are related but non-interchangeable evaluation dimensions, supporting CRS as a complementary measure to conventional gene-level reconstruction metrics.

5 Conclusion

Vis2Cell-Bench provides a unified evaluation framework with matched measured cellular references for assessing cellular recovery in spatial transcriptomics super-resolution. Across 87 Xenium datasets and seven methods, performance varies substantially with gene-panel choice and spatial evaluation setting, with reconstruction generally becoming more difficult in unobserved regions under cross-grid evaluation. More importantly, higher gene-wise reconstruction accuracy does not necessarily correspond to better preservation of cell-specific information, supporting gene-wise reconstruction and cell-specific recovery as complementary dimensions of evaluation. To complement conventional reconstruction metrics, we further introduce the Cellular Recovery Score (CRS), which shows stronger agreement with annotation-based NMI than gene-wise PCC on the independently annotated NCBI785 dataset, providing initial support for its use as a complementary measure of cellular recovery.

Two aspects warrant further investigation. Controlled pseudo-Visium aggregation does not fully reproduce platform-specific effects present in real assays, and CRS has so far been examined against independent annotations in a limited setting; evaluation across additional tissues and real spatial transcriptomics measurements will further clarify the scope of these criteria. More broadly, our results highlight spatial completion and cellular recovery as distinct aspects of the spatial transcriptomics super-resolution problem. Modeling and evaluating these processes separately may help disentangle recovery of expression in unmeasured spatial regions from reconstruction of cellular expression and support more reliable cell-scale spatial transcriptomic reconstruction.

Reproducibility statement

Details of benchmark construction, pseudo-Visium aggregation, gene-panel selection, cross-grid evaluation and evaluation metrics are provided in the main text and appendix. The appendix further documents dataset statistics, implementation and configuration details for the seven compared methods, and the complete definition of CRS. An anonymous repository is available at `https://anonymous.4open.science/r/Vis2Cell-Bench/`.

AI use statement

Generative AI was used solely for language editing. All AI-assisted revisions were reviewed and verified by the authors, who take responsibility for the final content.

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A Detailed Experimental Protocol

A.1 Benchmark Dataset

Vis2Cell-Bench comprises 87 Xenium-derived benchmark datasets. Each dataset retains experimentally measured cellular expression profiles and spatial coordinates, enabling direct comparison between super-resolved predictions and matched measured cellular references.

A benchmark instance is defined by a dataset, a pseudo-Visium spatial grid and a spatial offset seed. The 87 datasets, four spatial grids and three spatial offset seeds yield $87 \times 4 \times 3 = 1{,}044$ benchmark instances. The seeds control spatial grid offsets during pseudo-Visium construction rather than model initialization, thereby changing cell-to-spot assignments and aggregated spot expression. Within each instance, methods share the same pseudo-spot observations, target gene set and evaluation target.

A.2 Compared Methods

We benchmark seven spatial transcriptomics super-resolution methods using their official implementations: FineST (Li et al., 2026), PanoSpace (He et al., 2026), HISTEX (Xue et al., 2025), Hist2SR (Huang et al., 2025), DeepSpot2Cell (Nonchev et al., 2025), sCellST (Chadoutaud et al., 2026) and STARS (Zhao et al., 2026). Each method retains its native training formulation, inference inputs and output representation; the benchmark harmonizes observations, target genes and evaluation coordinates rather than requiring identical model architectures or native inputs.

A.3 Gene Panels

We vary both gene-selection strategy and panel size to examine how the target gene set affects super-resolution performance.

Highly expressed genes (HEGs), highly variable genes (HVGs) and spatially variable genes (SVGs) are selected independently for each dataset–grid–seed benchmark instance from its aggregated pseudo-Visium expression, with panel sizes of 20, 50 and 100 genes. Different spatial grids and offset seeds alter spot placement, cell-to-spot assignments and aggregated expression; consequently, selected genes can differ across instances from the same dataset. Each panel defines the target genes used for training, prediction and evaluation, such that changing panel size changes the reconstruction target rather than selecting a different evaluation subset after training.

CancerCore89 is a predefined set of 89 tumor-associated genes and is evaluated only on eligible tumor datasets. For each dataset, the fixed set is intersected with genes measured in the corresponding Xenium assay; consequently, the effective CancerCore89 panel can vary across datasets and contains at most 89 genes.

Panel comparisons therefore probe reconstruction under different expression-abundance, variability and spatial-structure regimes rather than repeated evaluation of an identical gene set.

A.4 Evaluation Protocol

The evaluation protocol separately examines gene-wise reconstruction, clustering structure derived from cell-level expression and annotation-aligned cellular structure in datasets with independent cell-type annotations.

The seven methods retain their native output representations. Native cell-level predictions are matched directly to the corresponding Xenium cells, whereas dense or subspot outputs are mapped by spatial position to the common Xenium cell evaluation coordinates. This common evaluation target does not imply that all methods directly output cellular expression. FineST supports subspot and nucleus-resolved inference (Li et al., 2026), HISTEX produces superpixel-level expression (Xue et al., 2025), and PanoSpace, Hist2SR, DeepSpot2Cell, sCellST and STARS provide cell-associated or cell-level expression predictions through their respective pipelines (He et al., 2026; Huang et al., 2025; Nonchev et al., 2025; Chadoutaud et al., 2026; Zhao et al., 2026).

For gene-wise reconstruction, PCC and RMSE are computed separately for each gene across matched evaluated cells. Evaluation within observed spot regions uses regions defined by the observed grid, whereas cross-grid evaluation assesses regions defined by the remaining three spatial grids. Cross-grid evaluation therefore measures reconstruction under a change in spatial partitioning rather than treating the grids as strictly independent spatial train/test partitions.

For expression-derived clustering, measured and predicted expression are processed independently using the same pipeline comprising normalization, log1p transformation, projection to a 15-dimensional PCA space and Leiden clustering at resolution 0.1 (Traag et al., 2019). Normalized mutual information (NMI) (Vinh et al., 2010) and homogeneity score (HS) (Rosenberg & Hirschberg, 2007) quantify agreement between clusters derived separately from predicted and measured expression.

Annotation-based metric alignment is evaluated on the breast cancer dataset NCBI785 (GEO: GSM7780153; Sample 1, Replicate 1) from Janesick et al. (2023), using SVG100 as the target gene panel. Seven methods across four spatial grids and three offset seeds yield 84 method–grid–seed observations. For each observation, NMI is computed between clusters derived from predicted expression and four reference cell-type categories—tumor, myoepithelial, immune and stromal—and its association with gene-wise PCC and CRS is examined. Cell-type annotations are not used to compute CRS.

A.5 Metric Aggregation

For each benchmark instance and evaluation setting, PCC and RMSE are calculated separately for each gene across the matched evaluated cells and then averaged over genes within the corresponding panel. For example, HEG20 first yields 20 gene-level PCC and RMSE values before panel averaging; genes are not concatenated to compute a single pooled correlation.

For a given method, gene panel and metric, each dataset–grid–seed instance contributes one panel-level score. These scores are summarized directly as mean $\pm$ standard deviation across benchmark instances rather than by first averaging grids and seeds within each dataset. The full design contains 1,044 instances; CancerCore89 summaries include only eligible tumor datasets and their measured gene intersections. Grid–seed instances derived from the same dataset share the underlying cellular measurements and therefore do not represent independent biological replicates.

B Cellular Recovery Score: Expanded Definition

This section provides the complete definition of the two components of the Cellular Recovery Score (CRS) and specifies the conditions under which they are defined. CRS is computed from matched measured and predicted cellular expression and does not use cell-type annotations. The metric is defined for pseudo-spots with matched cellular expression references; in this study, CRS is evaluated only on the annotated NCBI785 dataset using the SVG100 gene panel.

For spot s, let N_s denote the number of matched cells, and let $\mathbf{x}_{si}$ and $\widehat{\mathbf{x}}_{si}$ denote the measured and predicted expression vectors, respectively, for matched cell i over the same G genes. Cell Fidelity (CF) first computes the Pearson correlation across genes for each matched cell, rescales it from $[-1, 1]$ to $[0, 1]$, and then averages over matched cells:

$$r_{si} = \mathrm{corr}_g(x_{sig}, \widehat{x}_{sig}), \tag{2}$$

$$\mathrm{CF}_s = \frac{1}{N_s} \sum_{i=1}^{N_s} \frac{r_{si} + 1}{2}. \tag{3}$$

When all constituent correlations are defined, $\mathrm{CF}_s \in [0, 1]$. Higher CF indicates stronger agreement between measured and predicted gene-expression patterns within matched cells.

To evaluate relative transcriptomic relationships among cells within the same spot, we compute correlation distances for every unordered pair of matched cells $1 \le i < j \le N_s$:

$$d^{\mathrm{true}}_{s,ij} = 1 - \mathrm{corr}_g(x_{sig}, x_{sjg}), \tag{4}$$

$$d^{\mathrm{pred}}_{s,ij} = 1 - \mathrm{corr}_g(\widehat{x}_{sig}, \widehat{x}_{sjg}). \tag{5}$$

Collecting all cell pairs in the same order gives the measured and predicted distance vectors $\mathbf{d}_s^{\mathrm{true}}$ and $\mathbf{d}_s^{\mathrm{pred}}$, each containing $N_s(N_s-1)/2$ entries. Heterogeneity Preservation (HP) is defined as

$$\mathrm{HP}_s = \frac{1+\mathrm{corr}\left(\mathbf{d}_s^{\mathrm{true}}, \mathbf{d}_s^{\mathrm{pred}}\right)}{2}. \tag{6}$$

When defined, $\mathrm{HP}_s \in [0,1]$. HP measures preservation of the relative within-spot transcriptomic relationships among cell pairs; it does not require equality of absolute pairwise distances and does not directly quantify the absolute magnitude of cellular heterogeneity.

The two components are combined using a numerically stabilized harmonic mean:

$$\mathrm{CRS}_s = \frac{2\,\mathrm{CF}_s\,\mathrm{HP}_s}{\mathrm{CF}_s + \mathrm{HP}_s + 10^{-8}}. \tag{7}$$

The harmonic mean penalizes imbalance between CF and HP, such that a high CRS requires both components to remain high. When CF and HP are defined, CRS is non-negative and remains below 1 because of the numerical stabilizer; the stabilizing term does not affect the practical interpretation of the metric.

Only spots for which both CF and HP are defined contribute to CRS computation. At least three matched cells are required because two cells produce only one pairwise distance, for which the Pearson correlation used in HP is undefined. A spot is also excluded if any required measured or predicted cellular expression vector is constant across genes, if either pairwise-distance vector is constant, or if non-finite values occur during computation. Undefined cases are excluded rather than assigned an arbitrary score.

In this study, CRS is evaluated only under the SVG100 setting on NCBI785. Seven methods across four spatial grids and three spatial offset seeds yield 84 method–grid–seed observations. The CRS value for each observation is paired with annotation-based NMI from the same observation to assess its association with annotation-aligned cellular structure. The four reference cell-type annotations are used only for this downstream comparison and are not used to define or compute CRS.

C Dataset Landscape

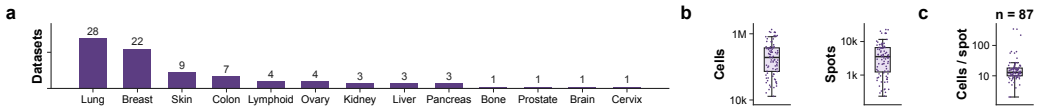


Figure S1: **Dataset coverage, scale and spot occupancy in Vis2Cell-Bench. (a)** Distribution of 87 datasets across 13 tissue and organ categories. **(b)** Distributions of cell counts (left) and pseudo-spot counts (right) across datasets; grid–seed-dependent pseudo-spot counts are summarized within each dataset across four spatial grids and three offset seeds. **(c)** Dataset-level spot occupancy, defined as the mean across grid–seed combinations of the median number of cells per pseudo-spot. Each overlaid point in **(b,c)** represents one dataset, and the vertical axes are logarithmic.

Vis2Cell-Bench comprises 87 Xenium-derived benchmark datasets spanning 13 tissue and organ categories (Figure S1). Lung and breast are the most represented categories, with 28 and 22 datasets, respectively, followed by skin (9), colon (7), lymphoid tissue and ovary (4 each), kidney, liver and pancreas (3 each), and bone, brain, cervix and prostate (1 each). The benchmark therefore covers diverse tissue contexts, although representation across tissue categories is uneven.

Datasets vary substantially in cell count, pseudo-spot count and the number of cells contributing to each pseudo-spot. Figure S1b shows the distributions of cell counts and pseudo-spot counts across datasets, whereas Figure S1c summarizes spot occupancy. Because pseudo-spot count and spot occupancy depend on the spatial grid and offset seed, these quantities are first computed for each grid–seed combination and then summarized within each dataset across the 12 combinations. Each dataset therefore contributes a single point to the landscape analysis rather than treating the 1,044 benchmark instances as independent observations.

For spot occupancy, we first compute the median number of cells per pseudo-spot within each grid–seed combination and then average these medians across the 12 combinations for each dataset. This statistic describes the number of cellular profiles contributing to spot-level mixtures; it does not directly quantify cell-type diversity or tissue heterogeneity.

Variation in dataset scale and spot occupancy broadens the spatial aggregation conditions under which the seven methods are compared, while uneven tissue representation limits the scope of conclusions across tissue categories. Per-dataset cell counts, pseudo-spot counts and spot-occupancy statistics for all 87 datasets are reported in Appendix D.

D XENIUM DATASET AND PSEUDO-VISIUM GRID STATISTICS

Table S1: Statistics of 87 Xenium datasets and four pseudo-Visium grids. Non-tumor includes healthy and non-tumor diseased tissues.

Organ	Status	Dataset	Cells	Pseudo-Visium spots				Median cells per spot			
				Grid 0	Grid 1	Grid 2	Grid 3	Grid 0	Grid 1	Grid 2	Grid 3
Lung (*n*=28)	**Tumor**	TENX190	278,455	6,436	6,388	6,396	6,409	10	10	10	10
		TENX189	278,184	6,387	6,389	6,363	6,370	10	10	10	10
		TENX118	162,006	2,095	2,105	2,106	2,097	21	21	22	22
		TENX141	160,941	3,397	3,378	3,396	3,385	12	12	12	12
	Non-tumor	NCBI887	1,112,646	17,811	17,789	17,833	17,793	16	16	16	16
		NCBI885	1,110,662	17,549	17,624	17,557	17,514	17	17	17	17
		NCBI886	1,107,296	17,818	17,809	17,806	17,814	16	16	16	16
		NCBI888	1,098,746	17,661	17,707	17,669	17,662	16	16	16	16
		NCBI867	140,838	2,880	2,870	2,872	2,879	13	12	13	13
		NCBI865	133,303	2,517	2,492	2,489	2,507	14	14	14	14
		NCBI864	108,078	2,244	2,249	2,258	2,253	12	12	12	12
		NCBI884	73,784	1,341	1,348	1,351	1,359	15	15	16	15
		NCBI866	72,153	1,304	1,294	1,295	1,292	13	13	13	13
		NCBI857	59,609	1,315	1,312	1,307	1,314	10	10.5	11	11
		NCBI882	52,164	1,166	1,158	1,156	1,157	12	12	12	12
		NCBI856	46,277	1,086	1,086	1,085	1,088	11	11	12	11
		NCBI861	45,677	819	819	811	810	15	15	15	16
		NCBI881	40,798	918	928	923	913	12	12	11	12
		NCBI880	38,291	851	848	852	850	10	10	10	10
		NCBI860	34,966	744	742	744	730	13	13	12	13
		NCBI883	34,850	753	740	747	732	12	12	11	12
		NCBI875	31,189	623	625	621	620	13	12	13	13
		NCBI873	27,971	945	936	943	953	8	8	7	8
		NCBI859	26,395	841	838	844	843	8	8	8	8
		NCBI870	24,791	622	624	614	612	9	9	9	9
		NCBI879	23,708	612	599	611	607	9	10	10	11
		NCBI858	16,430	692	694	686	678	6	6	5	6
		NCBI876	12,915	369	366	366	363	9	8	9	8

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Table S1 (continued)

Organ	Status	Dataset	Cells	Pseudo-Visium spots				Median cells per spot			
				Grid 0	Grid 1	Grid 2	Grid 3	Grid 0	Grid 1	Grid 2	Grid 3
Breast (*n*=22)	**Tumor**	TENX99	890,372	22,779	22,788	22,800	22,734	10	10	10	10
		TENX98	883,342	22,510	22,516	22,493	22,537	10	10	10	10
		XPR-BR	699,110	8,853	8,836	8,834	8,842	18	19	18	18
		TENX95	574,765	8,689	8,682	8,669	8,671	18	18	18	18
		TENX97	574,473	8,855	8,853	8,856	8,838	18	18	18	18
		TENX195	379,059	6,921	6,947	6,910	6,924	14	14	14	14
		TENX198	373,101	8,217	8,232	8,182	8,184	12	12	12	12
		TENX192	372,179	6,670	6,680	6,682	6,724	16	16	16	16
		TENX96	365,599	6,500	6,446	6,504	6,449	17	17	17	17
		TENX196	357,054	9,603	9,633	9,538	9,580	8	8	8	8
		TENX94	356,742	6,362	6,373	6,385	6,379	17	17	17	16
		TENX201	335,245	5,762	5,756	5,742	5,710	16	16	16	16
		TENX197	307,898	7,882	7,797	7,844	7,847	6	6	6	6
		TENX193	254,369	8,114	8,138	8,151	8,089	7	7	7	7
		TENX191	208,437	5,164	5,146	5,106	5,129	8	8	9	8
		TENX202	201,886	4,850	4,866	4,844	4,831	11	11	11	11
		TENX200	192,430	5,220	5,175	5,197	5,204	9	9	9	9
		NCBI785	166,541	4,435	4,457	4,433	4,481	9	9	9	9
		TENX199	150,080	2,560	2,561	2,556	2,550	16	16	16	17
		NCBI783	141,987	3,355	3,353	3,316	3,334	9	9	9	9
		NCBI784	118,711	3,865	3,871	3,876	3,829	5	5	5	6
	Non-tumor	TENX194	299,531	6,567	6,581	6,548	6,567	8	8	8	8
Skin (*n*=9)	**Tumor**	TENX158	112,346	1,765	1,775	1,774	1,782	18	18	18	18
		TENX115	106,896	1,817	1,833	1,848	1,807	17	17	17	17
		TENX117	87,499	1,087	1,092	1,100	1,112	22	22	22	21
	Non-tumor	JF-B1	105,194	468	474	466	468	63	62	62	62
		TENX122	87,846	3,247	3,230	3,221	3,286	4	4	4	4
		TENX123	64,740	4,054	4,055	3,997	3,956	2	2	2	2
		JF-A2	60,634	234	248	240	242	62.5	57	63	56
		JF-A1	42,696	305	300	301	300	27	27	27	25.5
		JF-C1	20,686	292	294	286	290	5	6	6	6
Colon (*n*=7)	**Tumor**	TENX111	587,035	5,937	5,934	5,928	5,944	27	27	27	27
		X5K-COAD	405,927	334	337	343	333	348	345	346	351
		TENX139	388,131	3,687	3,692	3,686	3,711	27	27	27	26
		TENX148	340,480	3,969	3,976	3,975	4,008	23	22	22	23
		TENX149	307,534	3,987	3,989	3,987	3,995	21	21	21	21
		TENX147	275,919	3,543	3,528	3,549	3,530	19	19	19	19
	Non-tumor	TENX114	270,911	4,722	4,728	4,710	4,692	11	11	11	11
Lymphoid (*n*=4)	**Non-tumor**	TENX125	1,349,529	7,319	7,298	7,271	7,298	56	56	56	56
		TENX124	863,281	6,612	6,603	6,597	6,620	38	38	39	38
		TENX143	708,762	4,158	4,187	4,161	4,151	56	56	56	56
		TENX133	83,022	1,547	1,548	1,556	1,555	11	11	11	11

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Table S1 (continued)

Organ	Status	Dataset	Cells	Pseudo-Visium spots				Median cells per spot			
				Grid 0	Grid 1	Grid 2	Grid 3	Grid 0	Grid 1	Grid 2	Grid 3
Ovary (*n*=4)	**Tumor**	TENX160	1,157,593	20,323	20,311	20,338	20,334	17	17	17	17
		X5K-OV	410,193	382	379	377	381	343	334	342	349
		TENX187	406,847	7,808	7,799	7,791	7,819	12	12	12	12
		TENX142	247,532	3,181	3,179	3,194	3,175	22	22	22	22
Kidney (*n*=3)	**Tumor**	XV1-KID	465,534	7,192	7,197	7,199	7,191	16	15	15	15
		TENX105	56,509	1,463	1,454	1,469	1,465	9	9	9	9
	Non-tumor	TENX106	97,549	2,171	2,167	2,161	2,162	12	12	12	12
Liver (*n*=3)	**Tumor**	X5K-HCC	271,687	375	376	373	379	218	219	221	218
		TENX120	162,628	3,018	3,012	3,017	3,020	15	15	15	15
	Non-tumor	TENX121	239,246	6,609	6,602	6,608	6,600	10	10	9.5	10
Pancreas (*n*=3)	**Tumor**	TENX140	234,958	3,889	3,880	3,881	3,871	14	14	14	14
		TENX116	190,964	2,186	2,187	2,193	2,193	26	26	26	26
		TENX126	140,353	2,188	2,187	2,180	2,189	16	16	17	16
Bone	**Non-tumor**	TENX132	33,409	2,970	2,913	2,939	2,929	2	2	2	2
Brain	**Tumor**	TENX138	816,624	10,295	10,292	10,293	10,254	22	22	22	22
Cervix	**Tumor**	TENX188	839,220	11,584	11,596	11,597	11,593	19	18	18	18
Prostate	**Tumor**	TENX157	192,580	4,123	4,133	4,119	4,125	12	12	12	12

E Additional Spatial Expression Comparisons

Figure S2 extends the spatial expression example in Figure 2c using the same NCBI784 sample, grid 0, seed 0 and region of interest. Because the corresponding H&E image is already shown in the main figure, we focus here on the measured expression and predictions from all seven methods.

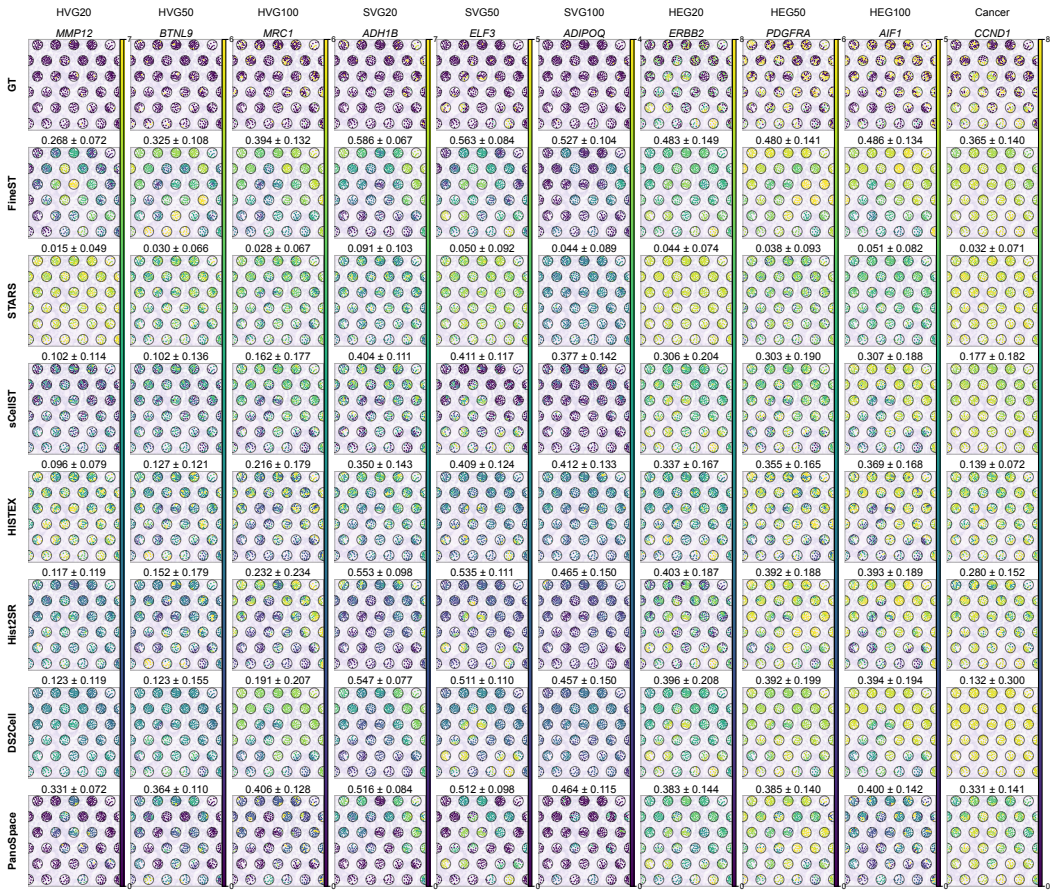


Figure S2: **Additional spatial expression comparisons across seven super-resolution methods.** Measured expression (GT) and predictions from all seven methods are shown for ten representative genes and their corresponding gene panels on NCBI784 (grid 0, seed 0), using the same region of interest as Figure 2c. The corresponding H&E image is shown in the main figure and is therefore not repeated here. Color scales are gene-specific.

Table S2: TENX190 — Lung — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.207±0.013	**0.346±0.018**	0.170±0.013	0.114±0.013	0.132±0.015	0.096±0.010	0.121±0.004
	Spearman ↑	0.174±0.012	**0.270±0.019**	0.143±0.013	0.095±0.009	0.124±0.013	0.086±0.011	0.102±0.005
	RMSE ↓	3.351±0.074	3.039±0.197	3.472±0.090	4.212±0.213	3.650±0.385	**2.628±0.126**	3.749±0.080
HVG50	PCC ↑	0.259±0.026	**0.373±0.006**	0.209±0.015	0.154±0.028	0.155±0.023	0.118±0.016	0.124±0.007
	Spearman ↑	0.192±0.022	**0.299±0.005**	0.165±0.010	0.112±0.016	0.136±0.019	0.099±0.011	0.106±0.007
	RMSE ↓	2.452±0.020	2.434±0.062	2.601±0.043	3.002±0.261	2.583±0.097	**1.896±0.093**	2.966±0.116
HVG100	PCC ↑	0.267±0.009	**0.351±0.005**	0.227±0.007	0.148±0.007	0.140±0.009	0.112±0.007	0.128±0.002
	Spearman ↑	0.179±0.008	**0.289±0.004**	0.167±0.005	0.105±0.005	0.123±0.007	0.092±0.005	0.111±0.003
	RMSE ↓	1.911±0.062	2.241±0.027	1.915±0.086	2.312±0.047	2.062±0.139	**1.510±0.063**	2.290±0.092
SVG20	PCC ↑	0.356±0.003	**0.419±0.003**	0.191±0.022	0.252±0.006	0.346±0.005	0.319±0.005	0.125±0.026
	Spearman ↑	0.355±0.003	**0.379±0.007**	0.188±0.023	0.220±0.004	0.349±0.008	0.300±0.007	0.104±0.032
	RMSE ↓	3.971±0.079	**3.226±0.021**	4.316±0.067	3.975±0.038	3.763±0.052	3.377±0.075	4.490±0.091
SVG50	PCC ↑	0.389±0.005	**0.430±0.008**	0.308±0.016	0.325±0.009	0.360±0.009	0.332±0.005	0.131±0.008
	Spearman ↑	0.379±0.004	**0.390±0.004**	0.265±0.017	0.283±0.007	0.345±0.006	0.305±0.005	0.120±0.009
	RMSE ↓	3.381±0.030	**2.673±0.028**	3.464±0.029	3.173±0.050	3.349±0.061	2.919±0.046	3.906±0.065
SVG100	PCC ↑	0.396±0.002	**0.410±0.003**	0.372±0.009	0.340±0.001	0.344±0.003	0.304±0.004	0.137±0.008
	Spearman ↑	**0.376±0.001**	0.368±0.002	0.307±0.010	0.282±0.002	0.323±0.002	0.272±0.002	0.112±0.010
	RMSE ↓	2.969±0.009	**2.449±0.014**	2.957±0.036	2.740±0.004	3.095±0.010	2.679±0.034	3.444±0.019
HEG20	PCC ↑	0.318±0.001	**0.343±0.001**	0.303±0.018	0.297±0.003	0.235±0.007	0.202±0.010	0.120±0.017
	Spearman ↑	**0.342±0.001**	0.337±0.001	0.291±0.021	0.293±0.002	0.253±0.006	0.214±0.009	0.099±0.020
	RMSE ↓	4.517±0.003	4.012±0.010	4.047±0.007	**3.971±0.010**	4.531±0.021	4.249±0.070	4.488±0.044
HEG50	PCC ↑	**0.345±0.001**	0.344±0.000	0.344±0.007	0.305±0.002	0.279±0.003	0.222±0.007	0.107±0.006
	Spearman ↑	**0.362±0.001**	0.340±0.001	0.313±0.009	0.298±0.002	0.288±0.003	0.228±0.007	0.091±0.005
	RMSE ↓	3.908±0.001	**3.407±0.012**	3.428±0.009	3.493±0.007	3.952±0.009	3.689±0.064	3.922±0.026
HEG100	PCC ↑	0.357±0.001	0.345±0.001	**0.361±0.004**	0.306±0.001	0.288±0.002	0.233±0.006	0.124±0.003
	Spearman ↑	**0.363±0.001**	0.340±0.001	0.314±0.005	0.287±0.001	0.285±0.002	0.226±0.006	0.103±0.006
	RMSE ↓	3.369±0.003	**2.916±0.011**	2.989±0.016	3.055±0.005	3.472±0.006	3.172±0.033	3.483±0.027
CancerCore89	PCC ↑	0.241±0.004	**0.294±0.003**	0.145±0.005	0.160±0.005	0.178±0.007	0.099±0.003	0.110±0.008
	Spearman ↑	0.245±0.003	**0.279±0.003**	0.145±0.007	0.152±0.006	0.206±0.006	0.103±0.003	0.090±0.009
	RMSE ↓	5.211±0.029	**4.443±0.004**	4.879±0.083	5.262±0.030	5.071±0.070	4.818±0.007	5.079±0.058

Table S3: TENX189 — Lung — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.204±0.004	**0.251±0.012**	0.145±0.014	0.062±0.010	0.054±0.009	0.031±0.015	0.121±0.005
	Spearman ↑	0.178±0.006	**0.210±0.023**	0.126±0.009	0.053±0.015	0.045±0.009	0.027±0.014	0.102±0.006
	RMSE ↓	4.297±0.212	3.799±0.289	4.081±0.153	4.903±0.126	4.299±0.253	**3.780±0.307**	4.602±0.151
HVG50	PCC ↑	0.201±0.011	**0.260±0.004**	0.155±0.011	0.049±0.010	0.051±0.010	0.042±0.010	0.120±0.001
	Spearman ↑	0.152±0.016	**0.189±0.013**	0.124±0.009	0.035±0.010	0.041±0.012	0.034±0.010	0.101±0.001
	RMSE ↓	3.234±0.169	2.794±0.203	2.924±0.073	3.967±0.098	3.223±0.240	**2.511±0.298**	3.515±0.099
HVG100	PCC ↑	0.197±0.008	**0.259±0.001**	0.158±0.011	0.036±0.007	0.043±0.011	0.042±0.011	0.118±0.004
	Spearman ↑	0.133±0.010	**0.178±0.005**	0.120±0.007	0.021±0.007	0.032±0.013	0.036±0.011	0.098±0.006
	RMSE ↓	2.614±0.100	2.260±0.062	2.312±0.049	3.352±0.094	2.621±0.171	**1.828±0.140**	2.812±0.122
SVG20	PCC ↑	0.359±0.002	0.403±0.014	0.298±0.009	0.313±0.006	**0.407±0.009**	0.384±0.010	0.119±0.016
	Spearman ↑	0.380±0.003	0.367±0.011	0.298±0.007	0.290±0.008	**0.394±0.006**	0.352±0.008	0.098±0.021
	RMSE ↓	3.941±0.038	3.170±0.042	4.074±0.037	4.020±0.015	3.317±0.051	**3.145±0.022**	4.750±0.046
SVG50	PCC ↑	0.352±0.004	**0.393±0.011**	0.296±0.019	0.272±0.014	0.369±0.010	0.352±0.003	0.124±0.013
	Spearman ↑	0.345±0.007	0.339±0.012	0.283±0.015	0.243±0.012	**0.356±0.005**	0.316±0.005	0.111±0.027
	RMSE ↓	3.343±0.034	**2.710±0.036**	3.547±0.047	3.475±0.035	3.011±0.054	2.751±0.065	3.990±0.043
SVG100	PCC ↑	0.352±0.002	**0.381±0.016**	0.336±0.007	0.275±0.006	0.346±0.002	0.335±0.006	0.117±0.019
	Spearman ↑	**0.328±0.003**	0.317±0.016	0.305±0.010	0.237±0.005	0.317±0.002	0.291±0.001	0.089±0.036
	RMSE ↓	2.898±0.017	**2.415±0.033**	3.020±0.015	3.031±0.017	2.768±0.017	2.426±0.049	3.376±0.044
HEG20	PCC ↑	**0.326±0.001**	0.293±0.001	0.291±0.006	0.225±0.002	0.229±0.003	0.212±0.004	0.131±0.013
	Spearman ↑	**0.359±0.001**	0.333±0.003	0.304±0.005	0.269±0.002	0.247±0.001	0.236±0.003	0.120±0.011
	RMSE ↓	4.080±0.008	3.950±0.013	**3.662±0.025**	3.921±0.002	4.116±0.007	4.045±0.018	3.991±0.027
HEG50	PCC ↑	**0.301±0.003**	0.277±0.001	0.267±0.013	0.198±0.004	0.201±0.004	0.179±0.011	0.132±0.006
	Spearman ↑	**0.317±0.003**	0.299±0.003	0.261±0.013	0.220±0.005	0.208±0.004	0.188±0.009	0.120±0.009
	RMSE ↓	3.741±0.004	3.613±0.014	**3.349±0.016**	3.611±0.006	3.795±0.009	3.734±0.020	3.644±0.009
HEG100	PCC ↑	**0.302±0.000**	0.284±0.002	0.280±0.008	0.199±0.001	0.206±0.002	0.172±0.008	0.122±0.004
	Spearman ↑	**0.311±0.001**	0.295±0.003	0.267±0.009	0.209±0.002	0.205±0.002	0.174±0.006	0.100±0.005
	RMSE ↓	3.365±0.003	3.243±0.014	**3.038±0.004**	3.244±0.001	3.442±0.006	3.362±0.020	3.305±0.018
CancerCore89	PCC ↑	0.228±0.001	**0.255±0.001**	0.173±0.006	0.063±0.000	0.092±0.001	0.086±0.003	0.121±0.003
	Spearman ↑	0.217±0.001	**0.222±0.001**	0.149±0.008	0.059±0.001	0.091±0.002	0.074±0.003	0.097±0.004
	RMSE ↓	3.585±0.012	**3.123±0.010**	3.219±0.028	3.849±0.007	3.568±0.014	3.361±0.005	3.597±0.009

Table S4: TENX118 — Lung — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.170±0.005	**0.214±0.012**	0.143±0.011	0.072±0.009	0.063±0.008	0.053±0.003	0.120±0.006
	Spearman ↑	0.135±0.009	**0.166±0.014**	0.123±0.011	0.063±0.008	0.060±0.008	0.048±0.006	0.102±0.006
	RMSE ↓	3.786±0.252	3.404±0.196	3.719±0.147	4.868±0.059	4.250±0.361	**2.735±0.375**	4.084±0.094
HVG50	PCC ↑	0.192±0.006	**0.232±0.008**	0.179±0.014	0.092±0.013	0.073±0.014	0.068±0.013	0.124±0.003
	Spearman ↑	0.147±0.011	**0.191±0.006**	0.140±0.013	0.072±0.009	0.069±0.017	0.059±0.013	0.105±0.003
	RMSE ↓	3.061±0.135	2.777±0.168	2.864±0.216	3.846±0.390	3.448±0.351	**2.104±0.241**	3.083±0.296
HVG100	PCC ↑	0.239±0.003	**0.246±0.003**	0.228±0.007	0.135±0.007	0.110±0.007	0.100±0.008	0.124±0.003
	Spearman ↑	0.171±0.003	**0.209±0.002**	0.173±0.005	0.098±0.002	0.098±0.003	0.081±0.004	0.105±0.003
	RMSE ↓	2.169±0.041	2.287±0.032	2.061±0.016	2.565±0.051	2.611±0.111	**1.631±0.042**	2.291±0.052
SVG20	PCC ↑	0.276±0.019	**0.313±0.016**	0.228±0.010	0.310±0.010	0.167±0.007	0.174±0.015	0.132±0.015
	Spearman ↑	0.301±0.019	**0.327±0.022**	0.249±0.009	0.306±0.009	0.187±0.014	0.181±0.023	0.109±0.015
	RMSE ↓	4.526±0.091	4.048±0.046	4.026±0.025	**4.009±0.021**	4.487±0.014	4.211±0.022	4.376±0.027
SVG50	PCC ↑	0.269±0.001	**0.277±0.007**	0.253±0.006	0.253±0.005	0.161±0.002	0.147±0.009	0.131±0.011
	Spearman ↑	0.282±0.002	**0.283±0.010**	0.252±0.007	0.249±0.005	0.176±0.002	0.138±0.009	0.111±0.014
	RMSE ↓	3.859±0.020	3.506±0.017	**3.458±0.028**	3.573±0.010	3.976±0.010	3.639±0.033	3.786±0.011
SVG100	PCC ↑	0.294±0.006	0.279±0.006	**0.306±0.005**	0.251±0.005	0.190±0.010	0.177±0.007	0.132±0.002
	Spearman ↑	**0.293±0.006**	0.275±0.007	0.267±0.004	0.225±0.006	0.191±0.008	0.163±0.007	0.115±0.002
	RMSE ↓	3.227±0.006	2.906±0.006	**2.875±0.012**	2.961±0.007	3.436±0.013	2.957±0.025	3.289±0.019
HEG20	PCC ↑	0.277±0.007	0.286±0.010	0.321±0.010	**0.326±0.004**	0.203±0.003	0.189±0.003	0.104±0.014
	Spearman ↑	0.314±0.004	0.303±0.014	0.323±0.009	**0.327±0.004**	0.237±0.006	0.195±0.003	0.077±0.011
	RMSE ↓	4.421±0.016	4.054±0.009	**3.812±0.018**	3.898±0.012	4.393±0.007	4.216±0.012	4.291±0.014
HEG50	PCC ↑	0.322±0.001	0.289±0.008	**0.381±0.003**	0.332±0.003	0.240±0.004	0.233±0.004	0.133±0.005
	Spearman ↑	0.344±0.000	0.300±0.011	**0.361±0.004**	0.334±0.002	0.246±0.002	0.233±0.005	0.115±0.005
	RMSE ↓	3.865±0.006	3.536±0.006	**3.278±0.007**	3.464±0.007	3.941±0.006	3.615±0.023	3.880±0.015
HEG100	PCC ↑	0.320±0.001	0.273±0.005	**0.380±0.002**	0.306±0.002	0.249±0.004	0.237±0.003	0.128±0.004
	Spearman ↑	0.335±0.001	0.281±0.007	**0.354±0.004**	0.303±0.002	0.250±0.004	0.229±0.003	0.109±0.004
	RMSE ↓	3.421±0.003	3.106±0.011	**2.912±0.017**	3.068±0.007	3.567±0.002	3.138±0.007	3.472±0.013
CancerCore89	PCC ↑	**0.248±0.003**	0.239±0.002	0.226±0.007	0.221±0.004	0.112±0.007	0.102±0.004	0.146±0.015
	Spearman ↑	**0.274±0.004**	0.272±0.005	0.225±0.007	0.224±0.004	0.144±0.008	0.118±0.005	0.129±0.016
	RMSE ↓	5.504±0.016	4.964±0.031	**4.944±0.038**	5.127±0.018	5.451±0.017	5.053±0.026	5.401±0.041

Table S5: TENX141 — Lung — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.262±0.018**	0.255±0.010	0.188±0.007	0.125±0.018	0.121±0.020	0.072±0.008	0.120±0.005
	Spearman ↑	**0.251±0.019**	0.237±0.015	0.161±0.006	0.106±0.014	0.121±0.024	0.071±0.010	0.104±0.005
	RMSE ↓	4.368±0.145	3.865±0.126	4.181±0.141	4.537±0.293	4.250±0.260	**3.819±0.127**	4.677±0.158
HVG50	PCC ↑	**0.295±0.007**	0.276±0.007	0.221±0.008	0.156±0.015	0.149±0.011	0.086±0.006	0.127±0.006
	Spearman ↑	**0.273±0.013**	0.255±0.007	0.178±0.008	0.127±0.014	0.145±0.013	0.080±0.008	0.109±0.005
	RMSE ↓	3.414±0.095	3.125±0.047	3.231±0.106	3.456±0.050	3.561±0.171	**3.007±0.116**	3.595±0.082
HVG100	PCC ↑	**0.335±0.007**	0.297±0.008	0.285±0.009	0.203±0.010	0.189±0.007	0.123±0.006	0.139±0.002
	Spearman ↑	**0.303±0.010**	0.273±0.009	0.232±0.009	0.171±0.011	0.179±0.009	0.110±0.006	0.122±0.003
	RMSE ↓	2.562±0.032	2.463±0.015	**2.352±0.022**	2.433±0.014	2.714±0.038	2.378±0.047	2.654±0.083
SVG20	PCC ↑	**0.378±0.012**	0.334±0.032	0.246±0.022	0.324±0.017	0.329±0.012	0.204±0.013	0.123±0.012
	Spearman ↑	**0.407±0.014**	0.320±0.042	0.246±0.019	0.319±0.017	0.343±0.020	0.210±0.014	0.110±0.011
	RMSE ↓	4.085±0.020	3.731±0.029	3.961±0.034	**3.657±0.056**	4.076±0.016	3.920±0.039	4.233±0.036
SVG50	PCC ↑	**0.395±0.006**	0.331±0.020	0.327±0.004	0.335±0.006	0.327±0.008	0.206±0.009	0.128±0.013
	Spearman ↑	**0.414±0.006**	0.326±0.024	0.297±0.004	0.317±0.005	0.332±0.009	0.206±0.010	0.114±0.012
	RMSE ↓	3.467±0.025	3.171±0.029	3.168±0.022	**3.089±0.033**	3.572±0.032	3.338±0.028	3.665±0.035
SVG100	PCC ↑	**0.406±0.004**	0.334±0.017	0.379±0.009	0.336±0.005	0.339±0.002	0.225±0.002	0.124±0.007
	Spearman ↑	**0.419±0.004**	0.329±0.019	0.340±0.009	0.324±0.004	0.338±0.003	0.224±0.002	0.107±0.004
	RMSE ↓	2.925±0.062	2.721±0.055	**2.614±0.051**	2.657±0.060	3.011±0.076	2.813±0.059	3.113±0.054
HEG20	PCC ↑	**0.329±0.011**	0.268±0.016	0.277±0.005	0.266±0.010	0.203±0.019	0.136±0.019	0.119±0.010
	Spearman ↑	**0.411±0.009**	0.311±0.020	0.314±0.007	0.343±0.011	0.239±0.015	0.195±0.011	0.100±0.010
	RMSE ↓	3.434±0.012	3.310±0.011	**3.151±0.006**	3.255±0.030	3.507±0.009	3.455±0.016	3.431±0.012
HEG50	PCC ↑	**0.365±0.002**	0.286±0.011	0.338±0.001	0.300±0.002	0.268±0.004	0.165±0.004	0.116±0.005
	Spearman ↑	**0.411±0.002**	0.304±0.013	0.342±0.003	0.342±0.001	0.283±0.003	0.198±0.004	0.103±0.005
	RMSE ↓	3.207±0.008	3.091±0.009	**2.887±0.009**	3.017±0.011	3.269±0.007	3.192±0.009	3.291±0.007
HEG100	PCC ↑	**0.362±0.002**	0.285±0.010	0.340±0.004	0.279±0.002	0.273±0.002	0.157±0.002	0.121±0.009
	Spearman ↑	**0.386±0.002**	0.289±0.011	0.330±0.004	0.302±0.002	0.276±0.002	0.170±0.001	0.105±0.007
	RMSE ↓	2.982±0.005	2.870±0.006	**2.683±0.011**	2.835±0.005	3.056±0.006	2.969±0.009	3.039±0.009
CancerCore89	PCC ↑	0.221±0.006	**0.232±0.002**	0.196±0.006	0.147±0.002	0.125±0.004	0.065±0.009	0.113±0.006
	Spearman ↑	**0.245±0.004**	0.233±0.003	0.192±0.004	0.150±0.002	0.144±0.003	0.074±0.007	0.098±0.007
	RMSE ↓	4.348±0.017	4.078±0.009	**3.907±0.016**	4.185±0.013	4.247±0.013	4.154±0.020	4.102±0.035

Table S6: NCBI887 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.153±0.010	**0.200±0.005**	0.120±0.006	0.043±0.011	0.044±0.009	0.034±0.008	0.123±0.004
	Spearman ↑	0.132±0.014	**0.156±0.025**	0.104±0.005	0.030±0.009	0.043±0.012	0.031±0.010	0.105±0.004
	RMSE ↓	4.497±0.216	**3.674±0.570**	4.379±0.298	5.592±0.026	5.135±0.319	3.805±0.298	4.963±0.332
HVG50	PCC ↑	0.166±0.006	**0.204±0.002**	0.126±0.004	0.058±0.006	0.041±0.010	0.040±0.009	0.121±0.002
	Spearman ↑	0.137±0.007	**0.158±0.020**	0.105±0.004	0.036±0.005	0.038±0.008	0.033±0.006	0.103±0.002
	RMSE ↓	3.570±0.165	2.991±0.325	3.483±0.097	4.061±0.011	4.070±0.119	**2.962±0.197**	3.967±0.230
HVG100	PCC ↑	0.164±0.005	**0.211±0.001**	0.131±0.005	0.070±0.005	0.041±0.007	0.040±0.005	0.122±0.001
	Spearman ↑	0.122±0.003	**0.165±0.020**	0.105±0.004	0.045±0.004	0.037±0.006	0.032±0.004	0.104±0.002
	RMSE ↓	2.794±0.094	2.593±0.261	2.631±0.157	2.908±0.006	3.387±0.132	**2.274±0.084**	3.054±0.151
SVG20	PCC ↑	0.331±0.005	**0.341±0.008**	0.224±0.010	0.337±0.013	0.335±0.007	0.292±0.008	0.141±0.006
	Spearman ↑	**0.246±0.003**	0.241±0.022	0.192±0.006	0.240±0.013	0.203±0.003	0.160±0.002	0.121±0.006
	RMSE ↓	3.158±0.065	2.838±0.124	4.010±0.076	3.009±0.024	2.748±0.080	**2.663±0.077**	4.208±0.068
SVG50	PCC ↑	**0.313±0.003**	0.300±0.005	0.248±0.010	0.300±0.007	0.284±0.004	0.245±0.006	0.134±0.006
	Spearman ↑	**0.254±0.004**	0.236±0.009	0.205±0.010	0.232±0.007	0.207±0.005	0.162±0.003	0.117±0.005
	RMSE ↓	3.174±0.066	2.885±0.020	3.485±0.053	2.963±0.012	3.002±0.078	**2.764±0.082**	3.793±0.099
SVG100	PCC ↑	**0.290±0.001**	0.273±0.004	0.248±0.006	0.272±0.008	0.245±0.003	0.218±0.002	0.134±0.003
	Spearman ↑	**0.248±0.001**	0.226±0.009	0.205±0.005	0.222±0.007	0.199±0.002	0.157±0.001	0.115±0.003
	RMSE ↓	3.010±0.011	2.690±0.024	3.064±0.021	2.764±0.011	2.971±0.010	**2.645±0.030**	3.340±0.042
HEG20	PCC ↑	**0.269±0.002**	0.232±0.005	0.220±0.003	0.268±0.010	0.215±0.001	0.181±0.007	0.112±0.011
	Spearman ↑	0.290±0.001	0.235±0.005	0.221±0.004	**0.298±0.010**	0.217±0.001	0.172±0.008	0.094±0.011
	RMSE ↓	4.750±0.003	4.559±0.016	4.464±0.018	**4.386±0.025**	4.744±0.005	4.627±0.044	4.510±0.072
HEG50	PCC ↑	**0.254±0.001**	0.232±0.004	0.217±0.004	0.251±0.007	0.199±0.002	0.163±0.003	0.117±0.005
	Spearman ↑	**0.273±0.001**	0.233±0.002	0.213±0.003	0.271±0.006	0.203±0.001	0.157±0.002	0.100±0.005
	RMSE ↓	4.222±0.004	3.997±0.033	3.920±0.020	**3.916±0.014**	4.242±0.008	4.111±0.028	4.095±0.034
HEG100	PCC ↑	**0.246±0.001**	0.237±0.003	0.203±0.006	0.216±0.003	0.183±0.001	0.150±0.003	0.118±0.003
	Spearman ↑	**0.260±0.001**	0.234±0.003	0.198±0.006	0.227±0.003	0.187±0.001	0.144±0.004	0.101±0.004
	RMSE ↓	3.745±0.002	**3.473±0.006**	3.512±0.020	3.518±0.005	3.816±0.006	3.647±0.030	3.692±0.020

Table S7: NCBI885 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.242±0.010	**0.286±0.010**	0.143±0.005	0.110±0.010	0.195±0.023	0.130±0.010	0.130±0.006
	Spearman ↑	0.214±0.009	**0.241±0.009**	0.118±0.009	0.084±0.009	0.150±0.012	0.106±0.004	0.110±0.008
	RMSE ↓	4.039±0.127	3.632±0.021	4.478±0.171	5.214±0.024	4.104±0.331	**3.300±0.177**	4.911±0.088
HVG50	PCC ↑	0.268±0.005	**0.293±0.005**	0.163±0.009	0.135±0.005	0.207±0.011	0.143±0.007	0.121±0.009
	Spearman ↑	0.231±0.003	**0.242±0.004**	0.122±0.005	0.096±0.004	0.164±0.005	0.111±0.004	0.099±0.008
	RMSE ↓	3.425±0.058	3.092±0.008	3.812±0.075	4.033±0.009	3.566±0.122	**2.822±0.117**	4.115±0.070
HVG100	PCC ↑	0.342±0.003	**0.352±0.003**	0.238±0.008	0.207±0.003	0.220±0.009	0.204±0.009	0.130±0.006
	Spearman ↑	0.274±0.003	**0.289±0.003**	0.172±0.004	0.149±0.003	0.175±0.006	0.146±0.005	0.109±0.009
	RMSE ↓	2.030±0.024	2.109±0.004	2.240±0.039	2.282±0.004	2.319±0.017	**1.753±0.037**	2.653±0.077
SVG20	PCC ↑	0.434±0.003	**0.450±0.007**	0.367±0.009	0.411±0.007	0.404±0.004	0.332±0.009	0.147±0.008
	Spearman ↑	**0.466±0.006**	0.439±0.006	0.371±0.009	0.396±0.006	0.418±0.006	0.333±0.003	0.124±0.005
	RMSE ↓	3.201±0.095	**2.744±0.012**	3.061±0.122	2.908±0.012	3.149±0.080	3.069±0.048	3.463±0.094
SVG50	PCC ↑	**0.410±0.004**	0.396±0.007	0.362±0.007	0.376±0.007	0.376±0.005	0.318±0.004	0.148±0.009
	Spearman ↑	**0.420±0.002**	0.377±0.007	0.338±0.008	0.352±0.007	0.376±0.002	0.301±0.002	0.128±0.009
	RMSE ↓	2.921±0.016	**2.576±0.012**	2.812±0.034	2.684±0.012	2.918±0.019	2.763±0.014	3.207±0.007
SVG100	PCC ↑	**0.394±0.001**	0.340±0.001	0.341±0.002	0.321±0.001	0.351±0.002	0.291±0.004	0.142±0.003
	Spearman ↑	**0.388±0.001**	0.316±0.001	0.300±0.003	0.293±0.001	0.336±0.001	0.261±0.003	0.123±0.002
	RMSE ↓	2.696±0.006	**2.480±0.002**	2.651±0.017	2.561±0.002	2.774±0.007	2.537±0.031	3.033±0.038
HEG20	PCC ↑	**0.429±0.001**	0.354±0.004	0.380±0.006	0.373±0.004	0.392±0.004	0.337±0.004	0.118±0.005
	Spearman ↑	**0.484±0.001**	0.390±0.004	0.414±0.006	0.437±0.004	0.436±0.002	0.366±0.004	0.106±0.004
	RMSE ↓	3.184±0.003	3.112±0.008	**2.879±0.017**	3.020±0.007	3.161±0.026	3.125±0.022	3.229±0.041
HEG50	PCC ↑	**0.384±0.001**	0.302±0.001	0.330±0.004	0.307±0.001	0.339±0.003	0.288±0.003	0.121±0.004
	Spearman ↑	**0.411±0.001**	0.314±0.001	0.330±0.004	0.340±0.001	0.359±0.001	0.291±0.004	0.102±0.004
	RMSE ↓	3.126±0.002	3.039±0.002	**2.883±0.006**	3.009±0.002	3.132±0.013	3.037±0.011	3.197±0.125
HEG100	PCC ↑	**0.353±0.001**	0.283±0.001	0.309±0.003	0.262±0.001	0.301±0.000	0.239±0.005	0.126±0.006
	Spearman ↑	**0.371±0.001**	0.287±0.001	0.293±0.003	0.279±0.001	0.311±0.001	0.238±0.004	0.108±0.006
	RMSE ↓	2.917±0.002	2.767±0.002	**2.663±0.015**	2.804±0.002	2.981±0.007	2.795±0.023	2.973±0.051

Table S8: NCBI886 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.224±0.007	**0.275±0.003**	0.151±0.008	0.094±0.006	0.177±0.009	0.127±0.008	0.121±0.007
	Spearman ↑	0.200±0.007	**0.230±0.004**	0.122±0.010	0.070±0.005	0.135±0.009	0.100±0.005	0.098±0.005
	RMSE ↓	4.186±0.111	3.407±0.247	4.445±0.265	5.211±0.013	4.284±0.290	**3.211±0.197**	4.925±0.118
HVG50	PCC ↑	**0.282±0.003**	0.273±0.011	0.181±0.010	0.143±0.010	0.225±0.007	0.155±0.004	0.132±0.005
	Spearman ↑	**0.235±0.005**	0.227±0.008	0.136±0.007	0.100±0.009	0.168±0.007	0.118±0.003	0.113±0.007
	RMSE ↓	3.086±0.083	2.822±0.107	3.654±0.117	3.713±0.018	3.124±0.081	**2.553±0.119**	3.983±0.108
HVG100	PCC ↑	**0.340±0.005**	0.292±0.021	0.246±0.008	0.195±0.016	0.223±0.013	0.204±0.011	0.135±0.005
	Spearman ↑	**0.276±0.008**	0.248±0.013	0.179±0.007	0.143±0.015	0.179±0.011	0.150±0.007	0.117±0.006
	RMSE ↓	2.056±0.081	2.053±0.146	2.281±0.090	2.301±0.019	2.350±0.049	**1.810±0.090**	2.680±0.124
SVG20	PCC ↑	**0.407±0.006**	0.373±0.010	0.375±0.012	0.380±0.009	0.370±0.010	0.313±0.014	0.155±0.011
	Spearman ↑	**0.434±0.007**	0.370±0.008	0.371±0.013	0.364±0.008	0.378±0.009	0.310±0.014	0.136±0.012
	RMSE ↓	3.071±0.007	**2.804±0.072**	2.955±0.026	2.855±0.015	3.001±0.015	2.954±0.050	3.466±0.042
SVG50	PCC ↑	**0.399±0.003**	0.390±0.005	0.362±0.004	0.369±0.005	0.364±0.003	0.302±0.005	0.143±0.009
	Spearman ↑	**0.403±0.002**	0.368±0.005	0.333±0.005	0.342±0.005	0.357±0.002	0.284±0.005	0.128±0.009
	RMSE ↓	2.957±0.006	**2.620±0.009**	2.876±0.022	2.730±0.009	2.945±0.013	2.819±0.016	3.299±0.099
SVG100	PCC ↑	**0.385±0.001**	0.339±0.005	0.350±0.005	0.320±0.005	0.342±0.001	0.293±0.006	0.138±0.003
	Spearman ↑	**0.377±0.001**	0.313±0.005	0.306±0.006	0.289±0.005	0.325±0.000	0.261±0.004	0.119±0.004
	RMSE ↓	2.740±0.007	**2.501±0.007**	2.662±0.026	2.582±0.007	2.819±0.012	2.554±0.027	3.040±0.023
HEG20	PCC ↑	**0.412±0.001**	0.356±0.010	0.384±0.010	0.375±0.010	0.374±0.000	0.331±0.002	0.122±0.013
	Spearman ↑	**0.464±0.001**	0.389±0.009	0.412±0.009	0.436±0.009	0.414±0.001	0.361±0.002	0.106±0.011
	RMSE ↓	3.292±0.001	3.186±0.019	**2.953±0.014**	3.092±0.019	3.257±0.023	3.199±0.004	3.347±0.011
HEG50	PCC ↑	**0.371±0.001**	0.304±0.005	0.344±0.005	0.309±0.005	0.325±0.001	0.281±0.005	0.126±0.012
	Spearman ↑	**0.399±0.001**	0.317±0.005	0.344±0.005	0.343±0.005	0.343±0.001	0.287±0.005	0.110±0.012
	RMSE ↓	3.192±0.002	3.079±0.009	**2.920±0.033**	3.049±0.009	3.202±0.011	3.066±0.028	3.258±0.022
HEG100	PCC ↑	**0.342±0.001**	0.276±0.004	0.314±0.005	0.255±0.004	0.287±0.002	0.248±0.004	0.123±0.006
	Spearman ↑	**0.361±0.001**	0.281±0.004	0.303±0.005	0.274±0.004	0.297±0.002	0.247±0.004	0.107±0.007
	RMSE ↓	2.977±0.001	2.820±0.007	**2.707±0.026**	2.857±0.007	3.042±0.005	2.862±0.032	2.989±0.027

Table S9: NCBI888 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.161±0.004	**0.194±0.007**	0.121±0.004	0.041±0.003	0.046±0.003	0.044±0.003	0.122±0.001
	Spearman ↑	**0.143±0.008**	0.140±0.010	0.105±0.004	0.027±0.003	0.044±0.004	0.039±0.002	0.104±0.001
	RMSE ↓	4.443±0.161	**3.257±0.123**	4.278±0.128	5.450±0.007	4.964±0.295	3.823±0.278	4.898±0.174
HVG50	PCC ↑	0.175±0.003	**0.209±0.005**	0.132±0.003	0.064±0.002	0.051±0.002	0.051±0.004	0.122±0.001
	Spearman ↑	**0.141±0.010**	0.136±0.008	0.107±0.003	0.037±0.002	0.045±0.001	0.041±0.001	0.103±0.001
	RMSE ↓	3.472±0.171	**2.541±0.144**	3.410±0.106	3.928±0.004	4.058±0.156	2.955±0.230	3.986±0.068
HVG100	PCC ↑	0.178±0.003	**0.218±0.002**	0.139±0.006	0.081±0.002	0.058±0.002	0.057±0.004	0.124±0.002
	Spearman ↑	0.128±0.007	**0.137±0.006**	0.109±0.003	0.047±0.002	0.047±0.002	0.042±0.003	0.105±0.001
	RMSE ↓	2.754±0.119	**2.190±0.143**	2.689±0.113	2.816±0.003	3.337±0.153	2.191±0.222	3.113±0.056
SVG20	PCC ↑	**0.353±0.007**	0.348±0.005	0.232±0.007	0.335±0.008	0.353±0.014	0.311±0.013	0.153±0.007
	Spearman ↑	**0.261±0.007**	0.222±0.002	0.199±0.007	0.233±0.007	0.218±0.007	0.169±0.004	0.129±0.007
	RMSE ↓	3.006±0.130	2.564±0.064	3.875±0.032	2.895±0.013	2.646±0.161	**2.553±0.129**	4.166±0.092
SVG50	PCC ↑	**0.324±0.002**	0.311±0.001	0.255±0.005	0.302±0.003	0.295±0.004	0.252±0.003	0.137±0.005
	Spearman ↑	**0.262±0.002**	0.227±0.003	0.210±0.003	0.232±0.002	0.217±0.002	0.167±0.001	0.120±0.006
	RMSE ↓	3.077±0.021	2.708±0.045	3.378±0.040	2.868±0.004	2.897±0.033	**2.688±0.023**	3.726±0.019
SVG100	PCC ↑	**0.301±0.001**	0.277±0.001	0.258±0.008	0.272±0.001	0.257±0.001	0.228±0.002	0.138±0.007
	Spearman ↑	**0.260±0.002**	0.224±0.002	0.215±0.007	0.223±0.000	0.213±0.002	0.168±0.003	0.120±0.008
	RMSE ↓	2.978±0.033	2.665±0.022	3.050±0.022	2.757±0.001	2.955±0.028	**2.624±0.045**	3.370±0.061
HEG20	PCC ↑	**0.292±0.001**	0.236±0.001	0.247±0.008	0.264±0.003	0.239±0.004	0.200±0.003	0.109±0.006
	Spearman ↑	**0.317±0.001**	0.240±0.001	0.246±0.007	0.297±0.003	0.252±0.003	0.196±0.004	0.093±0.006
	RMSE ↓	4.631±0.003	4.479±0.017	4.323±0.020	**4.322±0.007**	4.628±0.019	4.480±0.024	4.421±0.029
HEG50	PCC ↑	**0.271±0.001**	0.236±0.001	0.222±0.004	0.254±0.001	0.217±0.002	0.176±0.002	0.131±0.004
	Spearman ↑	**0.288±0.000**	0.239±0.001	0.213±0.006	0.272±0.001	0.223±0.002	0.172±0.003	0.114±0.004
	RMSE ↓	4.135±0.001	3.971±0.013	**3.835±0.007**	3.871±0.001	4.158±0.008	4.010±0.007	4.086±0.027
HEG100	PCC ↑	**0.254±0.000**	0.232±0.000	0.209±0.002	0.216±0.002	0.195±0.001	0.156±0.004	0.123±0.004
	Spearman ↑	**0.268±0.000**	0.233±0.001	0.202±0.003	0.227±0.002	0.201±0.001	0.154±0.004	0.105±0.004
	RMSE ↓	3.693±0.001	3.534±0.012	**3.439±0.005**	3.484±0.003	3.757±0.006	3.587±0.047	3.619±0.028

Table S10: NCBI867 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.255±0.021	**0.314±0.018**	0.184±0.017	0.117±0.029	0.099±0.018	0.071±0.014	0.124±0.003
	Spearman ↑	0.193±0.030	**0.260±0.013**	0.157±0.015	0.092±0.027	0.091±0.018	0.063±0.016	0.105±0.003
	RMSE ↓	2.896±0.258	2.803±0.112	3.035±0.178	3.783±0.359	**2.079±0.425**	2.127±0.377	3.447±0.332
HVG50	PCC ↑	0.284±0.009	**0.344±0.011**	0.194±0.006	0.142±0.009	0.116±0.008	0.075±0.006	0.122±0.002
	Spearman ↑	0.208±0.006	**0.270±0.007**	0.152±0.004	0.097±0.006	0.105±0.007	0.064±0.004	0.103±0.003
	RMSE ↓	2.310±0.096	2.262±0.043	2.542±0.120	2.891±0.144	2.362±0.216	**1.819±0.075**	2.718±0.042
HVG100	PCC ↑	**0.336±0.011**	0.327±0.006	0.242±0.008	0.190±0.013	0.141±0.009	0.102±0.009	0.126±0.002
	Spearman ↑	0.234±0.009	**0.260±0.008**	0.179±0.007	0.124±0.011	0.119±0.008	0.078±0.008	0.103±0.002
	RMSE ↓	1.685±0.118	1.828±0.054	1.843±0.192	1.796±0.194	1.948±0.269	**1.455±0.088**	2.084±0.140
SVG20	PCC ↑	**0.479±0.002**	0.395±0.016	0.318±0.013	0.423±0.014	0.364±0.016	0.244±0.014	0.128±0.007
	Spearman ↑	**0.456±0.007**	0.354±0.013	0.291±0.012	0.359±0.011	0.325±0.015	0.201±0.008	0.102±0.004
	RMSE ↓	3.362±0.048	3.094±0.069	3.921±0.105	**3.038±0.052**	3.409±0.059	3.251±0.083	4.305±0.032
SVG50	PCC ↑	**0.475±0.009**	0.380±0.016	0.370±0.019	0.426±0.012	0.333±0.010	0.231±0.008	0.124±0.009
	Spearman ↑	**0.429±0.006**	0.326±0.011	0.306±0.012	0.332±0.006	0.281±0.004	0.190±0.006	0.103±0.010
	RMSE ↓	2.709±0.065	2.515±0.082	2.991±0.098	**2.443±0.065**	2.804±0.064	2.698±0.029	3.404±0.049
SVG100	PCC ↑	**0.444±0.003**	0.344±0.009	0.381±0.006	0.380±0.004	0.299±0.005	0.215±0.006	0.129±0.006
	Spearman ↑	**0.401±0.002**	0.302±0.007	0.307±0.010	0.298±0.004	0.257±0.003	0.181±0.003	0.106±0.007
	RMSE ↓	2.413±0.036	2.257±0.047	2.484±0.032	**2.207±0.032**	2.611±0.047	2.394±0.026	2.854±0.037
HEG20	PCC ↑	**0.404±0.002**	0.247±0.017	0.316±0.008	0.330±0.004	0.132±0.009	0.160±0.008	0.117±0.006
	Spearman ↑	**0.482±0.002**	0.291±0.025	0.353±0.008	0.422±0.001	0.112±0.006	0.182±0.007	0.101±0.007
	RMSE ↓	2.937±0.010	3.086±0.046	**2.754±0.009**	2.839±0.005	3.120±0.012	3.045±0.012	3.023±0.010
HEG50	PCC ↑	**0.388±0.002**	0.255±0.009	0.295±0.005	0.281±0.002	0.179±0.001	0.144±0.007	0.123±0.005
	Spearman ↑	**0.428±0.002**	0.278±0.013	0.301±0.005	0.341±0.002	0.170±0.000	0.157±0.006	0.106±0.006
	RMSE ↓	2.950±0.009	2.995±0.022	**2.731±0.017**	2.870±0.008	3.169±0.011	3.045±0.011	3.042±0.025
HEG100	PCC ↑	**0.362±0.001**	0.250±0.008	0.283±0.002	0.241±0.003	0.171±0.004	0.130±0.008	0.124±0.001
	Spearman ↑	**0.382±0.001**	0.260±0.010	0.272±0.004	0.271±0.002	0.162±0.004	0.134±0.006	0.106±0.002
	RMSE ↓	2.801±0.005	2.750±0.015	**2.569±0.007**	2.710±0.009	3.032±0.011	2.853±0.027	2.854±0.009

Table S11: NCBI865 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.226±0.028	**0.309±0.015**	0.145±0.013	0.109±0.027	0.109±0.033	0.055±0.020	0.123±0.003
	Spearman ↑	0.190±0.024	**0.256±0.015**	0.125±0.007	0.078±0.019	0.100±0.025	0.053±0.016	0.105±0.004
	RMSE ↓	3.895±0.345	**3.102±0.130**	3.297±0.302	4.791±0.389	4.779±0.721	3.307±0.570	4.139±0.070
HVG50	PCC ↑	0.298±0.017	**0.329±0.004**	0.188±0.017	0.165±0.022	0.151±0.011	0.090±0.009	0.133±0.005
	Spearman ↑	0.236±0.015	**0.270±0.004**	0.145±0.014	0.108±0.015	0.131±0.010	0.078±0.007	0.115±0.005
	RMSE ↓	2.672±0.101	2.478±0.016	2.924±0.111	3.023±0.223	3.304±0.411	**2.235±0.165**	3.166±0.100
HVG100	PCC ↑	**0.354±0.002**	0.310±0.002	0.268±0.007	0.218±0.006	0.159±0.003	0.115±0.004	0.139±0.004
	Spearman ↑	**0.275±0.004**	0.257±0.003	0.206±0.005	0.158±0.007	0.136±0.002	0.097±0.003	0.123±0.005
	RMSE ↓	1.878±0.050	2.038±0.017	1.968±0.043	1.785±0.050	2.111±0.111	**1.696±0.020**	2.255±0.053
SVG20	PCC ↑	**0.484±0.010**	0.406±0.004	0.331±0.012	0.457±0.009	0.370±0.006	0.237±0.003	0.143±0.010
	Spearman ↑	**0.455±0.012**	0.347±0.006	0.294±0.013	0.357±0.012	0.324±0.009	0.211±0.005	0.126±0.008
	RMSE ↓	3.387±0.029	2.897±0.037	4.095±0.072	**2.733±0.033**	3.405±0.087	3.270±0.079	4.549±0.036
SVG50	PCC ↑	**0.462±0.003**	0.352±0.006	0.377±0.005	0.408±0.004	0.323±0.004	0.225±0.003	0.153±0.005
	Spearman ↑	**0.432±0.007**	0.305±0.004	0.318±0.009	0.334±0.009	0.291±0.007	0.202±0.004	0.139±0.006
	RMSE ↓	2.953±0.039	2.631±0.042	3.150±0.018	**2.562±0.031**	3.141±0.053	2.905±0.039	3.609±0.054
SVG100	PCC ↑	**0.445±0.007**	0.321±0.004	0.392±0.010	0.372±0.007	0.305±0.007	0.216±0.003	0.155±0.002
	Spearman ↑	**0.422±0.009**	0.293±0.003	0.334±0.010	0.327±0.011	0.287±0.009	0.199±0.004	0.141±0.003
	RMSE ↓	2.588±0.060	2.389±0.034	2.542±0.075	**2.343±0.048**	2.859±0.076	2.593±0.044	2.966±0.069
HEG20	PCC ↑	**0.418±0.006**	0.261±0.004	0.316±0.005	0.319±0.004	0.150±0.004	0.180±0.002	0.133±0.008
	Spearman ↑	**0.509±0.005**	0.318±0.006	0.360±0.003	0.442±0.004	0.175±0.005	0.220±0.005	0.120±0.008
	RMSE ↓	2.822±0.011	2.890±0.008	**2.708±0.008**	2.756±0.006	3.033±0.011	2.924±0.019	2.923±0.018
HEG50	PCC ↑	**0.394±0.003**	0.247±0.002	0.312±0.003	0.285±0.003	0.161±0.005	0.170±0.005	0.137±0.004
	Spearman ↑	**0.447±0.004**	0.277±0.003	0.335±0.003	0.368±0.003	0.170±0.005	0.196±0.004	0.122±0.005
	RMSE ↓	2.830±0.011	2.868±0.008	**2.649±0.012**	2.775±0.012	3.034±0.011	2.904±0.025	2.902±0.016
HEG100	PCC ↑	**0.377±0.002**	0.250±0.002	0.317±0.002	0.266±0.001	0.178±0.005	0.142±0.004	0.147±0.002
	Spearman ↑	**0.404±0.002**	0.260±0.002	0.318±0.003	0.311±0.001	0.181±0.005	0.159±0.003	0.134±0.002
	RMSE ↓	2.746±0.008	2.698±0.006	**2.523±0.004**	2.654±0.005	2.961±0.007	2.808±0.020	2.830±0.011

Table S12: NCBI864 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.206±0.005	**0.294±0.007**	0.160±0.010	0.056±0.009	0.062±0.007	0.039±0.012	0.122±0.003
	Spearman ↑	0.153±0.008	**0.236±0.005**	0.128±0.007	0.045±0.005	0.057±0.005	0.037±0.009	0.104±0.003
	RMSE ↓	3.483±0.305	3.142±0.088	3.247±0.064	4.947±0.340	3.895±1.343	**2.814±0.515**	4.017±0.182
HVG50	PCC ↑	0.254±0.016	**0.316±0.021**	0.180±0.007	0.098±0.016	0.092±0.015	0.058±0.010	0.125±0.004
	Spearman ↑	0.196±0.018	**0.256±0.017**	0.138±0.007	0.068±0.012	0.083±0.012	0.053±0.010	0.107±0.005
	RMSE ↓	2.783±0.074	**2.189±0.223**	2.954±0.149	3.690±0.171	3.232±0.169	2.245±0.095	2.980±0.064
HVG100	PCC ↑	**0.325±0.010**	0.311±0.006	0.235±0.010	0.165±0.014	0.125±0.012	0.087±0.010	0.131±0.002
	Spearman ↑	0.238±0.011	**0.262±0.007**	0.181±0.008	0.119±0.012	0.109±0.011	0.076±0.010	0.112±0.003
	RMSE ↓	1.817±0.087	1.917±0.044	1.902±0.064	1.960±0.097	1.963±0.169	**1.563±0.070**	2.072±0.110
SVG20	PCC ↑	**0.402±0.024**	0.396±0.010	0.272±0.025	0.399±0.014	0.375±0.010	0.222±0.010	0.120±0.004
	Spearman ↑	**0.443±0.013**	0.386±0.007	0.267±0.022	0.362±0.011	0.386±0.007	0.228±0.009	0.100±0.006
	RMSE ↓	4.024±0.113	**3.425±0.034**	4.266±0.056	3.460±0.046	3.862±0.070	3.725±0.074	4.592±0.033
SVG50	PCC ↑	**0.445±0.003**	0.366±0.008	0.383±0.004	0.410±0.004	0.345±0.002	0.227±0.004	0.135±0.006
	Spearman ↑	**0.443±0.002**	0.343±0.009	0.341±0.007	0.361±0.002	0.329±0.002	0.217±0.002	0.116±0.007
	RMSE ↓	2.953±0.049	2.703±0.024	2.892±0.025	**2.570±0.042**	3.011±0.040	2.866±0.045	3.445±0.044
SVG100	PCC ↑	**0.418±0.005**	0.327±0.005	0.385±0.007	0.349±0.006	0.274±0.002	0.196±0.002	0.136±0.005
	Spearman ↑	**0.402±0.005**	0.306±0.005	0.328±0.006	0.300±0.006	0.254±0.001	0.185±0.004	0.119±0.004
	RMSE ↓	2.562±0.061	2.335±0.036	2.427±0.055	**2.308±0.063**	2.775±0.061	2.530±0.063	2.894±0.060
HEG20	PCC ↑	**0.369±0.002**	0.231±0.016	0.297±0.003	0.298±0.004	0.098±0.004	0.177±0.009	0.124±0.003
	Spearman ↑	**0.446±0.003**	0.286±0.026	0.334±0.003	0.395±0.004	0.104±0.003	0.196±0.004	0.110±0.004
	RMSE ↓	2.998±0.011	3.151±0.054	**2.804±0.005**	2.903±0.006	3.182±0.006	3.060±0.015	2.997±0.005
HEG50	PCC ↑	**0.387±0.004**	0.254±0.008	0.318±0.003	0.289±0.004	0.177±0.004	0.140±0.004	0.123±0.005
	Spearman ↑	**0.421±0.004**	0.275±0.010	0.321±0.002	0.339±0.004	0.159±0.005	0.159±0.004	0.105±0.005
	RMSE ↓	3.026±0.006	3.011±0.026	**2.761±0.008**	2.886±0.008	3.206±0.008	3.107±0.023	3.114±0.015
HEG100	PCC ↑	**0.358±0.001**	0.252±0.006	0.299±0.001	0.240±0.002	0.155±0.002	0.123±0.004	0.127±0.004
	Spearman ↑	**0.372±0.001**	0.261±0.008	0.287±0.001	0.259±0.002	0.140±0.001	0.132±0.004	0.111±0.004
	RMSE ↓	2.827±0.003	2.750±0.011	**2.573±0.007**	2.685±0.003	3.035±0.006	2.881±0.004	2.926±0.003

Table S13: NCBI884 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.219±0.021	**0.241±0.014**	0.163±0.010	0.082±0.023	0.072±0.024	0.042±0.015	0.125±0.005
	Spearman ↑	0.168±0.014	**0.211±0.010**	0.132±0.008	0.063±0.015	0.054±0.019	0.037±0.015	0.107±0.005
	RMSE ↓	3.540±0.417	2.968±0.306	3.385±0.326	4.665±0.740	3.288±1.080	**2.479±0.530**	3.708±0.186
HVG50	PCC ↑	**0.262±0.011**	0.215±0.012	0.202±0.009	0.119±0.016	0.090±0.013	0.057±0.011	0.125±0.001
	Spearman ↑	**0.198±0.015**	0.189±0.003	0.159±0.008	0.083±0.013	0.063±0.013	0.046±0.009	0.105±0.001
	RMSE ↓	2.549±0.075	2.505±0.143	2.515±0.123	3.022±0.086	2.199±0.178	**1.946±0.143**	2.759±0.061
HVG100	PCC ↑	**0.284±0.003**	0.208±0.006	0.224±0.003	0.120±0.005	0.092±0.005	0.058±0.005	0.127±0.002
	Spearman ↑	**0.209±0.004**	0.185±0.004	0.176±0.002	0.090±0.004	0.058±0.004	0.044±0.004	0.107±0.004
	RMSE ↓	1.926±0.059	2.108±0.032	1.877±0.054	2.047±0.082	2.022±0.067	**1.667±0.111**	2.018±0.079
SVG20	PCC ↑	**0.389±0.010**	0.298±0.016	0.273±0.019	0.316±0.024	0.308±0.017	0.169±0.009	0.140±0.011
	Spearman ↑	**0.342±0.011**	0.220±0.006	0.250±0.017	0.245±0.010	0.181±0.013	0.123±0.006	0.123±0.012
	RMSE ↓	3.426±0.143	**3.007±0.197**	3.979±0.184	3.323±0.230	3.343±0.222	3.290±0.162	4.145±0.147
SVG50	PCC ↑	**0.383±0.008**	0.240±0.011	0.319±0.012	0.302±0.010	0.238±0.013	0.149±0.005	0.138±0.002
	Spearman ↑	**0.344±0.007**	0.195±0.005	0.276±0.012	0.243±0.010	0.141±0.009	0.118±0.007	0.117±0.003
	RMSE ↓	3.025±0.038	**2.723±0.044**	3.077±0.103	2.864±0.061	3.147±0.032	3.006±0.052	3.419±0.094
SVG100	PCC ↑	**0.364±0.005**	0.209±0.010	0.320±0.005	0.266±0.008	0.192±0.009	0.128±0.004	0.130±0.002
	Spearman ↑	**0.334±0.002**	0.187±0.004	0.275±0.006	0.229±0.004	0.117±0.005	0.107±0.004	0.110±0.004
	RMSE ↓	2.699±0.033	2.592±0.046	2.590±0.042	**2.577±0.038**	2.919±0.025	2.708±0.036	2.895±0.028
HEG20	PCC ↑	**0.332±0.003**	0.149±0.010	0.260±0.003	0.242±0.003	0.038±0.006	0.125±0.006	0.114±0.002
	Spearman ↑	**0.393±0.002**	0.179±0.011	0.291±0.005	0.322±0.002	0.051±0.005	0.128±0.006	0.096±0.001
	RMSE ↓	2.781±0.012	2.940±0.027	**2.651±0.009**	2.719±0.006	2.901±0.007	2.818±0.020	2.752±0.012
HEG50	PCC ↑	**0.335±0.005**	0.147±0.006	0.271±0.003	0.226±0.002	0.081±0.008	0.118±0.005	0.129±0.002
	Spearman ↑	**0.365±0.005**	0.163±0.007	0.284±0.004	0.277±0.002	0.058±0.005	0.116±0.006	0.110±0.003
	RMSE ↓	2.899±0.049	2.950±0.021	**2.675±0.008**	2.832±0.007	3.057±0.007	2.955±0.024	2.881±0.010
HEG100	PCC ↑	**0.316±0.002**	0.150±0.003	0.263±0.002	0.192±0.003	0.064±0.004	0.095±0.001	0.123±0.002
	Spearman ↑	**0.332±0.001**	0.162±0.004	0.265±0.002	0.225±0.003	0.042±0.003	0.090±0.003	0.104±0.002
	RMSE ↓	2.811±0.003	2.809±0.009	**2.597±0.007**	2.768±0.008	2.994±0.004	2.883±0.013	2.800±0.009

Table S14: NCBI866 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.228±0.017	**0.348±0.007**	0.178±0.010	0.110±0.018	0.096±0.021	0.074±0.007	0.126±0.011
	Spearman ↑	0.193±0.016	**0.282±0.008**	0.148±0.006	0.091±0.015	0.094±0.017	0.071±0.005	0.105±0.010
	RMSE ↓	3.625±0.074	3.123±0.097	3.689±0.151	4.983±0.136	5.265±0.079	**3.099±0.289**	3.889±0.116
HVG50	PCC ↑	0.351±0.022	**0.361±0.010**	0.257±0.016	0.234±0.028	0.167±0.020	0.143±0.016	0.129±0.001
	Spearman ↑	0.278±0.016	**0.285±0.007**	0.195±0.009	0.162±0.017	0.151±0.014	0.118±0.010	0.106±0.001
	RMSE ↓	2.449±0.086	2.239±0.057	2.928±0.078	2.656±0.158	2.988±0.134	**2.021±0.096**	3.154±0.115
HVG100	PCC ↑	**0.390±0.002**	0.342±0.006	0.356±0.006	0.283±0.010	0.189±0.010	0.165±0.005	0.131±0.003
	Spearman ↑	**0.304±0.005**	0.275±0.005	0.249±0.002	0.195±0.006	0.168±0.007	0.137±0.004	0.106±0.004
	RMSE ↓	1.855±0.054	1.920±0.030	1.929±0.060	**1.660±0.049**	2.321±0.156	1.669±0.064	2.325±0.077
SVG20	PCC ↑	**0.496±0.013**	0.402±0.015	0.380±0.023	0.483±0.022	0.324±0.013	0.265±0.014	0.147±0.004
	Spearman ↑	**0.479±0.011**	0.375±0.013	0.328±0.017	0.391±0.016	0.320±0.009	0.239±0.009	0.120±0.007
	RMSE ↓	3.372±0.112	2.994±0.111	3.719±0.136	**2.811±0.125**	3.441±0.127	3.267±0.100	4.167±0.088
SVG50	PCC ↑	**0.513±0.009**	0.380±0.010	0.481±0.011	0.479±0.014	0.327±0.005	0.290±0.009	0.151±0.008
	Spearman ↑	**0.491±0.009**	0.353±0.005	0.401±0.009	0.412±0.012	0.318±0.008	0.263±0.009	0.124±0.006
	RMSE ↓	2.774±0.074	2.632±0.047	2.744±0.093	**2.425±0.084**	2.952±0.079	2.731±0.047	3.298±0.078
SVG100	PCC ↑	**0.473±0.004**	0.353±0.006	0.471±0.006	0.422±0.009	0.284±0.003	0.271±0.005	0.139±0.004
	Spearman ↑	**0.435±0.002**	0.319±0.002	0.381±0.004	0.348±0.004	0.270±0.002	0.240±0.004	0.113±0.005
	RMSE ↓	2.323±0.039	2.173±0.039	2.257±0.046	**2.065±0.045**	2.643±0.043	2.296±0.019	2.731±0.051
HEG20	PCC ↑	**0.460±0.003**	0.281±0.007	0.378±0.003	0.383±0.005	0.168±0.012	0.196±0.019	0.132±0.006
	Spearman ↑	**0.550±0.002**	0.351±0.007	0.438±0.001	0.511±0.002	0.195±0.008	0.254±0.010	0.124±0.007
	RMSE ↓	2.661±0.006	2.916±0.016	**2.534±0.011**	2.566±0.008	2.969±0.009	2.785±0.021	2.798±0.004
HEG50	PCC ↑	**0.410±0.003**	0.266±0.004	0.359±0.004	0.314±0.004	0.121±0.005	0.173±0.008	0.124±0.006
	Spearman ↑	**0.459±0.002**	0.302±0.004	0.389±0.004	0.400±0.002	0.128±0.006	0.207±0.004	0.107±0.006
	RMSE ↓	2.775±0.009	2.849±0.010	**2.546±0.007**	2.700±0.009	3.053±0.010	2.836±0.008	2.884±0.010
HEG100	PCC ↑	**0.386±0.002**	0.264±0.003	0.355±0.003	0.284±0.002	0.138±0.003	0.168±0.006	0.126±0.003
	Spearman ↑	**0.409±0.002**	0.280±0.002	0.359±0.003	0.330±0.001	0.135±0.004	0.180±0.003	0.109±0.004
	RMSE ↓	2.683±0.006	2.647±0.004	**2.418±0.007**	2.590±0.004	2.973±0.012	2.689±0.002	2.761±0.008

Table S15: NCBI857 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.226±0.007	**0.377±0.031**	0.201±0.006	0.095±0.008	0.096±0.006	0.074±0.005	0.129±0.006
	Spearman ↑	0.190±0.009	**0.318±0.037**	0.170±0.003	0.083±0.006	0.097±0.006	0.076±0.005	0.111±0.006
	RMSE ↓	3.653±0.054	**2.914±0.148**	3.458±0.150	5.048±0.123	5.241±0.117	3.164±0.213	4.060±0.159
HVG50	PCC ↑	0.365±0.016	**0.399±0.008**	0.313±0.017	0.267±0.029	0.191±0.027	0.178±0.022	0.139±0.002
	Spearman ↑	0.312±0.022	**0.347±0.010**	0.257±0.014	0.213±0.022	0.187±0.028	0.160±0.020	0.117±0.002
	RMSE ↓	2.446±0.126	2.177±0.050	2.566±0.172	2.571±0.068	2.469±0.214	**1.949±0.146**	2.924±0.191
HVG100	PCC ↑	**0.404±0.017**	0.378±0.007	0.371±0.022	0.293±0.025	0.224±0.018	0.208±0.016	0.132±0.009
	Spearman ↑	**0.342±0.025**	0.333±0.008	0.308±0.019	0.245±0.024	0.214±0.018	0.187±0.016	0.111±0.010
	RMSE ↓	1.912±0.105	1.921±0.047	1.903±0.086	1.809±0.050	2.049±0.181	**1.692±0.157**	2.305±0.128
SVG20	PCC ↑	0.545±0.004	0.413±0.009	0.495±0.007	**0.550±0.004**	0.447±0.016	0.426±0.004	0.174±0.013
	Spearman ↑	**0.574±0.004**	0.407±0.010	0.478±0.007	0.528±0.003	0.411±0.014	0.387±0.008	0.156±0.014
	RMSE ↓	3.526±0.034	3.209±0.023	3.320±0.024	**2.929±0.031**	3.609±0.032	3.275±0.030	4.076±0.038
SVG50	PCC ↑	0.537±0.006	0.434±0.007	**0.543±0.012**	0.533±0.004	0.422±0.008	0.395±0.006	0.178±0.010
	Spearman ↑	**0.538±0.004**	0.407±0.008	0.483±0.012	0.482±0.005	0.409±0.005	0.358±0.005	0.159±0.012
	RMSE ↓	2.870±0.025	2.620±0.022	2.704±0.043	**2.439±0.020**	3.003±0.032	2.723±0.019	3.499±0.036
SVG100	PCC ↑	0.500±0.003	0.394±0.003	**0.525±0.004**	0.466±0.004	0.388±0.003	0.358±0.004	0.159±0.014
	Spearman ↑	**0.498±0.004**	0.379±0.002	0.476±0.001	0.433±0.007	0.374±0.003	0.333±0.004	0.140±0.015
	RMSE ↓	2.514±0.056	2.321±0.040	2.286±0.058	**2.228±0.037**	2.736±0.060	2.420±0.050	2.952±0.068
HEG20	PCC ↑	**0.453±0.003**	0.279±0.008	0.399±0.002	0.374±0.002	0.159±0.009	0.263±0.002	0.126±0.017
	Spearman ↑	**0.558±0.001**	0.351±0.008	0.462±0.003	0.521±0.004	0.194±0.008	0.320±0.004	0.115±0.020
	RMSE ↓	2.741±0.014	2.880±0.016	**2.536±0.013**	2.614±0.011	3.046±0.013	2.800±0.006	2.907±0.026
HEG50	PCC ↑	**0.424±0.001**	0.281±0.004	0.389±0.001	0.329±0.003	0.163±0.002	0.233±0.002	0.143±0.009
	Spearman ↑	**0.486±0.001**	0.322±0.003	0.429±0.002	0.427±0.003	0.179±0.001	0.266±0.005	0.130±0.009
	RMSE ↓	2.753±0.007	2.807±0.008	**2.504±0.007**	2.652±0.010	3.032±0.011	2.808±0.005	2.911±0.020
HEG100	PCC ↑	**0.410±0.002**	0.295±0.003	0.388±0.002	0.310±0.002	0.183±0.008	0.227±0.002	0.135±0.005
	Spearman ↑	**0.442±0.001**	0.315±0.002	0.402±0.003	0.365±0.002	0.185±0.008	0.240±0.001	0.122±0.007
	RMSE ↓	2.657±0.004	2.623±0.007	**2.384±0.006**	2.542±0.006	2.943±0.006	2.666±0.019	2.792±0.014

Table S16: NCBI882 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.246±0.022	**0.311±0.015**	0.203±0.013	0.073±0.020	0.078±0.022	0.072±0.016	0.121±0.004
	Spearman ↑	0.189±0.020	**0.248±0.018**	0.167±0.009	0.058±0.016	0.069±0.018	0.063±0.012	0.102±0.005
	RMSE ↓	3.374±0.576	2.653±0.101	3.778±0.448	4.058±0.516	3.405±1.749	**2.535±0.904**	3.785±0.644
HVG50	PCC ↑	0.327±0.018	**0.340±0.003**	0.268±0.013	0.186±0.027	0.107±0.019	0.095±0.016	0.127±0.003
	Spearman ↑	0.260±0.021	**0.284±0.006**	0.213±0.010	0.143±0.021	0.103±0.017	0.084±0.014	0.109±0.003
	RMSE ↓	2.492±0.124	2.356±0.029	2.653±0.108	2.648±0.125	2.862±0.440	**2.000±0.174**	2.887±0.173
HVG100	PCC ↑	**0.372±0.019**	0.330±0.002	0.332±0.022	0.235±0.034	0.149±0.021	0.126±0.014	0.129±0.004
	Spearman ↑	**0.303±0.026**	0.282±0.004	0.258±0.020	0.189±0.031	0.144±0.021	0.110±0.013	0.108±0.004
	RMSE ↓	1.998±0.103	2.002±0.023	1.901±0.098	1.786±0.088	2.415±0.137	**1.775±0.122**	2.271±0.130
SVG20	PCC ↑	**0.460±0.011**	0.436±0.017	0.334±0.006	0.440±0.023	0.307±0.021	0.248±0.010	0.128±0.017
	Spearman ↑	**0.473±0.012**	0.405±0.020	0.330±0.009	0.409±0.019	0.305±0.016	0.218±0.012	0.104±0.019
	RMSE ↓	3.762±0.138	**3.241±0.118**	3.922±0.112	3.321±0.158	3.903±0.181	3.588±0.144	4.339±0.118
SVG50	PCC ↑	**0.479±0.017**	0.380±0.006	0.462±0.024	0.458±0.020	0.311±0.018	0.250±0.023	0.139±0.004
	Spearman ↑	**0.479±0.018**	0.349±0.008	0.399±0.023	0.412±0.025	0.307±0.015	0.227±0.019	0.114±0.004
	RMSE ↓	2.890±0.124	2.562±0.075	2.696±0.152	**2.486±0.128**	3.022±0.168	2.836±0.134	3.352±0.107
SVG100	PCC ↑	**0.460±0.009**	0.347±0.004	0.456±0.016	0.413±0.008	0.274±0.018	0.222±0.018	0.127±0.006
	Spearman ↑	**0.452±0.006**	0.324±0.004	0.395±0.012	0.382±0.007	0.258±0.014	0.204±0.012	0.105±0.006
	RMSE ↓	2.408±0.038	2.252±0.015	2.187±0.054	**2.136±0.042**	2.610±0.026	2.389±0.044	2.735±0.028
HEG20	PCC ↑	**0.435±0.005**	0.265±0.009	0.399±0.007	0.398±0.006	0.134±0.013	0.248±0.004	0.115±0.009
	Spearman ↑	0.527±0.005	0.318±0.012	0.465±0.008	**0.528±0.006**	0.142±0.011	0.277±0.008	0.097±0.011
	RMSE ↓	2.644±0.021	2.793±0.027	**2.435±0.022**	2.443±0.011	2.877±0.019	2.665±0.015	2.731±0.023
HEG50	PCC ↑	**0.413±0.005**	0.272±0.008	0.371±0.005	0.328±0.005	0.116±0.010	0.181±0.014	0.120±0.003
	Spearman ↑	**0.467±0.004**	0.303±0.009	0.408±0.002	0.422±0.004	0.109±0.008	0.207±0.007	0.101±0.004
	RMSE ↓	2.619±0.010	2.695±0.014	**2.417±0.014**	2.519±0.018	2.892±0.009	2.691±0.016	2.737±0.012
HEG100	PCC ↑	**0.400±0.003**	0.275±0.008	0.369±0.004	0.309±0.004	0.115±0.003	0.139±0.007	0.125±0.001
	Spearman ↑	**0.427±0.003**	0.287±0.006	0.378±0.003	0.359±0.004	0.105±0.004	0.164±0.004	0.108±0.002
	RMSE ↓	2.582±0.006	2.561±0.011	**2.337±0.011**	2.454±0.013	2.858±0.009	2.654±0.011	2.681±0.008

Table S17: NCBI856 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.270±0.017	**0.334±0.008**	0.192±0.009	0.102±0.050	0.082±0.017	0.063±0.007	0.127±0.002
	Spearman ↑	0.222±0.017	**0.287±0.014**	0.162±0.009	0.090±0.036	0.079±0.015	0.059±0.004	0.109±0.002
	RMSE ↓	3.602±0.393	2.968±0.130	3.914±0.484	3.961±0.799	4.092±1.244	**2.965±0.550**	4.075±0.498
HVG50	PCC ↑	**0.341±0.014**	0.323±0.009	0.261±0.021	0.202±0.025	0.133±0.016	0.104±0.007	0.133±0.001
	Spearman ↑	0.277±0.014	**0.287±0.007**	0.209±0.015	0.160±0.016	0.127±0.016	0.091±0.008	0.113±0.001
	RMSE ↓	2.483±0.060	2.324±0.044	2.650±0.108	2.606±0.141	2.734±0.204	**2.029±0.078**	2.909±0.124
HVG100	PCC ↑	**0.351±0.007**	0.299±0.005	0.300±0.009	0.199±0.008	0.124±0.005	0.115±0.007	0.133±0.004
	Spearman ↑	**0.281±0.006**	0.276±0.004	0.239±0.009	0.168±0.009	0.116±0.006	0.102±0.006	0.115±0.004
	RMSE ↓	1.885±0.030	1.999±0.038	1.822±0.057	1.811±0.028	1.942±0.023	**1.624±0.021**	2.108±0.036
SVG20	PCC ↑	**0.470±0.003**	0.420±0.006	0.398±0.017	0.461±0.008	0.366±0.006	0.278±0.007	0.122±0.008
	Spearman ↑	**0.477±0.006**	0.387±0.005	0.379±0.019	0.422±0.009	0.350±0.007	0.245±0.004	0.109±0.010
	RMSE ↓	3.675±0.058	**3.052±0.036**	3.574±0.094	3.239±0.049	3.685±0.013	3.427±0.058	4.224±0.052
SVG50	PCC ↑	0.445±0.002	0.350±0.010	**0.451±0.005**	0.420±0.006	0.295±0.011	0.246±0.008	0.155±0.009
	Spearman ↑	**0.445±0.007**	0.334±0.006	0.401±0.007	0.382±0.007	0.278±0.011	0.224±0.005	0.141±0.010
	RMSE ↓	3.046±0.063	**2.636±0.050**	2.747±0.063	2.708±0.046	3.179±0.098	2.885±0.047	3.495±0.074
SVG100	PCC ↑	0.432±0.004	0.311±0.005	**0.444±0.007**	0.378±0.009	0.248±0.006	0.220±0.005	0.138±0.002
	Spearman ↑	**0.426±0.004**	0.306±0.004	0.398±0.003	0.355±0.005	0.232±0.006	0.207±0.005	0.120±0.001
	RMSE ↓	2.534±0.031	2.345±0.016	**2.284±0.019**	2.298±0.033	2.760±0.038	2.481±0.030	2.834±0.034
HEG20	PCC ↑	**0.381±0.002**	0.251±0.002	0.340±0.004	0.313±0.001	0.110±0.012	0.186±0.010	0.126±0.006
	Spearman ↑	**0.474±0.004**	0.320±0.002	0.402±0.006	0.448±0.003	0.125±0.012	0.226±0.013	0.109±0.007
	RMSE ↓	2.549±0.013	2.590±0.015	**2.418±0.009**	2.448±0.008	2.716±0.006	2.583±0.015	2.572±0.005
HEG50	PCC ↑	**0.378±0.003**	0.245±0.002	0.352±0.003	0.303±0.004	0.111±0.004	0.182±0.010	0.124±0.005
	Spearman ↑	**0.436±0.004**	0.283±0.002	0.393±0.004	0.394±0.004	0.118±0.004	0.211±0.002	0.108±0.006
	RMSE ↓	2.673±0.005	2.707±0.009	**2.461±0.007**	2.574±0.004	2.886±0.003	2.721±0.006	2.747±0.007
HEG100	PCC ↑	**0.378±0.003**	0.255±0.002	0.360±0.004	0.287±0.003	0.121±0.007	0.157±0.003	0.128±0.003
	Spearman ↑	**0.408±0.003**	0.275±0.002	0.376±0.004	0.341±0.003	0.114±0.007	0.169±0.002	0.111±0.003
	RMSE ↓	2.617±0.004	2.600±0.004	**2.375±0.002**	2.513±0.013	2.834±0.004	2.653±0.010	2.719±0.004

Table S18: NCBI861 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.192±0.021	**0.247±0.005**	0.192±0.004	0.017±0.008	0.042±0.004	0.035±0.004	0.123±0.003
	Spearman ↑	0.124±0.015	**0.191±0.006**	0.150±0.003	0.019±0.011	0.041±0.003	0.033±0.003	0.104±0.003
	RMSE ↓	3.445±0.116	3.191±0.143	3.347±0.274	4.468±0.496	4.079±1.126	**2.605±0.231**	3.840±0.220
HVG50	PCC ↑	0.243±0.013	**0.265±0.003**	0.234±0.009	0.108±0.016	0.067±0.011	0.063±0.009	0.124±0.005
	Spearman ↑	0.178±0.014	**0.222±0.005**	0.175±0.005	0.084±0.011	0.068±0.011	0.055±0.007	0.106±0.006
	RMSE ↓	2.745±0.082	2.488±0.190	2.643±0.132	3.351±0.174	3.538±0.697	**2.032±0.134**	2.912±0.129
HVG100	PCC ↑	**0.302±0.005**	0.270±0.003	0.301±0.003	0.182±0.006	0.102±0.004	0.103±0.006	0.131±0.003
	Spearman ↑	0.235±0.003	**0.238±0.005**	0.233±0.002	0.149±0.005	0.102±0.005	0.094±0.004	0.113±0.003
	RMSE ↓	2.155±0.033	2.121±0.051	1.974±0.008	2.162±0.039	2.773±0.040	**1.752±0.035**	2.296±0.038
SVG20	PCC ↑	**0.388±0.018**	0.379±0.012	0.334±0.023	0.365±0.034	0.258±0.004	0.218±0.015	0.114±0.008
	Spearman ↑	**0.415±0.019**	0.371±0.014	0.317±0.016	0.346±0.025	0.271±0.004	0.216±0.012	0.095±0.010
	RMSE ↓	4.389±0.085	**3.622±0.072**	4.223±0.074	3.936±0.173	4.645±0.079	3.953±0.174	4.836±0.066
SVG50	PCC ↑	0.392±0.012	0.327±0.005	**0.416±0.016**	0.380±0.021	0.232±0.011	0.208±0.010	0.132±0.006
	Spearman ↑	**0.401±0.012**	0.312±0.006	0.359±0.015	0.339±0.019	0.238±0.011	0.202±0.010	0.115±0.007
	RMSE ↓	3.577±0.065	**3.021±0.073**	3.163±0.094	3.055±0.103	3.894±0.134	3.307±0.043	3.930±0.046
SVG100	PCC ↑	0.367±0.007	0.289±0.008	**0.399±0.010**	0.331±0.010	0.195±0.006	0.186±0.013	0.132±0.004
	Spearman ↑	**0.370±0.006**	0.281±0.008	0.351±0.013	0.300±0.011	0.196±0.007	0.180±0.012	0.115±0.005
	RMSE ↓	3.051±0.045	2.709±0.056	**2.659±0.046**	2.667±0.052	3.383±0.033	2.864±0.085	3.271±0.035
HEG20	PCC ↑	**0.374±0.008**	0.266±0.007	0.356±0.007	0.336±0.010	0.145±0.019	0.199±0.008	0.132±0.005
	Spearman ↑	**0.420±0.009**	0.300±0.007	0.382±0.008	0.412±0.008	0.159±0.020	0.216±0.009	0.116±0.008
	RMSE ↓	3.853±0.055	3.617±0.019	**3.294±0.015**	3.475±0.050	4.079±0.014	3.783±0.038	3.821±0.013
HEG50	PCC ↑	0.362±0.005	0.254±0.005	**0.369±0.006**	0.315±0.006	0.145±0.005	0.187±0.007	0.128±0.012
	Spearman ↑	**0.386±0.005**	0.269±0.005	0.373±0.006	0.358±0.006	0.143±0.006	0.193±0.007	0.110±0.015
	RMSE ↓	3.585±0.018	3.376±0.016	**3.052±0.013**	3.259±0.015	3.864±0.007	3.506±0.051	3.627±0.017
HEG100	PCC ↑	0.336±0.004	0.248±0.003	**0.345±0.005**	0.270±0.004	0.107±0.006	0.157±0.004	0.125±0.007
	Spearman ↑	**0.350±0.004**	0.256±0.003	0.334±0.005	0.283±0.004	0.101±0.005	0.157±0.004	0.108±0.008
	RMSE ↓	3.240±0.012	3.030±0.013	**2.816±0.017**	2.950±0.014	3.529±0.006	3.119±0.062	3.289±0.005

Table S19: NCBI881 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.245±0.018	**0.315±0.014**	0.215±0.016	0.091±0.028	0.106±0.020	0.048±0.019	0.124±0.004
	Spearman ↑	0.201±0.029	**0.258±0.010**	0.177±0.015	0.076±0.024	0.099±0.023	0.046±0.018	0.107±0.003
	RMSE ↓	3.644±0.405	3.180±0.106	3.808±0.206	5.021±0.521	4.422±0.846	**2.881±0.596**	4.052±0.188
HVG50	PCC ↑	0.299±0.009	**0.324±0.012**	0.257±0.007	0.151±0.010	0.109±0.009	0.070±0.008	0.128±0.004
	Spearman ↑	0.242±0.009	**0.271±0.009**	0.202±0.005	0.114±0.007	0.104±0.008	0.065±0.009	0.109±0.005
	RMSE ↓	2.840±0.069	2.574±0.161	2.893±0.098	3.304±0.122	3.774±0.303	**2.453±0.142**	3.171±0.123
HVG100	PCC ↑	**0.354±0.008**	0.339±0.010	0.332±0.009	0.217±0.008	0.128±0.008	0.094±0.003	0.125±0.003
	Spearman ↑	0.286±0.006	**0.287±0.005**	0.253±0.006	0.170±0.008	0.115±0.007	0.083±0.005	0.105±0.002
	RMSE ↓	2.008±0.086	1.998±0.021	1.853±0.110	1.824±0.097	2.562±0.285	**1.789±0.094**	2.191±0.115
SVG20	PCC ↑	**0.456±0.024**	0.431±0.008	0.392±0.020	0.442±0.030	0.298±0.050	0.185±0.031	0.123±0.009
	Spearman ↑	**0.439±0.008**	0.380±0.003	0.350±0.013	0.365±0.018	0.278±0.036	0.166±0.018	0.104±0.007
	RMSE ↓	3.426±0.226	**2.912±0.149**	3.658±0.164	2.974±0.222	3.593±0.301	3.271±0.284	4.216±0.190
SVG50	PCC ↑	**0.484±0.009**	0.411±0.010	0.481±0.014	0.474±0.014	0.309±0.016	0.194±0.008	0.127±0.005
	Spearman ↑	**0.458±0.012**	0.372±0.004	0.394±0.013	0.396±0.016	0.290±0.009	0.176±0.005	0.105±0.005
	RMSE ↓	2.737±0.062	2.476±0.048	2.622±0.057	**2.282±0.064**	2.950±0.082	2.749±0.107	3.279±0.050
SVG100	PCC ↑	0.440±0.008	0.361±0.011	**0.441±0.008**	0.397±0.009	0.232±0.011	0.153±0.005	0.126±0.003
	Spearman ↑	**0.420±0.011**	0.334±0.011	0.370±0.013	0.347±0.014	0.214±0.009	0.145±0.006	0.105±0.004
	RMSE ↓	2.471±0.064	2.315±0.048	2.279±0.067	**2.179±0.055**	2.750±0.083	2.536±0.065	2.796±0.061
HEG20	PCC ↑	**0.422±0.003**	0.298±0.007	0.374±0.005	0.380±0.007	0.091±0.013	0.157±0.010	0.122±0.006
	Spearman ↑	**0.510±0.003**	0.366±0.018	0.441±0.005	0.497±0.003	0.102±0.016	0.175±0.005	0.106±0.006
	RMSE ↓	2.721±0.026	2.786±0.039	**2.533±0.014**	2.549±0.011	2.954±0.013	2.843±0.012	2.797±0.012
HEG50	PCC ↑	**0.394±0.004**	0.294±0.007	0.354±0.004	0.325±0.005	0.084±0.009	0.136±0.012	0.116±0.004
	Spearman ↑	**0.447±0.004**	0.331±0.014	0.387±0.002	0.400±0.005	0.085±0.009	0.143±0.011	0.096±0.004
	RMSE ↓	2.732±0.009	2.719±0.023	**2.508±0.007**	2.594±0.009	2.992±0.007	2.854±0.017	2.837±0.008
HEG100	PCC ↑	**0.379±0.001**	0.288±0.007	0.351±0.003	0.295±0.003	0.042±0.005	0.114±0.007	0.122±0.002
	Spearman ↑	**0.404±0.002**	0.301±0.010	0.357±0.002	0.334±0.002	0.038±0.004	0.118±0.007	0.105±0.003
	RMSE ↓	2.658±0.006	2.582±0.018	**2.411±0.013**	2.520±0.024	2.933±0.004	2.764±0.019	2.744±0.008

Table S20: NCBI880 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.232±0.020	**0.304±0.019**	0.210±0.027	0.056±0.026	0.076±0.013	0.057±0.025	0.122±0.004
	Spearman ↑	0.184±0.015	**0.263±0.012**	0.179±0.020	0.055±0.021	0.077±0.014	0.056±0.027	0.104±0.004
	RMSE ↓	3.599±0.212	3.126±0.160	3.586±0.291	5.034±0.270	4.493±0.422	**3.068±0.436**	3.863±0.290
HVG50	PCC ↑	0.309±0.009	**0.347±0.021**	0.282±0.012	0.172±0.016	0.113±0.017	0.103±0.009	0.128±0.005
	Spearman ↑	0.254±0.012	**0.312±0.022**	0.229±0.014	0.148±0.015	0.114±0.019	0.100±0.008	0.109±0.006
	RMSE ↓	2.664±0.127	2.521±0.072	2.583±0.126	2.972±0.202	3.299±0.385	**2.198±0.162**	2.897±0.124
HVG100	PCC ↑	**0.373±0.011**	0.343±0.007	0.349±0.015	0.238±0.022	0.144±0.016	0.141±0.011	0.135±0.006
	Spearman ↑	**0.309±0.013**	0.307±0.004	0.283±0.011	0.206±0.015	0.139±0.015	0.133±0.009	0.116±0.008
	RMSE ↓	1.905±0.058	1.982±0.045	1.809±0.070	1.732±0.024	2.326±0.098	**1.713±0.068**	2.193±0.089
SVG20	PCC ↑	0.558±0.013	0.500±0.005	0.532±0.052	**0.598±0.021**	0.442±0.009	0.369±0.014	0.134±0.036
	Spearman ↑	**0.604±0.009**	0.492±0.004	0.511±0.045	0.567±0.020	0.448±0.005	0.354±0.012	0.114±0.040
	RMSE ↓	3.549±0.088	3.109±0.066	3.314±0.199	**2.794±0.111**	3.679±0.072	3.314±0.098	4.299±0.061
SVG50	PCC ↑	0.535±0.006	0.443±0.005	**0.555±0.012**	0.537±0.007	0.396±0.008	0.317±0.009	0.151±0.008
	Spearman ↑	**0.542±0.006**	0.420±0.008	0.496±0.013	0.488±0.008	0.394±0.005	0.302±0.005	0.131±0.009
	RMSE ↓	2.891±0.063	2.548±0.092	2.618±0.069	**2.357±0.074**	3.188±0.042	2.824±0.069	3.497±0.033
SVG100	PCC ↑	0.486±0.005	0.389±0.003	**0.511±0.005**	0.452±0.004	0.321±0.007	0.275±0.002	0.138±0.010
	Spearman ↑	**0.479±0.005**	0.366±0.004	0.454±0.006	0.412±0.006	0.317±0.006	0.259±0.003	0.119±0.012
	RMSE ↓	2.485±0.040	2.263±0.021	2.225±0.031	**2.134±0.021**	2.849±0.043	2.435±0.041	2.904±0.029
HEG20	PCC ↑	**0.451±0.001**	0.302±0.005	0.405±0.005	0.379±0.003	0.202±0.016	0.258±0.014	0.122±0.014
	Spearman ↑	**0.551±0.003**	0.355±0.008	0.483±0.007	0.522±0.004	0.248±0.019	0.274±0.007	0.113±0.012
	RMSE ↓	2.695±0.018	2.662±0.014	**2.477±0.012**	2.524±0.011	3.018±0.013	2.721±0.016	2.839±0.030
HEG50	PCC ↑	**0.425±0.003**	0.288±0.005	0.394±0.005	0.345±0.003	0.200±0.004	0.234±0.008	0.124±0.007
	Spearman ↑	**0.488±0.003**	0.319±0.007	0.443±0.006	0.443±0.004	0.223±0.004	0.249±0.008	0.107±0.008
	RMSE ↓	2.701±0.007	2.686±0.012	**2.446±0.010**	2.558±0.005	3.007±0.008	2.745±0.007	2.852±0.010
HEG100	PCC ↑	**0.413±0.001**	0.292±0.006	0.388±0.002	0.321±0.001	0.186±0.006	0.212±0.005	0.130±0.007
	Spearman ↑	**0.446±0.001**	0.310±0.006	0.412±0.002	0.380±0.003	0.193±0.006	0.217±0.004	0.114±0.011
	RMSE ↓	2.624±0.006	2.559±0.010	**2.359±0.004**	2.491±0.012	2.899±0.007	2.665±0.024	2.771±0.008

Table S21: NCBI860 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.210±0.005	**0.238±0.012**	0.200±0.011	0.021±0.007	0.036±0.004	0.029±0.006	0.121±0.002
	Spearman ↑	0.138±0.004	**0.175±0.017**	0.156±0.004	0.021±0.007	0.033±0.006	0.029±0.005	0.103±0.002
	RMSE ↓	3.430±0.169	2.927±0.125	3.381±0.156	5.072±0.347	3.657±0.811	**2.716±0.350**	3.721±0.237
HVG50	PCC ↑	0.245±0.019	**0.255±0.013**	0.225±0.013	0.085±0.023	0.045±0.007	0.036±0.007	0.126±0.002
	Spearman ↑	0.165±0.019	**0.201±0.008**	0.167±0.010	0.065±0.022	0.043±0.008	0.034±0.006	0.108±0.002
	RMSE ↓	2.555±0.125	2.431±0.024	2.542±0.103	3.315±0.223	2.852±0.254	**1.957±0.080**	2.686±0.141
HVG100	PCC ↑	**0.273±0.007**	0.255±0.006	0.238±0.008	0.096±0.012	0.053±0.006	0.044±0.002	0.124±0.004
	Spearman ↑	0.181±0.009	**0.217±0.003**	0.176±0.006	0.072±0.009	0.046±0.006	0.039±0.002	0.106±0.005
	RMSE ↓	1.800±0.086	2.026±0.063	1.826±0.091	2.153±0.048	1.903±0.163	**1.409±0.068**	1.897±0.078
SVG20	PCC ↑	**0.334±0.005**	0.321±0.018	0.260±0.010	0.309±0.017	0.106±0.011	0.119±0.007	0.115±0.010
	Spearman ↑	**0.344±0.011**	0.284±0.014	0.243±0.011	0.287±0.020	0.092±0.016	0.125±0.010	0.099±0.011
	RMSE ↓	4.463±0.035	**3.789±0.108**	4.250±0.127	4.024±0.074	4.859±0.069	4.116±0.043	4.694±0.088
SVG50	PCC ↑	**0.361±0.007**	0.301±0.005	0.324±0.014	0.314±0.015	0.118±0.018	0.114±0.008	0.120±0.004
	Spearman ↑	**0.360±0.012**	0.272±0.007	0.283±0.014	0.279±0.021	0.118±0.020	0.119±0.011	0.100±0.002
	RMSE ↓	3.500±0.089	**2.993±0.041**	3.266±0.101	3.156±0.086	3.842±0.159	3.314±0.066	3.740±0.091
SVG100	PCC ↑	**0.350±0.007**	0.280±0.004	0.324±0.011	0.271±0.008	0.087±0.009	0.095±0.010	0.116±0.002
	Spearman ↑	**0.343±0.009**	0.265±0.006	0.282±0.012	0.245±0.014	0.086±0.008	0.101±0.011	0.097±0.004
	RMSE ↓	3.023±0.077	**2.656±0.014**	2.756±0.089	2.767±0.072	3.285±0.085	2.936±0.038	3.148±0.056
HEG20	PCC ↑	**0.356±0.006**	0.257±0.012	0.300±0.007	0.312±0.005	0.083±0.005	0.100±0.024	0.117±0.006
	Spearman ↑	**0.407±0.006**	0.286±0.016	0.327±0.007	0.378±0.005	0.089±0.009	0.109±0.017	0.100±0.007
	RMSE ↓	3.720±0.014	3.504±0.023	**3.266±0.013**	3.385±0.011	3.919±0.020	3.759±0.030	3.666±0.027
HEG50	PCC ↑	**0.356±0.005**	0.262±0.007	0.322±0.004	0.287±0.002	0.094±0.008	0.099±0.002	0.124±0.002
	Spearman ↑	**0.378±0.005**	0.271±0.012	0.321±0.004	0.319±0.003	0.091±0.006	0.105±0.004	0.106±0.002
	RMSE ↓	3.441±0.009	3.254±0.033	**3.023±0.016**	3.196±0.009	3.730±0.012	3.496±0.036	3.479±0.013
HEG100	PCC ↑	**0.334±0.004**	0.256±0.006	0.305±0.006	0.245±0.003	0.065±0.007	0.088±0.006	0.121±0.004
	Spearman ↑	**0.348±0.004**	0.262±0.008	0.292±0.006	0.256±0.002	0.050±0.003	0.092±0.005	0.103±0.005
	RMSE ↓	3.130±0.009	2.911±0.041	**2.790±0.016**	2.906±0.030	3.391±0.013	3.148±0.033	3.142±0.012

Table S22: NCBI883 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.200±0.006**	0.189±0.006	0.174±0.008	0.012±0.004	0.017±0.004	0.018±0.004	0.123±0.001
	Spearman ↑	0.129±0.014	**0.162±0.006**	0.137±0.005	0.014±0.005	0.017±0.010	0.013±0.005	0.105±0.001
	RMSE ↓	3.323±0.519	3.028±0.304	3.274±0.352	5.024±0.515	2.629±0.650	**2.286±0.412**	3.613±0.471
HVG50	PCC ↑	**0.216±0.005**	0.196±0.004	0.191±0.004	0.047±0.006	0.017±0.002	0.016±0.002	0.125±0.001
	Spearman ↑	0.146±0.007	**0.170±0.004**	0.145±0.002	0.042±0.004	0.023±0.003	0.012±0.002	0.105±0.001
	RMSE ↓	2.644±0.084	2.595±0.221	2.455±0.076	3.388±0.040	2.134±0.249	**1.905±0.215**	2.655±0.134
HVG100	PCC ↑	**0.237±0.004**	0.192±0.004	0.203±0.004	0.057±0.003	0.020±0.003	0.016±0.007	0.125±0.002
	Spearman ↑	0.166±0.003	**0.170±0.003**	0.160±0.005	0.054±0.004	0.019±0.001	0.013±0.007	0.106±0.002
	RMSE ↓	2.019±0.090	2.133±0.072	1.826±0.030	2.315±0.060	1.911±0.059	**1.591±0.062**	1.922±0.056
SVG20	PCC ↑	**0.245±0.010**	0.173±0.012	0.211±0.003	0.163±0.004	0.030±0.018	0.052±0.029	0.121±0.008
	Spearman ↑	**0.259±0.009**	0.165±0.013	0.207±0.008	0.180±0.004	0.030±0.019	0.044±0.023	0.104±0.008
	RMSE ↓	4.367±0.195	4.030±0.231	**3.843±0.118**	4.200±0.158	4.459±0.240	4.364±0.268	4.282±0.139
SVG50	PCC ↑	**0.252±0.007**	0.176±0.010	0.221±0.009	0.152±0.014	0.014±0.006	0.045±0.024	0.126±0.002
	Spearman ↑	**0.259±0.006**	0.170±0.012	0.212±0.010	0.166±0.014	0.024±0.007	0.038±0.020	0.107±0.002
	RMSE ↓	3.820±0.068	3.503±0.095	**3.374±0.060**	3.672±0.076	3.937±0.072	3.841±0.097	3.716±0.055
SVG100	PCC ↑	**0.255±0.006**	0.177±0.005	0.225±0.009	0.140±0.008	0.002±0.005	0.044±0.023	0.127±0.002
	Spearman ↑	**0.260±0.004**	0.176±0.006	0.216±0.008	0.150±0.006	-0.007±0.007	0.038±0.020	0.108±0.002
	RMSE ↓	3.311±0.033	3.034±0.019	**2.974±0.036**	3.175±0.030	3.450±0.038	3.322±0.021	3.234±0.035
HEG20	PCC ↑	**0.251±0.005**	0.149±0.011	0.231±0.006	0.191±0.007	0.026±0.004	0.049±0.032	0.126±0.005
	Spearman ↑	**0.287±0.005**	0.145±0.011	0.248±0.007	0.233±0.007	0.020±0.003	0.044±0.029	0.107±0.006
	RMSE ↓	3.918±0.027	3.660±0.029	**3.478±0.016**	3.729±0.016	4.034±0.014	3.943±0.031	3.800±0.012
HEG50	PCC ↑	**0.264±0.005**	0.161±0.003	0.239±0.005	0.179±0.004	0.024±0.002	0.055±0.020	0.122±0.002
	Spearman ↑	**0.278±0.004**	0.159±0.003	0.241±0.004	0.207±0.003	0.021±0.004	0.050±0.018	0.104±0.003
	RMSE ↓	3.655±0.015	3.386±0.026	**3.237±0.018**	3.503±0.018	3.801±0.013	3.716±0.034	3.570±0.015
HEG100	PCC ↑	**0.258±0.004**	0.166±0.003	0.232±0.004	0.150±0.003	-0.004±0.003	0.048±0.022	0.127±0.003
	Spearman ↑	**0.266±0.004**	0.166±0.003	0.227±0.003	0.166±0.002	-0.016±0.003	0.043±0.020	0.110±0.002
	RMSE ↓	3.334±0.004	3.070±0.023	**2.994±0.005**	3.196±0.009	3.488±0.008	3.375±0.038	3.259±0.005

Table S23: NCBI875 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.226±0.026	**0.230±0.007**	0.187±0.014	0.026±0.029	0.041±0.016	0.022±0.009	0.123±0.003
	Spearman ↑	0.169±0.021	**0.194±0.006**	0.149±0.016	0.023±0.024	0.037±0.015	0.019±0.011	0.106±0.003
	RMSE ↓	3.690±0.264	3.112±0.162	3.717±0.288	4.903±0.636	3.636±0.525	**2.715±0.387**	4.009±0.091
HVG50	PCC ↑	**0.268±0.005**	0.215±0.004	0.235±0.007	0.125±0.008	0.054±0.003	0.038±0.003	0.127±0.004
	Spearman ↑	**0.205±0.005**	0.191±0.006	0.185±0.007	0.097±0.008	0.045±0.001	0.036±0.003	0.109±0.004
	RMSE ↓	2.775±0.134	2.272±0.033	2.666±0.154	3.098±0.182	2.860±0.202	**2.189±0.085**	3.088±0.126
HVG100	PCC ↑	**0.283±0.007**	0.197±0.005	0.252±0.004	0.120±0.004	0.046±0.004	0.040±0.007	0.128±0.002
	Spearman ↑	**0.205±0.007**	0.177±0.004	0.195±0.004	0.100±0.006	0.033±0.002	0.034±0.006	0.110±0.002
	RMSE ↓	1.929±0.069	2.123±0.079	1.723±0.049	1.968±0.055	2.057±0.042	**1.610±0.060**	1.992±0.047
SVG20	PCC ↑	**0.332±0.012**	0.199±0.005	0.302±0.009	0.279±0.011	0.213±0.010	0.100±0.026	0.134±0.005
	Spearman ↑	**0.322±0.010**	0.169±0.006	0.277±0.010	0.253±0.008	0.132±0.017	0.078±0.026	0.111±0.007
	RMSE ↓	3.821±0.309	**3.388±0.295**	3.404±0.225	3.568±0.320	3.901±0.276	3.789±0.298	3.926±0.247
SVG50	PCC ↑	**0.338±0.004**	0.185±0.005	0.310±0.005	0.254±0.005	0.153±0.005	0.093±0.015	0.132±0.009
	Spearman ↑	**0.326±0.006**	0.176±0.006	0.278±0.005	0.234±0.005	0.111±0.006	0.081±0.019	0.114±0.010
	RMSE ↓	3.204±0.116	**2.802±0.090**	2.837±0.122	2.991±0.120	3.375±0.100	3.140±0.090	3.334±0.134
SVG100	PCC ↑	**0.318±0.001**	0.179±0.003	0.289±0.002	0.205±0.009	0.093±0.005	0.076±0.012	0.127±0.003
	Spearman ↑	**0.308±0.003**	0.178±0.002	0.263±0.003	0.196±0.006	0.068±0.005	0.067±0.015	0.110±0.004
	RMSE ↓	2.730±0.034	2.509±0.015	**2.458±0.033**	2.560±0.031	2.932±0.024	2.683±0.054	2.792±0.036
HEG20	PCC ↑	**0.304±0.003**	0.116±0.008	0.255±0.003	0.213±0.005	0.035±0.007	0.080±0.023	0.114±0.007
	Spearman ↑	**0.358±0.002**	0.144±0.008	0.291±0.007	0.299±0.005	0.041±0.005	0.083±0.021	0.089±0.007
	RMSE ↓	2.864±0.013	2.964±0.025	**2.721±0.017**	2.799±0.010	2.993±0.012	2.918±0.016	2.822±0.006
HEG50	PCC ↑	**0.298±0.003**	0.137±0.006	0.249±0.005	0.193±0.006	0.038±0.003	0.065±0.009	0.120±0.004
	Spearman ↑	**0.326±0.003**	0.152±0.006	0.270±0.003	0.248±0.005	0.037±0.003	0.065±0.012	0.101±0.002
	RMSE ↓	2.977±0.010	2.982±0.013	**2.756±0.011**	2.930±0.009	3.133±0.011	3.040±0.012	2.944±0.011
HEG100	PCC ↑	**0.288±0.002**	0.145±0.003	0.242±0.003	0.166±0.003	0.011±0.002	0.058±0.003	0.124±0.003
	Spearman ↑	**0.301±0.002**	0.155±0.004	0.253±0.002	0.201±0.001	0.008±0.002	0.052±0.006	0.107±0.003
	RMSE ↓	2.894±0.008	2.821±0.006	**2.677±0.012**	2.844±0.009	3.052±0.005	2.941±0.005	2.845±0.010

Table S24: NCBI873 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.273±0.015	**0.350±0.016**	0.197±0.009	0.081±0.020	0.058±0.006	0.029±0.004	0.123±0.006
	Spearman ↑	0.219±0.016	**0.286±0.020**	0.165±0.004	0.067±0.016	0.057±0.003	0.029±0.004	0.105±0.006
	RMSE ↓	3.791±0.115	**3.013±0.081**	3.955±0.212	4.935±0.260	5.021±0.099	3.737±0.098	3.998±0.217
HVG50	PCC ↑	**0.345±0.008**	0.328±0.010	0.252±0.004	0.156±0.014	0.075±0.001	0.047±0.007	0.129±0.004
	Spearman ↑	0.276±0.012	**0.279±0.012**	0.198±0.005	0.123±0.016	0.072±0.002	0.045±0.005	0.110±0.005
	RMSE ↓	2.735±0.085	**2.443±0.034**	2.716±0.071	3.052±0.131	3.173±0.370	2.478±0.171	3.026±0.056
HVG100	PCC ↑	**0.369±0.005**	0.304±0.008	0.273±0.007	0.155±0.009	0.063±0.005	0.060±0.012	0.128±0.002
	Spearman ↑	**0.295±0.009**	0.268±0.011	0.222±0.009	0.134±0.009	0.062±0.005	0.056±0.010	0.110±0.003
	RMSE ↓	1.874±0.027	1.900±0.021	1.800±0.042	1.884±0.043	1.941±0.082	**1.677±0.068**	2.029±0.038
SVG20	PCC ↑	**0.482±0.011**	0.368±0.012	0.399±0.012	0.401±0.011	0.198±0.011	0.137±0.007	0.153±0.008
	Spearman ↑	**0.498±0.011**	0.351±0.013	0.381±0.013	0.400±0.013	0.205±0.009	0.149±0.009	0.141±0.009
	RMSE ↓	3.234±0.134	2.938±0.059	2.965±0.142	**2.937±0.101**	3.469±0.173	3.349±0.178	3.673±0.157
SVG50	PCC ↑	**0.458±0.005**	0.319±0.008	0.410±0.005	0.372±0.006	0.148±0.011	0.123±0.007	0.142±0.007
	Spearman ↑	**0.471±0.009**	0.310±0.013	0.395±0.008	0.386±0.012	0.146±0.010	0.131±0.008	0.126±0.008
	RMSE ↓	2.728±0.108	2.578±0.056	**2.457±0.090**	2.520±0.074	2.975±0.123	2.847±0.121	3.011±0.132
SVG100	PCC ↑	**0.429±0.007**	0.304±0.006	0.383±0.005	0.317±0.006	0.091±0.004	0.102±0.014	0.133±0.003
	Spearman ↑	**0.436±0.006**	0.301±0.006	0.367±0.004	0.326±0.006	0.090±0.004	0.106±0.015	0.115±0.004
	RMSE ↓	2.364±0.036	2.279±0.039	**2.180±0.031**	2.220±0.032	2.594±0.047	2.464±0.037	2.573±0.039
HEG20	PCC ↑	**0.416±0.008**	0.240±0.009	0.353±0.006	0.334±0.009	0.041±0.007	0.122±0.019	0.113±0.018
	Spearman ↑	**0.515±0.011**	0.306±0.018	0.428±0.006	0.485±0.009	0.043±0.014	0.158±0.022	0.096±0.022
	RMSE ↓	2.177±0.035	2.481±0.029	2.206±0.030	**2.172±0.027**	2.391±0.019	2.309±0.026	2.256±0.020
HEG50	PCC ↑	**0.418±0.007**	0.259±0.007	0.358±0.007	0.319±0.008	0.044±0.004	0.113±0.017	0.129±0.006
	Spearman ↑	**0.480±0.008**	0.297±0.013	0.401±0.007	0.415±0.007	0.047±0.004	0.127±0.020	0.111±0.007
	RMSE ↓	2.382±0.021	2.514±0.012	**2.260±0.016**	2.345±0.020	2.639±0.016	2.551±0.020	2.507±0.018
HEG100	PCC ↑	**0.392±0.006**	0.259±0.006	0.330±0.008	0.266±0.007	0.023±0.003	0.082±0.021	0.129±0.004
	Spearman ↑	**0.428±0.007**	0.278±0.010	0.355±0.006	0.324±0.007	0.022±0.004	0.087±0.024	0.113±0.004
	RMSE ↓	2.408±0.017	2.443±0.010	**2.263±0.018**	2.368±0.018	2.650±0.013	2.562±0.038	2.488±0.021

Table S25: NCBI859 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.254±0.001	**0.332±0.007**	0.201±0.012	0.015±0.015	0.046±0.017	0.031±0.005	0.123±0.002
	Spearman ↑	0.177±0.018	**0.271±0.014**	0.160±0.005	0.015±0.014	0.045±0.016	0.030±0.003	0.104±0.003
	RMSE ↓	3.605±0.265	**3.118±0.250**	3.885±0.150	4.797±0.242	4.560±0.565	3.253±0.439	4.171±0.166
HVG50	PCC ↑	0.312±0.024	**0.340±0.007**	0.230±0.011	0.123±0.024	0.083±0.011	0.062±0.014	0.128±0.003
	Spearman ↑	0.244±0.025	**0.294±0.010**	0.178±0.012	0.093±0.020	0.079±0.013	0.059±0.012	0.109±0.005
	RMSE ↓	2.787±0.064	**2.155±0.074**	2.820±0.038	3.368±0.262	3.687±0.203	2.550±0.145	2.925±0.106
HVG100	PCC ↑	**0.374±0.007**	0.324±0.007	0.288±0.006	0.174±0.010	0.087±0.008	0.080±0.009	0.132±0.005
	Spearman ↑	0.288±0.010	**0.291±0.006**	0.220±0.007	0.140±0.008	0.087±0.008	0.071±0.007	0.113±0.006
	RMSE ↓	1.841±0.100	1.884±0.024	1.816±0.103	1.920±0.090	1.967±0.179	**1.661±0.098**	2.034±0.121
SVG20	PCC ↑	**0.468±0.006**	0.406±0.006	0.342±0.011	0.415±0.017	0.339±0.015	0.188±0.006	0.125±0.013
	Spearman ↑	**0.508±0.008**	0.404±0.007	0.326±0.012	0.392±0.023	0.348±0.019	0.186±0.009	0.106±0.013
	RMSE ↓	3.453±0.056	3.118±0.089	3.502±0.101	**2.995±0.078**	3.688±0.172	3.392±0.121	4.114±0.072
SVG50	PCC ↑	**0.478±0.006**	0.369±0.005	0.409±0.008	0.387±0.006	0.246±0.006	0.177±0.015	0.138±0.007
	Spearman ↑	**0.484±0.006**	0.371±0.013	0.358±0.010	0.355±0.006	0.250±0.005	0.167±0.012	0.117±0.007
	RMSE ↓	2.531±0.161	2.381±0.142	2.438±0.168	**2.290±0.130**	2.709±0.218	2.614±0.138	2.939±0.165
SVG100	PCC ↑	**0.456±0.008**	0.338±0.012	0.400±0.009	0.333±0.005	0.186±0.011	0.180±0.009	0.134±0.002
	Spearman ↑	**0.446±0.008**	0.339±0.016	0.345±0.008	0.299±0.009	0.188±0.008	0.163±0.009	0.117±0.003
	RMSE ↓	2.214±0.076	2.121±0.072	2.142±0.083	**2.067±0.056**	2.423±0.096	2.270±0.055	2.520±0.094
HEG20	PCC ↑	**0.430±0.011**	0.276±0.012	0.327±0.003	0.323±0.009	0.059±0.007	0.131±0.006	0.118±0.011
	Spearman ↑	**0.542±0.005**	0.371±0.029	0.385±0.006	0.459±0.007	0.077±0.014	0.150±0.006	0.101±0.011
	RMSE ↓	**2.179±0.032**	2.573±0.034	2.269±0.033	2.237±0.030	2.403±0.037	2.341±0.039	2.292±0.025
HEG50	PCC ↑	**0.418±0.004**	0.277±0.009	0.320±0.002	0.286±0.004	0.055±0.011	0.125±0.009	0.128±0.002
	Spearman ↑	**0.479±0.002**	0.334±0.019	0.346±0.003	0.372±0.003	0.063±0.012	0.128±0.009	0.110±0.003
	RMSE ↓	2.428±0.025	2.597±0.026	**2.354±0.012**	2.445±0.017	2.697±0.028	2.593±0.030	2.540±0.038
HEG100	PCC ↑	**0.399±0.003**	0.288±0.008	0.308±0.000	0.247±0.004	0.047±0.005	0.119±0.006	0.123±0.003
	Spearman ↑	**0.429±0.002**	0.319±0.015	0.311±0.001	0.287±0.004	0.056±0.005	0.115±0.005	0.106±0.004
	RMSE ↓	2.402±0.015	2.445±0.013	**2.302±0.012**	2.372±0.018	2.679±0.018	2.549±0.019	2.506±0.010

Table S26: NCBI870 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.240±0.019	**0.284±0.018**	0.203±0.018	0.040±0.036	0.059±0.017	0.032±0.013	0.127±0.002
	Spearman ↑	0.176±0.020	**0.233±0.009**	0.168±0.015	0.034±0.030	0.049±0.013	0.031±0.012	0.110±0.002
	RMSE ↓	3.280±0.159	3.051±0.233	3.320±0.132	4.838±0.730	3.134±1.266	**2.569±0.432**	3.736±0.264
HVG50	PCC ↑	0.298±0.007	**0.300±0.020**	0.255±0.010	0.136±0.010	0.083±0.009	0.065±0.004	0.129±0.004
	Spearman ↑	0.224±0.007	**0.239±0.009**	0.199±0.006	0.109±0.006	0.075±0.003	0.061±0.005	0.110±0.003
	RMSE ↓	2.566±0.152	2.448±0.103	2.581±0.171	3.025±0.100	2.717±0.313	**2.189±0.132**	2.891±0.125
HVG100	PCC ↑	**0.329±0.012**	0.311±0.017	0.283±0.011	0.157±0.018	0.099±0.012	0.077±0.011	0.134±0.001
	Spearman ↑	0.241±0.007	**0.250±0.008**	0.218±0.008	0.125±0.014	0.078±0.009	0.069±0.009	0.116±0.002
	RMSE ↓	1.866±0.055	1.961±0.042	1.871±0.037	2.077±0.050	2.077±0.137	**1.631±0.061**	2.085±0.059
SVG20	PCC ↑	**0.436±0.053**	0.413±0.026	0.337±0.067	0.363±0.104	0.341±0.031	0.218±0.035	0.134±0.022
	Spearman ↑	**0.411±0.034**	0.350±0.015	0.308±0.045	0.305±0.065	0.297±0.011	0.196±0.024	0.111±0.027
	RMSE ↓	3.517±0.444	**2.949±0.217**	4.120±0.594	3.628±0.756	3.688±0.582	3.266±0.185	4.477±0.428
SVG50	PCC ↑	**0.449±0.010**	0.371±0.016	0.424±0.013	0.394±0.013	0.296±0.008	0.218±0.011	0.148±0.003
	Spearman ↑	**0.409±0.007**	0.319±0.012	0.347±0.009	0.315±0.007	0.249±0.008	0.192±0.008	0.127±0.002
	RMSE ↓	2.929±0.054	**2.584±0.044**	2.973±0.065	2.748±0.059	2.996±0.090	2.898±0.112	3.506±0.062
SVG100	PCC ↑	**0.427±0.004**	0.327±0.013	0.403±0.003	0.339±0.004	0.239±0.007	0.199±0.004	0.143±0.004
	Spearman ↑	**0.392±0.003**	0.291±0.009	0.337±0.003	0.283±0.004	0.187±0.007	0.171±0.007	0.124±0.003
	RMSE ↓	2.591±0.031	**2.388±0.039**	2.491±0.038	2.432±0.028	2.759±0.050	2.596±0.054	2.861±0.043
HEG20	PCC ↑	**0.389±0.007**	0.231±0.012	0.314±0.005	0.348±0.012	0.086±0.015	0.142±0.026	0.120±0.012
	Spearman ↑	**0.462±0.008**	0.252±0.012	0.360±0.004	0.419±0.008	0.092±0.014	0.146±0.022	0.104±0.013
	RMSE ↓	3.139±0.017	3.287±0.048	**2.854±0.020**	2.907±0.020	3.356±0.015	3.264±0.017	3.139±0.021
HEG50	PCC ↑	**0.361±0.004**	0.234±0.008	0.304±0.004	0.274±0.003	0.049±0.003	0.099±0.024	0.122±0.003
	Spearman ↑	**0.398±0.005**	0.241±0.008	0.329±0.004	0.326±0.003	0.040±0.003	0.098±0.018	0.103±0.005
	RMSE ↓	3.048±0.015	3.065±0.017	**2.774±0.017**	2.928±0.015	3.272±0.014	3.178±0.009	3.060±0.023
HEG100	PCC ↑	**0.357±0.005**	0.246±0.009	0.309±0.005	0.246±0.001	0.016±0.002	0.106±0.019	0.127±0.004
	Spearman ↑	**0.376±0.006**	0.248±0.008	0.314±0.004	0.273±0.002	0.005±0.001	0.101±0.017	0.110±0.004
	RMSE ↓	2.864±0.010	2.789±0.012	**2.617±0.016**	2.761±0.001	3.087±0.004	2.972±0.036	2.883±0.016

Table S27: NCBI879 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.247±0.011	**0.255±0.021**	0.211±0.008	0.066±0.018	0.050±0.010	0.028±0.003	0.124±0.007
	Spearman ↑	0.184±0.009	**0.211±0.012**	0.167±0.006	0.056±0.016	0.055±0.011	0.026±0.003	0.107±0.008
	RMSE ↓	3.557±0.155	2.980±0.183	3.507±0.204	4.824±0.270	3.783±0.679	**2.865±0.232**	3.833±0.294
HVG50	PCC ↑	**0.272±0.003**	0.253±0.006	0.220±0.004	0.092±0.006	0.051±0.004	0.025±0.002	0.127±0.004
	Spearman ↑	0.201±0.004	**0.213±0.007**	0.172±0.004	0.074±0.005	0.050±0.003	0.022±0.001	0.109±0.004
	RMSE ↓	2.726±0.065	2.493±0.097	2.742±0.022	3.366±0.081	2.592±0.174	**2.148±0.034**	2.878±0.048
HVG100	PCC ↑	**0.287±0.005**	0.238±0.003	0.228±0.004	0.098±0.003	0.049±0.005	0.024±0.004	0.129±0.001
	Spearman ↑	**0.214±0.008**	0.210±0.008	0.180±0.001	0.081±0.004	0.043±0.001	0.021±0.004	0.111±0.003
	RMSE ↓	2.150±0.091	2.056±0.034	2.081±0.101	2.424±0.118	2.134±0.164	**1.753±0.151**	2.236±0.135
SVG20	PCC ↑	**0.355±0.018**	0.276±0.013	0.289±0.011	0.271±0.013	0.144±0.037	0.082±0.011	0.133±0.008
	Spearman ↑	**0.340±0.018**	0.241±0.016	0.264±0.010	0.241±0.017	0.105±0.026	0.065±0.010	0.116±0.008
	RMSE ↓	3.767±0.173	**3.253±0.078**	3.581±0.113	3.546±0.143	3.814±0.223	3.633±0.121	3.943±0.167
SVG50	PCC ↑	**0.339±0.010**	0.241±0.009	0.273±0.005	0.217±0.010	0.090±0.012	0.078±0.014	0.129±0.002
	Spearman ↑	**0.333±0.009**	0.226±0.011	0.252±0.006	0.210±0.013	0.080±0.009	0.068±0.016	0.108±0.004
	RMSE ↓	3.419±0.036	**3.059±0.059**	3.194±0.039	3.308±0.034	3.631±0.055	3.463±0.067	3.514±0.031
SVG100	PCC ↑	**0.330±0.004**	0.233±0.007	0.263±0.006	0.189±0.007	0.048±0.005	0.069±0.001	0.129±0.003
	Spearman ↑	**0.326±0.005**	0.223±0.009	0.244±0.008	0.188±0.010	0.028±0.001	0.058±0.003	0.109±0.004
	RMSE ↓	2.988±0.057	**2.733±0.031**	2.815±0.059	2.914±0.053	3.206±0.101	3.025±0.077	3.039±0.059
HEG20	PCC ↑	**0.317±0.004**	0.194±0.012	0.249±0.012	0.245±0.009	0.042±0.008	0.083±0.013	0.118±0.009
	Spearman ↑	**0.378±0.008**	0.205±0.011	0.275±0.010	0.299±0.009	0.034±0.005	0.080±0.009	0.099±0.009
	RMSE ↓	3.033±0.029	2.968±0.037	**2.819±0.017**	2.911±0.019	3.144±0.028	3.075±0.021	2.968±0.025
HEG50	PCC ↑	**0.329±0.008**	0.212±0.008	0.252±0.005	0.218±0.007	0.048±0.012	0.075±0.006	0.121±0.003
	Spearman ↑	**0.360±0.009**	0.217±0.011	0.262±0.005	0.254±0.007	0.037±0.007	0.068±0.006	0.102±0.003
	RMSE ↓	3.035±0.015	2.928±0.017	**2.808±0.017**	2.951±0.014	3.181±0.016	3.115±0.032	3.019±0.020
HEG100	PCC ↑	**0.323±0.004**	0.208±0.007	0.256±0.006	0.193±0.004	0.014±0.007	0.071±0.007	0.120±0.001
	Spearman ↑	**0.341±0.005**	0.213±0.009	0.258±0.004	0.215±0.005	-0.006±0.004	0.063±0.009	0.100±0.001
	RMSE ↓	2.920±0.007	2.763±0.011	**2.712±0.009**	2.843±0.013	3.068±0.006	2.990±0.017	2.912±0.013

Table S28: NCBI858 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.292±0.027	**0.371±0.009**	0.227±0.015	0.052±0.036	0.069±0.012	0.033±0.008	0.122±0.010
	Spearman ↑	0.216±0.019	**0.292±0.024**	0.179±0.011	0.042±0.030	0.059±0.015	0.031±0.009	0.104±0.011
	RMSE ↓	3.591±0.410	**2.691±0.242**	3.704±0.385	4.862±0.506	4.386±1.093	3.357±0.916	3.952±0.462
HVG50	PCC ↑	0.342±0.005	**0.367±0.003**	0.250±0.006	0.122±0.009	0.065±0.008	0.032±0.007	0.126±0.004
	Spearman ↑	0.256±0.006	**0.308±0.006**	0.193±0.005	0.096±0.006	0.059±0.008	0.030±0.006	0.107±0.004
	RMSE ↓	2.633±0.179	**2.180±0.089**	2.756±0.239	3.318±0.209	2.989±0.463	2.312±0.278	2.935±0.350
HVG100	PCC ↑	**0.383±0.006**	0.339±0.003	0.293±0.008	0.145±0.006	0.068±0.005	0.039±0.004	0.126±0.001
	Spearman ↑	0.280±0.001	**0.292±0.005**	0.223±0.002	0.119±0.005	0.059±0.004	0.033±0.003	0.108±0.001
	RMSE ↓	1.800±0.051	1.844±0.029	1.750±0.041	1.931±0.022	1.838±0.118	**1.556±0.025**	1.986±0.070
SVG20	PCC ↑	**0.480±0.025**	0.406±0.012	0.388±0.042	0.391±0.031	0.246±0.016	0.097±0.034	0.139±0.009
	Spearman ↑	**0.468±0.029**	0.352±0.008	0.356±0.039	0.365±0.036	0.209±0.018	0.088±0.025	0.123±0.009
	RMSE ↓	3.149±0.393	**2.750±0.352**	3.129±0.423	2.946±0.402	3.312±0.395	3.198±0.388	3.678±0.342
SVG50	PCC ↑	**0.455±0.009**	0.348±0.013	0.386±0.009	0.346±0.017	0.146±0.017	0.094±0.012	0.132±0.007
	Spearman ↑	**0.458±0.013**	0.322±0.007	0.358±0.017	0.343±0.022	0.124±0.017	0.085±0.013	0.113±0.006
	RMSE ↓	2.554±0.240	**2.336±0.167**	2.447±0.217	2.448±0.222	2.768±0.276	2.654±0.246	2.871±0.253
SVG100	PCC ↑	**0.437±0.005**	0.319±0.003	0.363±0.004	0.286±0.009	0.120±0.003	0.077±0.019	0.127±0.003
	Spearman ↑	**0.433±0.009**	0.309±0.004	0.338±0.007	0.290±0.015	0.103±0.001	0.074±0.017	0.108±0.003
	RMSE ↓	2.244±0.031	2.160±0.017	**2.148±0.017**	2.189±0.026	2.454±0.038	2.325±0.022	2.471±0.018
HEG20	PCC ↑	**0.406±0.008**	0.265±0.013	0.323±0.011	0.305±0.014	0.053±0.009	0.104±0.010	0.120±0.020
	Spearman ↑	**0.513±0.004**	0.314±0.021	0.388±0.009	0.440±0.007	0.041±0.013	0.138±0.014	0.105±0.032
	RMSE ↓	**2.248±0.064**	2.514±0.056	2.261±0.043	2.250±0.044	2.448±0.065	2.360±0.063	2.323±0.058
HEG50	PCC ↑	**0.408±0.004**	0.270±0.008	0.325±0.007	0.282±0.006	0.055±0.013	0.095±0.005	0.126±0.004
	Spearman ↑	**0.473±0.004**	0.296±0.011	0.364±0.007	0.368±0.005	0.050±0.010	0.102±0.006	0.109±0.002
	RMSE ↓	2.374±0.027	2.514±0.024	**2.295±0.025**	2.368±0.033	2.638±0.027	2.534±0.027	2.481±0.026
HEG100	PCC ↑	**0.401±0.002**	0.285±0.004	0.319±0.003	0.252±0.003	0.049±0.005	0.072±0.020	0.125±0.004
	Spearman ↑	**0.440±0.002**	0.301±0.006	0.338±0.003	0.302±0.003	0.040±0.004	0.077±0.017	0.108±0.004
	RMSE ↓	2.383±0.020	2.417±0.015	**2.264±0.013**	2.365±0.012	2.641±0.019	2.542±0.024	2.485±0.017

Table S29: NCBI876 — Lung — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.254±0.018	**0.311±0.015**	0.182±0.005	0.113±0.040	0.089±0.022	0.026±0.011	0.137±0.004
	Spearman ↑	0.199±0.022	**0.246±0.011**	0.151±0.011	0.095±0.036	0.078±0.021	0.026±0.009	0.119±0.003
	RMSE ↓	3.468±0.233	**2.812±0.166**	3.214±0.318	4.442±0.382	3.796±0.645	3.025±0.319	3.777±0.354
HVG50	PCC ↑	**0.294±0.006**	0.278±0.013	0.219±0.010	0.143±0.017	0.088±0.012	0.020±0.008	0.138±0.001
	Spearman ↑	0.211±0.012	**0.234±0.006**	0.167±0.008	0.110±0.012	0.074±0.010	0.018±0.007	0.121±0.001
	RMSE ↓	2.550±0.113	2.242±0.162	2.427±0.149	3.033±0.175	2.614±0.300	**2.136±0.213**	2.834±0.072
HVG100	PCC ↑	**0.325±0.004**	0.250±0.005	0.263±0.007	0.161±0.007	0.087±0.003	0.022±0.016	0.138±0.006
	Spearman ↑	**0.228±0.008**	0.218±0.005	0.194±0.005	0.126±0.007	0.065±0.003	0.018±0.013	0.117±0.005
	RMSE ↓	1.846±0.069	2.056±0.067	1.732±0.037	1.929±0.034	1.764±0.084	**1.634±0.076**	2.036±0.050
SVG20	PCC ↑	**0.415±0.038**	0.381±0.037	0.206±0.023	0.404±0.023	0.358±0.023	0.075±0.034	0.208±0.020
	Spearman ↑	**0.347±0.019**	0.267±0.021	0.191±0.023	0.276±0.021	0.210±0.020	0.066±0.028	0.177±0.015
	RMSE ↓	2.775±0.280	**2.301±0.192**	3.981±0.109	2.701±0.222	2.443±0.334	2.716±0.265	3.545±0.184
SVG50	PCC ↑	**0.420±0.010**	0.298±0.020	0.286±0.011	0.368±0.014	0.251±0.011	0.054±0.032	0.170±0.010
	Spearman ↑	**0.360±0.008**	0.242±0.014	0.260±0.006	0.274±0.009	0.160±0.013	0.044±0.023	0.140±0.008
	RMSE ↓	2.520±0.080	**2.212±0.072**	2.836±0.083	2.331±0.063	2.452±0.106	2.569±0.165	2.951±0.104
SVG100	PCC ↑	**0.380±0.008**	0.250±0.010	0.296±0.007	0.295±0.007	0.184±0.010	0.033±0.023	0.157±0.007
	Spearman ↑	**0.339±0.008**	0.226±0.011	0.255±0.008	0.241±0.010	0.126±0.007	0.029±0.016	0.133±0.005
	RMSE ↓	2.369±0.030	**2.184±0.015**	2.322±0.033	2.229±0.012	2.426±0.043	2.407±0.076	2.592±0.049
HEG20	PCC ↑	**0.351±0.017**	0.177±0.014	0.230±0.009	0.272±0.011	0.076±0.035	0.037±0.010	0.130±0.015
	Spearman ↑	**0.409±0.017**	0.204±0.015	0.257±0.003	0.358±0.012	0.065±0.024	0.042±0.008	0.107±0.012
	RMSE ↓	2.724±0.035	2.784±0.026	2.951±0.016	**2.617±0.042**	2.814±0.049	2.821±0.049	2.709±0.046
HEG50	PCC ↑	**0.344±0.007**	0.187±0.013	0.243±0.003	0.247±0.005	0.097±0.007	0.021±0.023	0.125±0.004
	Spearman ↑	**0.378±0.008**	0.200±0.013	0.257±0.002	0.311±0.005	0.072±0.007	0.026±0.020	0.108±0.007
	RMSE ↓	2.782±0.031	2.815±0.017	2.776±0.012	**2.713±0.023**	2.931±0.025	2.924±0.026	2.799±0.023
HEG100	PCC ↑	**0.337±0.005**	0.191±0.012	0.249±0.004	0.235±0.006	0.072±0.002	0.014±0.016	0.129±0.002
	Spearman ↑	**0.356±0.006**	0.201±0.011	0.252±0.004	0.278±0.006	0.053±0.003	0.017±0.015	0.111±0.005
	RMSE ↓	2.729±0.014	2.685±0.015	**2.608±0.012**	2.654±0.016	2.883±0.017	2.879±0.015	2.741±0.015

Table S30: TENX99 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.184±0.028	**0.296±0.016**	0.132±0.011	0.055±0.013	0.056±0.012	0.028±0.008	0.121±0.004
	Spearman ↑	0.135±0.021	**0.250±0.008**	0.113±0.007	0.043±0.011	0.054±0.013	0.030±0.009	0.104±0.004
	RMSE ↓	3.280±0.400	2.827±0.256	**1.924±0.291**	3.837±0.021	3.720±1.147	2.753±0.684	3.878±0.101
HVG50	PCC ↑	0.247±0.015	**0.302±0.014**	0.147±0.013	0.103±0.016	0.084±0.017	0.051±0.011	0.126±0.002
	Spearman ↑	0.169±0.016	**0.257±0.009**	0.123±0.011	0.077±0.013	0.080±0.016	0.048±0.010	0.109±0.003
	RMSE ↓	2.369±0.203	2.204±0.328	1.925±0.235	2.552±0.018	2.172±0.261	**1.696±0.184**	2.842±0.222
HVG100	PCC ↑	0.297±0.004	**0.297±0.002**	0.194±0.006	0.149±0.003	0.124±0.006	0.085±0.007	0.129±0.005
	Spearman ↑	0.211±0.007	**0.258±0.002**	0.163±0.006	0.119±0.003	0.119±0.006	0.083±0.006	0.111±0.004
	RMSE ↓	1.858±0.016	1.880±0.170	1.653±0.064	1.874±0.003	1.687±0.031	**1.485±0.018**	2.173±0.116
SVG20	PCC ↑	**0.439±0.002**	0.391±0.011	0.347±0.011	0.398±0.003	0.417±0.008	0.315±0.004	0.128±0.036
	Spearman ↑	**0.491±0.002**	0.387±0.009	0.350±0.010	0.387±0.003	0.429±0.008	0.325±0.008	0.111±0.036
	RMSE ↓	3.625±0.006	**3.202±0.057**	3.421±0.014	3.259±0.005	3.493±0.040	3.455±0.021	3.826±0.015
SVG50	PCC ↑	**0.430±0.002**	0.359±0.011	0.374±0.003	0.376±0.007	0.386±0.005	0.301±0.010	0.139±0.019
	Spearman ↑	**0.475±0.002**	0.366±0.013	0.383±0.003	0.377±0.006	0.411±0.004	0.323±0.007	0.125±0.023
	RMSE ↓	3.095±0.020	**2.805±0.066**	2.881±0.031	2.812±0.012	3.055±0.020	2.990±0.016	3.261±0.051
SVG100	PCC ↑	**0.394±0.002**	0.324±0.007	0.333±0.003	0.312±0.003	0.312±0.002	0.238±0.002	0.129±0.009
	Spearman ↑	**0.418±0.001**	0.326±0.007	0.328±0.003	0.309±0.003	0.329±0.002	0.251±0.002	0.114±0.012
	RMSE ↓	2.765±0.008	**2.543±0.057**	2.611±0.018	2.567±0.005	2.785±0.008	2.695±0.019	2.941±0.016
HEG20	PCC ↑	**0.426±0.000**	0.318±0.010	0.372±0.004	0.361±0.006	0.360±0.002	0.256±0.003	0.115±0.020
	Spearman ↑	**0.498±0.001**	0.349±0.028	0.428±0.004	0.436±0.005	0.410±0.001	0.327±0.002	0.099±0.019
	RMSE ↓	3.248±0.005	3.173±0.034	**2.994±0.007**	3.070±0.010	3.261±0.004	3.250±0.006	3.308±0.011
HEG50	PCC ↑	**0.418±0.000**	0.313±0.008	0.373±0.004	0.340±0.002	0.354±0.001	0.262±0.004	0.131±0.023
	Spearman ↑	**0.462±0.000**	0.330±0.016	0.395±0.005	0.385±0.002	0.381±0.001	0.297±0.003	0.115±0.024
	RMSE ↓	3.072±0.005	2.975±0.027	**2.839±0.005**	2.936±0.004	3.088±0.015	3.052±0.008	3.168±0.026
HEG100	PCC ↑	**0.398±0.001**	0.303±0.007	0.361±0.001	0.305±0.002	0.323±0.002	0.248±0.005	0.127±0.009
	Spearman ↑	**0.428±0.001**	0.315±0.009	0.365±0.002	0.331±0.001	0.341±0.002	0.265±0.003	0.111±0.010
	RMSE ↓	2.878±0.001	2.738±0.019	**2.660±0.002**	2.760±0.002	2.920±0.003	2.836±0.005	2.997±0.007
CancerCore89	PCC ↑	**0.308±0.002**	0.307±0.004	0.239±0.004	0.221±0.002	0.203±0.003	0.158±0.002	0.117±0.007
	Spearman ↑	**0.367±0.001**	0.305±0.013	0.246±0.006	0.229±0.001	0.239±0.004	0.174±0.001	0.101±0.007
	RMSE ↓	4.219±0.006	**3.789±0.024**	4.001±0.027	4.172±0.003	4.065±0.010	3.943±0.003	4.309±0.062

Table S31: TENX98 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.168±0.022	**0.282±0.016**	0.120±0.006	0.040±0.004	0.041±0.003	0.017±0.004	0.124±0.003
	Spearman ↑	0.119±0.009	**0.233±0.011**	0.102±0.006	0.029±0.003	0.041±0.004	0.020±0.004	0.106±0.003
	RMSE ↓	3.455±0.533	2.947±0.262	**1.616±0.109**	4.031±0.006	4.402±1.462	3.281±0.856	4.056±0.285
HVG50	PCC ↑	0.252±0.016	**0.286±0.007**	0.148±0.010	0.107±0.012	0.086±0.019	0.051±0.015	0.127±0.006
	Spearman ↑	0.176±0.018	**0.243±0.010**	0.123±0.011	0.081±0.010	0.082±0.019	0.048±0.015	0.109±0.007
	RMSE ↓	2.413±0.112	2.152±0.201	2.021±0.162	2.601±0.014	2.133±0.145	**1.806±0.066**	2.932±0.161
HVG100	PCC ↑	**0.302±0.005**	0.293±0.000	0.196±0.006	0.147±0.001	0.127±0.009	0.091±0.004	0.128±0.003
	Spearman ↑	0.217±0.006	**0.256±0.001**	0.166±0.006	0.117±0.001	0.120±0.007	0.088±0.004	0.110±0.003
	RMSE ↓	1.839±0.048	1.923±0.200	1.661±0.057	1.886±0.001	1.699±0.070	**1.470±0.060**	2.220±0.162
SVG20	PCC ↑	**0.433±0.001**	0.386±0.012	0.344±0.004	0.399±0.004	0.421±0.000	0.332±0.005	0.139±0.015
	Spearman ↑	**0.483±0.001**	0.378±0.015	0.348±0.004	0.388±0.004	0.433±0.002	0.338±0.007	0.121±0.019
	RMSE ↓	3.638±0.010	**3.212±0.052**	3.444±0.010	3.263±0.009	3.473±0.006	3.400±0.035	3.860±0.049
SVG50	PCC ↑	**0.428±0.000**	0.355±0.010	0.370±0.006	0.375±0.003	0.379±0.002	0.303±0.003	0.124±0.030
	Spearman ↑	**0.472±0.000**	0.360±0.011	0.377±0.005	0.375±0.003	0.404±0.002	0.322±0.002	0.108±0.030
	RMSE ↓	3.086±0.004	**2.792±0.062**	2.875±0.019	2.796±0.005	3.038±0.010	2.974±0.019	3.238±0.023
SVG100	PCC ↑	**0.390±0.001**	0.319±0.005	0.322±0.004	0.312±0.006	0.310±0.002	0.239±0.003	0.142±0.019
	Spearman ↑	**0.415±0.001**	0.321±0.006	0.319±0.005	0.310±0.005	0.326±0.002	0.250±0.002	0.128±0.020
	RMSE ↓	2.788±0.007	**2.553±0.052**	2.633±0.008	2.574±0.009	2.805±0.007	2.696±0.015	2.932±0.024
HEG20	PCC ↑	**0.428±0.000**	0.317±0.006	0.370±0.005	0.364±0.002	0.366±0.003	0.268±0.001	0.109±0.009
	Spearman ↑	**0.496±0.001**	0.347±0.023	0.421±0.005	0.435±0.002	0.410±0.001	0.330±0.002	0.091±0.008
	RMSE ↓	3.275±0.003	3.194±0.039	**3.025±0.021**	3.090±0.004	3.288±0.007	3.268±0.009	3.313±0.016
HEG50	PCC ↑	**0.418±0.000**	0.313±0.006	0.370±0.004	0.340±0.002	0.355±0.001	0.271±0.004	0.115±0.012
	Spearman ↑	**0.461±0.001**	0.330±0.013	0.390±0.004	0.383±0.002	0.380±0.001	0.302±0.003	0.098±0.014
	RMSE ↓	3.088±0.003	2.988±0.026	**2.857±0.011**	2.950±0.003	3.100±0.003	3.071±0.008	3.183±0.020
HEG100	PCC ↑	**0.399±0.001**	0.304±0.006	0.309±0.099	0.302±0.008	0.327±0.002	0.258±0.003	0.115±0.027
	Spearman ↑	**0.428±0.001**	0.315±0.007	0.314±0.097	0.326±0.008	0.344±0.002	0.272±0.002	0.099±0.030
	RMSE ↓	2.891±0.002	2.744±0.019	**2.734±0.135**	2.773±0.013	2.923±0.004	2.840±0.012	3.010±0.015
CancerCore89	PCC ↑	**0.306±0.002**	0.302±0.006	0.232±0.007	0.217±0.002	0.203±0.005	0.155±0.002	0.130±0.010
	Spearman ↑	**0.363±0.002**	0.298±0.017	0.243±0.006	0.226±0.002	0.234±0.004	0.170±0.002	0.111±0.010
	RMSE ↓	4.244±0.016	**3.812±0.013**	4.071±0.047	4.228±0.005	4.095±0.018	3.996±0.004	4.397±0.030

Table S32: XPR-BR — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.075±0.007	**0.197±0.004**	0.107±0.003	0.011±0.004	0.019±0.006	0.013±0.003	0.119±0.000
	Spearman ↑	0.070±0.012	**0.166±0.003**	0.091±0.003	0.007±0.005	0.020±0.006	0.012±0.004	0.101±0.000
	RMSE ↓	5.009±0.228	4.269±0.008	4.778±0.277	5.588±0.150	5.996±0.074	**4.154±0.276**	4.929±0.223
HVG50	PCC ↑	0.111±0.007	**0.192±0.004**	0.114±0.002	0.020±0.003	0.009±0.006	0.027±0.005	0.120±0.001
	Spearman ↑	0.095±0.008	**0.160±0.003**	0.094±0.001	0.013±0.002	0.009±0.006	0.026±0.005	0.103±0.001
	RMSE ↓	3.807±0.100	3.263±0.006	3.491±0.129	4.357±0.114	4.498±0.326	**2.807±0.242**	3.963±0.149
HVG100	PCC ↑	0.116±0.001	**0.187±0.003**	0.120±0.003	0.017±0.002	0.010±0.004	0.026±0.002	0.119±0.001
	Spearman ↑	0.095±0.003	**0.158±0.003**	0.099±0.003	0.010±0.003	0.009±0.004	0.025±0.002	0.101±0.001
	RMSE ↓	3.137±0.075	3.095±0.005	2.921±0.055	3.711±0.050	3.990±0.111	**2.363±0.204**	3.229±0.094
SVG20	PCC ↑	0.215±0.033	0.244±0.054	0.109±0.033	0.169±0.057	0.221±0.068	**0.250±0.048**	0.066±0.034
	Spearman ↑	0.242±0.045	0.234±0.049	0.132±0.020	0.160±0.061	0.229±0.071	**0.248±0.047**	0.047±0.026
	RMSE ↓	4.984±0.180	4.265±0.124	4.840±0.216	4.901±0.317	4.848±0.292	**4.146±0.285**	5.038±0.107
SVG50	PCC ↑	0.227±0.001	0.236±0.004	0.189±0.006	0.176±0.001	0.208±0.007	**0.260±0.013**	0.100±0.013
	Spearman ↑	0.250±0.001	0.230±0.003	0.195±0.007	0.172±0.003	0.220±0.007	**0.251±0.010**	0.071±0.013
	RMSE ↓	4.136±0.008	3.619±0.007	3.953±0.007	4.077±0.003	4.194±0.026	**3.336±0.107**	4.345±0.028
SVG100	PCC ↑	**0.219±0.001**	0.197±0.003	0.202±0.004	0.150±0.003	0.155±0.002	0.208±0.008	0.101±0.014
	Spearman ↑	**0.234±0.001**	0.197±0.003	0.211±0.005	0.148±0.004	0.166±0.004	0.202±0.007	0.076±0.014
	RMSE ↓	3.684±0.008	3.333±0.005	3.520±0.007	3.665±0.008	3.901±0.011	**3.198±0.065**	3.792±0.053
HEG20	PCC ↑	**0.268±0.001**	0.239±0.001	0.209±0.005	0.219±0.002	0.226±0.002	0.205±0.002	0.135±0.008
	Spearman ↑	**0.324±0.001**	0.262±0.001	0.211±0.005	0.232±0.001	0.279±0.001	0.228±0.002	0.117±0.008
	RMSE ↓	4.027±0.002	3.891±0.002	3.843±0.039	3.837±0.018	3.871±0.015	**3.812±0.024**	4.063±0.062
HEG50	PCC ↑	**0.240±0.003**	0.209±0.004	0.206±0.002	0.171±0.001	0.192±0.003	0.179±0.001	0.110±0.015
	Spearman ↑	**0.279±0.001**	0.223±0.004	0.205±0.003	0.176±0.002	0.230±0.002	0.192±0.002	0.092±0.013
	RMSE ↓	3.663±0.017	3.498±0.008	**3.440±0.015**	3.535±0.010	3.646±0.029	3.445±0.043	3.632±0.052
HEG100	PCC ↑	**0.239±0.001**	0.213±0.001	0.218±0.001	0.165±0.001	0.180±0.001	0.183±0.001	0.106±0.003
	Spearman ↑	**0.268±0.000**	0.223±0.001	0.216±0.001	0.166±0.001	0.211±0.001	0.198±0.001	0.089±0.003
	RMSE ↓	3.294±0.001	3.098±0.001	3.094±0.013	3.145±0.005	3.408±0.002	**3.045±0.016**	3.287±0.023
CancerCore89	PCC ↑	0.144±0.001	**0.156±0.001**	0.118±0.005	0.023±0.001	-0.000±0.001	0.004±0.001	0.115±0.003
	Spearman ↑	**0.141±0.001**	0.140±0.001	0.097±0.005	0.020±0.001	-0.004±0.001	0.003±0.001	0.098±0.003
	RMSE ↓	3.805±0.011	3.627±0.002	**3.360±0.073**	4.187±0.015	4.340±0.017	3.749±0.001	3.889±0.011

Table S33: TENX95 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.176±0.031	**0.271±0.008**	0.137±0.010	0.059±0.027	0.068±0.031	0.036±0.019	0.120±0.005
	Spearman ↑	0.141±0.030	**0.235±0.006**	0.117±0.012	0.054±0.025	0.064±0.024	0.037±0.017	0.100±0.005
	RMSE ↓	3.705±0.438	3.363±0.111	**2.617±0.787**	5.207±0.535	4.769±0.841	3.318±0.785	4.218±0.267
HVG50	PCC ↑	0.254±0.019	**0.301±0.001**	0.163±0.011	0.137±0.031	0.134±0.026	0.096±0.022	0.132±0.009
	Spearman ↑	0.196±0.020	**0.266±0.002**	0.132±0.011	0.107±0.022	0.118±0.024	0.081±0.020	0.106±0.007
	RMSE ↓	2.536±0.065	2.636±0.012	2.688±0.210	3.000±0.202	2.611±0.069	**1.970±0.079**	2.895±0.053
HVG100	PCC ↑	0.289±0.009	**0.294±0.002**	0.229±0.026	0.199±0.017	0.177±0.013	0.146±0.013	0.140±0.004
	Spearman ↑	0.232±0.009	**0.272±0.001**	0.176±0.016	0.143±0.011	0.155±0.012	0.124±0.009	0.111±0.006
	RMSE ↓	2.274±0.016	2.363±0.016	2.306±0.036	2.147±0.076	2.493±0.023	**1.781±0.019**	2.507±0.047
SVG20	PCC ↑	0.401±0.004	0.346±0.006	0.354±0.013	**0.453±0.003**	0.398±0.010	0.347±0.006	0.108±0.007
	Spearman ↑	**0.417±0.001**	0.301±0.007	0.366±0.006	0.397±0.002	0.357±0.004	0.315±0.006	0.091±0.004
	RMSE ↓	3.413±0.010	3.144±0.008	3.309±0.027	**2.963±0.014**	3.290±0.007	3.183±0.017	3.565±0.022
SVG50	PCC ↑	0.451±0.004	0.363±0.006	**0.491±0.006**	0.484±0.003	0.447±0.004	0.386±0.001	0.125±0.013
	Spearman ↑	**0.453±0.005**	0.336±0.008	0.452±0.003	0.439±0.005	0.425±0.005	0.361±0.002	0.107±0.012
	RMSE ↓	2.868±0.004	2.671±0.008	2.574±0.009	**2.446±0.006**	2.804±0.005	2.666±0.009	3.182±0.020
SVG100	PCC ↑	0.438±0.001	0.340±0.006	**0.488±0.011**	0.441±0.002	0.422±0.003	0.372±0.002	0.180±0.020
	Spearman ↑	0.424±0.001	0.322±0.005	**0.436±0.006**	0.400±0.001	0.389±0.003	0.338±0.002	0.161±0.023
	RMSE ↓	2.592±0.007	2.445±0.008	2.276±0.006	**2.260±0.010**	2.664±0.005	2.399±0.016	2.743±0.019
HEG20	PCC ↑	0.441±0.002	0.308±0.009	**0.495±0.012**	0.467±0.003	0.428±0.002	0.348±0.006	0.096±0.014
	Spearman ↑	0.499±0.001	0.320±0.010	**0.517±0.010**	0.511±0.001	0.450±0.001	0.388±0.001	0.071±0.015
	RMSE ↓	3.221±0.005	3.105±0.010	2.766±0.017	**2.763±0.010**	3.106±0.009	3.047±0.012	3.404±0.014
HEG50	PCC ↑	0.397±0.000	0.291±0.006	**0.455±0.005**	0.392±0.002	0.363±0.003	0.308±0.004	0.136±0.016
	Spearman ↑	0.433±0.000	0.294±0.006	**0.450±0.004**	0.415±0.001	0.379±0.001	0.321±0.003	0.119±0.015
	RMSE ↓	3.038±0.004	2.974±0.006	**2.639±0.012**	2.723±0.006	2.983±0.009	2.881±0.015	3.154±0.030
HEG100	PCC ↑	0.392±0.001	0.295±0.005	**0.444±0.002**	0.373±0.002	0.362±0.003	0.312±0.002	0.188±0.004
	Spearman ↑	0.408±0.001	0.297±0.005	**0.425±0.002**	0.381±0.001	0.362±0.002	0.309±0.002	0.173±0.007
	RMSE ↓	2.839±0.003	2.760±0.006	**2.449±0.017**	2.565±0.005	2.846±0.006	2.649±0.010	2.866±0.005
CancerCore89	PCC ↑	**0.276±0.003**	0.223±0.005	0.256±0.007	0.275±0.002	0.222±0.001	0.153±0.004	0.091±0.011
	Spearman ↑	**0.332±0.003**	0.228±0.007	0.266±0.007	0.292±0.001	0.274±0.002	0.172±0.003	0.073±0.013
	RMSE ↓	4.039±0.009	3.796±0.006	**3.720±0.042**	3.742±0.008	3.902±0.010	3.722±0.007	3.965±0.025

Table S34: TENX97 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.195±0.010	**0.295±0.013**	0.145±0.010	0.086±0.017	0.077±0.017	0.049±0.015	0.119±0.000
	Spearman ↑	0.169±0.010	**0.234±0.011**	0.126±0.008	0.070±0.012	0.072±0.015	0.046±0.011	0.099±0.001
	RMSE ↓	4.056±0.139	**3.269±0.068**	3.748±0.254	5.170±0.148	4.838±0.177	3.488±0.288	4.638±0.209
HVG50	PCC ↑	0.266±0.006	**0.294±0.009**	0.172±0.008	0.162±0.008	0.156±0.006	0.110±0.007	0.125±0.005
	Spearman ↑	0.218±0.008	**0.247±0.006**	0.136±0.006	0.112±0.007	0.131±0.007	0.087±0.007	0.099±0.005
	RMSE ↓	2.925±0.073	2.635±0.028	3.130±0.105	3.075±0.083	2.970±0.157	**2.183±0.107**	3.556±0.096
HVG100	PCC ↑	0.326±0.006	**0.330±0.002**	0.242±0.085	0.260±0.010	0.228±0.010	0.183±0.009	0.158±0.003
	Spearman ↑	0.275±0.008	**0.289±0.002**	0.181±0.070	0.187±0.010	0.200±0.009	0.155±0.009	0.132±0.005
	RMSE ↓	2.410±0.031	2.212±0.015	2.257±0.199	2.112±0.026	2.566±0.033	**1.952±0.048**	2.738±0.037
SVG20	PCC ↑	0.372±0.001	0.352±0.004	0.315±0.003	**0.428±0.004**	0.365±0.007	0.303±0.005	0.115±0.012
	Spearman ↑	**0.376±0.002**	0.297±0.004	0.320±0.002	0.367±0.003	0.321±0.004	0.260±0.006	0.098±0.011
	RMSE ↓	3.324±0.017	3.052±0.016	3.399±0.006	**3.000±0.014**	3.207±0.009	3.169±0.024	3.558±0.033
SVG50	PCC ↑	0.439±0.010	0.382±0.004	0.446±0.019	**0.471±0.012**	0.434±0.013	0.366±0.012	0.151±0.036
	Spearman ↑	**0.440±0.010**	0.348±0.006	0.419±0.015	0.421±0.014	0.409±0.014	0.340±0.013	0.131±0.035
	RMSE ↓	2.893±0.016	2.669±0.015	2.728±0.055	**2.502±0.029**	2.805±0.026	2.719±0.030	3.163±0.030
SVG100	PCC ↑	0.452±0.001	0.385±0.003	**0.495±0.001**	0.458±0.001	0.437±0.002	0.378±0.004	0.205±0.011
	Spearman ↑	0.437±0.002	0.359±0.002	**0.441±0.001**	0.412±0.002	0.406±0.002	0.345±0.005	0.186±0.013
	RMSE ↓	2.570±0.011	2.381±0.018	2.330±0.014	**2.231±0.009**	2.632±0.015	2.400±0.007	2.770±0.018
HEG20	PCC ↑	0.405±0.001	0.317±0.004	**0.450±0.010**	0.426±0.001	0.378±0.003	0.316±0.000	0.127±0.007
	Spearman ↑	0.483±0.001	0.350±0.004	0.482±0.007	**0.491±0.001**	0.426±0.002	0.368±0.001	0.100±0.006
	RMSE ↓	3.160±0.005	3.009±0.012	2.762±0.007	**2.743±0.003**	3.054±0.011	3.003±0.014	3.273±0.006
HEG50	PCC ↑	0.401±0.004	0.317±0.004	**0.458±0.005**	0.408±0.006	0.378±0.006	0.320±0.009	0.151±0.021
	Spearman ↑	0.448±0.004	0.337±0.004	**0.463±0.004**	0.442±0.006	0.402±0.006	0.342±0.008	0.134±0.024
	RMSE ↓	2.999±0.003	2.887±0.010	**2.610±0.006**	2.675±0.009	2.916±0.010	2.844±0.012	3.112±0.035
HEG100	PCC ↑	0.388±0.000	0.310±0.002	**0.432±0.004**	0.368±0.001	0.353±0.000	0.303±0.004	0.197±0.015
	Spearman ↑	0.412±0.001	0.318±0.002	**0.422±0.005**	0.385±0.000	0.362±0.000	0.309±0.003	0.184±0.016
	RMSE ↓	2.820±0.002	2.715±0.007	**2.468±0.007**	2.566±0.001	2.817±0.001	2.677±0.002	2.836±0.017
CancerCore89	PCC ↑	**0.270±0.002**	0.230±0.003	0.267±0.009	0.252±0.002	0.197±0.002	0.146±0.001	0.104±0.006
	Spearman ↑	**0.315±0.001**	0.241±0.003	0.275±0.008	0.263±0.001	0.242±0.001	0.164±0.001	0.088±0.003
	RMSE ↓	4.083±0.017	3.857±0.010	**3.760±0.017**	3.832±0.016	3.976±0.012	3.779±0.002	3.988±0.028

Table S35: TENX195 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.192±0.019	**0.254±0.020**	0.134±0.013	0.061±0.022	0.073±0.021	0.065±0.019	0.121±0.007
	Spearman ↑	0.146±0.018	**0.249±0.021**	0.113±0.014	0.058±0.021	0.067±0.020	0.072±0.018	0.102±0.007
	RMSE ↓	3.264±0.137	3.863±0.077	2.835±0.250	4.051±0.257	2.792±0.328	**2.364±0.190**	3.741±0.176
HVG50	PCC ↑	0.231±0.010	**0.263±0.015**	0.169±0.018	0.093±0.018	0.107±0.018	0.094±0.024	0.123±0.007
	Spearman ↑	0.184±0.013	**0.255±0.014**	0.133±0.019	0.082±0.018	0.099±0.018	0.095±0.024	0.107±0.006
	RMSE ↓	2.760±0.127	2.741±0.042	2.437±0.163	3.089±0.158	2.551±0.185	**2.161±0.139**	2.938±0.177
HVG100	PCC ↑	0.243±0.008	**0.270±0.008**	0.175±0.016	0.099±0.008	0.114±0.012	0.100±0.011	0.121±0.003
	Spearman ↑	0.196±0.009	**0.260±0.008**	0.140±0.015	0.083±0.011	0.108±0.013	0.102±0.012	0.104±0.006
	RMSE ↓	2.031±0.069	2.508±0.026	1.841±0.064	2.202±0.055	2.047±0.076	**1.710±0.096**	2.023±0.055
SVG20	PCC ↑	0.195±0.025	**0.328±0.007**	-0.043±0.008	0.180±0.011	0.256±0.020	0.255±0.014	0.096±0.030
	Spearman ↑	0.208±0.025	0.273±0.013	0.017±0.008	0.151±0.015	**0.277±0.027**	0.269±0.015	0.078±0.037
	RMSE ↓	4.935±0.075	**4.031±0.021**	4.882±0.031	4.516±0.051	4.695±0.076	4.269±0.046	4.722±0.037
SVG50	PCC ↑	0.346±0.022	**0.359±0.009**	0.249±0.024	0.319±0.026	0.350±0.021	0.313±0.027	0.102±0.011
	Spearman ↑	**0.390±0.025**	0.359±0.011	0.251±0.023	0.309±0.028	0.378±0.019	0.329±0.023	0.087±0.011
	RMSE ↓	3.666±0.085	**3.198±0.090**	3.516±0.082	3.300±0.118	3.524±0.069	3.235±0.121	3.911±0.055
SVG100	PCC ↑	**0.338±0.001**	0.331±0.008	0.290±0.003	0.273±0.002	0.291±0.004	0.258±0.011	0.114±0.006
	Spearman ↑	**0.362±0.001**	0.329±0.009	0.279±0.006	0.266±0.002	0.303±0.003	0.264±0.010	0.098±0.008
	RMSE ↓	3.159±0.010	**2.864±0.014**	2.967±0.013	2.978±0.010	3.176±0.017	2.932±0.038	3.339±0.021
HEG20	PCC ↑	**0.267±0.002**	0.255±0.003	0.190±0.006	0.183±0.004	0.193±0.008	0.186±0.005	0.137±0.008
	Spearman ↑	**0.315±0.001**	0.272±0.004	0.222±0.007	0.221±0.003	0.197±0.004	0.208±0.005	0.120±0.004
	RMSE ↓	3.708±0.009	3.613±0.005	**3.426±0.009**	3.639±0.010	3.711±0.015	3.671±0.021	3.574±0.016
HEG50	PCC ↑	**0.280±0.002**	0.275±0.003	0.221±0.008	0.193±0.001	0.215±0.004	0.178±0.002	0.114±0.010
	Spearman ↑	**0.305±0.002**	0.285±0.004	0.231±0.007	0.213±0.000	0.222±0.003	0.195±0.004	0.098±0.010
	RMSE ↓	3.513±0.009	3.372±0.003	**3.218±0.014**	3.403±0.003	3.525±0.014	3.466±0.020	3.473±0.021
HEG100	PCC ↑	**0.305±0.000**	0.295±0.005	0.275±0.004	0.230±0.002	0.236±0.005	0.199±0.008	0.119±0.007
	Spearman ↑	**0.321±0.000**	0.296±0.006	0.269±0.003	0.232±0.002	0.239±0.004	0.204±0.007	0.103±0.008
	RMSE ↓	3.168±0.004	2.976±0.005	**2.902±0.011**	3.015±0.004	3.212±0.006	3.073±0.024	3.193±0.003
CancerCore89	PCC ↑	0.196±0.004	**0.244±0.005**	0.115±0.005	0.158±0.004	0.146±0.005	0.081±0.004	0.105±0.006
	Spearman ↑	0.223±0.003	**0.225±0.009**	0.120±0.014	0.160±0.002	0.163±0.002	0.089±0.003	0.083±0.007
	RMSE ↓	5.355±0.028	**4.640±0.010**	4.858±0.150	5.309±0.031	5.078±0.024	4.877±0.009	5.160±0.061

Table S36: TENX198 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.238±0.021	**0.316±0.007**	0.165±0.004	0.089±0.008	0.089±0.011	0.086±0.005	0.126±0.009
	Spearman ↑	0.194±0.012	**0.290±0.004**	0.151±0.002	0.077±0.011	0.087±0.008	0.090±0.004	0.109±0.009
	RMSE ↓	2.726±0.057	3.270±0.195	2.575±0.079	3.196±0.067	**1.858±0.185**	1.913±0.112	3.076±0.150
HVG50	PCC ↑	0.284±0.005	**0.345±0.019**	0.197±0.004	0.126±0.004	0.125±0.006	0.107±0.003	0.126±0.004
	Spearman ↑	0.229±0.006	**0.312±0.015**	0.162±0.004	0.102±0.003	0.119±0.006	0.104±0.003	0.109±0.004
	RMSE ↓	2.442±0.076	2.593±0.137	2.261±0.143	2.444±0.114	2.190±0.097	**1.908±0.025**	2.851±0.145
HVG100	PCC ↑	0.327±0.014	**0.354±0.003**	0.256±0.011	0.174±0.020	0.179±0.016	0.158±0.018	0.123±0.002
	Spearman ↑	0.263±0.015	**0.318±0.004**	0.204±0.010	0.140±0.017	0.163±0.013	0.145±0.015	0.104±0.003
	RMSE ↓	1.913±0.063	2.188±0.017	1.754±0.069	1.854±0.063	1.861±0.055	**1.644±0.026**	2.152±0.019
SVG20	PCC ↑	0.364±0.005	**0.416±0.003**	0.119±0.011	0.344±0.009	0.370±0.003	0.261±0.018	0.127±0.010
	Spearman ↑	**0.440±0.002**	0.439±0.002	0.162±0.013	0.337±0.009	0.357±0.003	0.263±0.010	0.105±0.011
	RMSE ↓	3.160±0.025	**2.912±0.019**	3.260±0.020	3.123±0.036	3.137±0.031	3.116±0.071	3.249±0.048
SVG50	PCC ↑	0.384±0.005	**0.414±0.005**	0.240±0.009	0.374±0.009	0.365±0.007	0.312±0.015	0.119±0.011
	Spearman ↑	0.403±0.004	**0.413±0.004**	0.249±0.007	0.349±0.008	0.341±0.006	0.285±0.013	0.098±0.013
	RMSE ↓	2.769±0.008	**2.548±0.021**	2.751±0.023	2.594±0.021	2.765±0.018	2.644±0.032	2.835±0.015
SVG100	PCC ↑	**0.398±0.002**	0.389±0.003	0.347±0.009	0.345±0.002	0.339±0.004	0.304±0.006	0.124±0.018
	Spearman ↑	**0.391±0.003**	0.376±0.002	0.310±0.007	0.313±0.002	0.321±0.004	0.276±0.007	0.103±0.012
	RMSE ↓	2.401±0.008	**2.250±0.007**	2.285±0.015	2.262±0.012	2.471±0.009	2.270±0.014	2.534±0.032
HEG20	PCC ↑	**0.326±0.001**	0.313±0.003	0.302±0.004	0.300±0.004	0.198±0.004	0.196±0.003	0.130±0.008
	Spearman ↑	**0.465±0.001**	0.436±0.001	0.389±0.005	0.430±0.002	0.333±0.004	0.330±0.002	0.119±0.015
	RMSE ↓	2.332±0.005	**2.255±0.005**	2.273±0.013	2.266±0.009	2.357±0.009	2.346±0.005	2.415±0.013
HEG50	PCC ↑	**0.321±0.002**	0.317±0.001	0.316±0.007	0.290±0.006	0.208±0.006	0.193±0.015	0.115±0.002
	Spearman ↑	**0.406±0.002**	0.382±0.001	0.347±0.009	0.352±0.005	0.282±0.002	0.274±0.010	0.098±0.003
	RMSE ↓	2.325±0.004	2.262±0.004	**2.200±0.014**	2.227±0.008	2.336±0.006	2.292±0.013	2.382±0.017
HEG100	PCC ↑	**0.343±0.001**	0.325±0.003	0.338±0.005	0.296±0.001	0.250±0.003	0.218±0.010	0.127±0.006
	Spearman ↑	**0.386±0.000**	0.357±0.003	0.345±0.006	0.327±0.001	0.288±0.002	0.259±0.007	0.105±0.007
	RMSE ↓	2.337±0.003	2.275±0.006	**2.162±0.010**	2.240±0.004	2.359±0.004	2.282±0.009	2.394±0.005
CancerCore89	PCC ↑	0.264±0.002	**0.299±0.002**	0.197±0.012	0.216±0.005	0.207±0.007	0.136±0.002	0.120±0.007
	Spearman ↑	0.294±0.002	**0.307±0.001**	0.204±0.008	0.201±0.003	0.226±0.005	0.141±0.002	0.090±0.004
	RMSE ↓	4.085±0.027	**3.745±0.009**	3.895±0.028	3.973±0.027	3.825±0.026	3.792±0.003	4.055±0.050

Table S37: TENX192 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.199±0.023	**0.266±0.009**	0.155±0.020	0.056±0.029	0.061±0.029	0.068±0.020	0.120±0.007
	Spearman ↑	0.171±0.023	**0.267±0.011**	0.138±0.017	0.047±0.024	0.062±0.028	0.068±0.019	0.102±0.008
	RMSE ↓	3.681±0.613	3.597±0.182	2.823±0.336	4.458±0.846	3.195±0.919	**2.721±0.583**	3.996±0.700
HVG50	PCC ↑	0.253±0.004	**0.309±0.021**	0.188±0.009	0.104±0.008	0.111±0.011	0.106±0.003	0.126±0.007
	Spearman ↑	0.218±0.005	**0.290±0.010**	0.149±0.009	0.087±0.007	0.104±0.008	0.099±0.004	0.106±0.009
	RMSE ↓	2.700±0.196	2.596±0.278	2.227±0.161	2.683±0.175	2.547±0.271	**2.157±0.181**	2.912±0.250
HVG100	PCC ↑	0.278±0.004	**0.334±0.012**	0.219±0.009	0.125±0.010	0.128±0.012	0.127±0.011	0.125±0.002
	Spearman ↑	0.233±0.010	**0.303±0.012**	0.173±0.010	0.102±0.010	0.117±0.012	0.113±0.010	0.107±0.003
	RMSE ↓	1.925±0.081	2.125±0.035	1.732±0.078	1.954±0.050	1.951±0.079	**1.654±0.099**	1.995±0.084
SVG20	PCC ↑	0.151±0.008	**0.395±0.009**	0.127±0.017	0.264±0.006	0.220±0.015	0.228±0.025	0.109±0.010
	Spearman ↑	0.242±0.010	**0.319±0.022**	0.194±0.016	0.251±0.006	0.168±0.009	0.185±0.017	0.092±0.008
	RMSE ↓	3.444±0.021	**3.051±0.011**	3.298±0.020	3.085±0.028	3.426±0.013	3.372±0.038	3.292±0.015
SVG50	PCC ↑	0.288±0.005	**0.382±0.010**	0.228±0.029	0.320±0.013	0.279±0.016	0.321±0.014	0.132±0.006
	Spearman ↑	0.307±0.006	**0.330±0.019**	0.249±0.025	0.278±0.012	0.231±0.015	0.257±0.010	0.106±0.006
	RMSE ↓	2.887±0.023	**2.646±0.004**	2.804±0.041	2.668±0.012	2.847±0.019	2.697±0.031	2.859±0.024
SVG100	PCC ↑	0.346±0.001	**0.391±0.007**	0.355±0.019	0.342±0.004	0.283±0.004	0.297±0.011	0.125±0.006
	Spearman ↑	0.348±0.002	**0.353±0.013**	0.316±0.014	0.287±0.005	0.246±0.005	0.237±0.010	0.104±0.005
	RMSE ↓	2.425±0.035	**2.242±0.003**	2.296±0.027	2.282±0.030	2.497±0.038	2.330±0.031	2.483±0.041
HEG20	PCC ↑	0.251±0.006	0.272±0.009	0.256±0.009	**0.312±0.005**	0.120±0.017	0.218±0.028	0.113±0.006
	Spearman ↑	**0.359±0.001**	0.287±0.015	0.292±0.009	0.300±0.004	0.166±0.005	0.203±0.012	0.090±0.008
	RMSE ↓	2.488±0.015	2.480±0.014	2.385±0.014	**2.344±0.012**	2.504±0.014	2.438±0.015	2.435±0.013
HEG50	PCC ↑	0.267±0.002	**0.327±0.007**	0.279±0.015	0.306±0.003	0.119±0.002	0.208±0.036	0.119±0.003
	Spearman ↑	**0.338±0.002**	0.314±0.014	0.295±0.013	0.284±0.001	0.164±0.003	0.186±0.020	0.098±0.002
	RMSE ↓	2.444±0.009	2.366±0.012	2.329±0.015	**2.276±0.009**	2.449±0.012	2.386±0.022	2.431±0.015
HEG100	PCC ↑	0.309±0.003	**0.347±0.007**	0.325±0.009	0.318±0.005	0.185±0.002	0.266±0.019	0.130±0.002
	Spearman ↑	**0.337±0.002**	0.320±0.014	0.314±0.009	0.281±0.004	0.185±0.003	0.212±0.015	0.103±0.003
	RMSE ↓	2.351±0.007	2.270±0.004	**2.214±0.008**	2.218±0.005	2.391±0.004	2.281±0.012	2.365±0.012
CancerCore89	PCC ↑	0.203±0.005	**0.298±0.005**	0.189±0.016	0.211±0.004	0.163±0.009	0.117±0.009	0.113±0.016
	Spearman ↑	0.244±0.003	**0.270±0.012**	0.195±0.028	0.182±0.003	0.145±0.007	0.112±0.008	0.089±0.018
	RMSE ↓	3.998±0.012	**3.635±0.020**	3.715±0.066	3.928±0.028	3.910±0.020	3.701±0.016	3.821±0.032

Table S38: TENX96 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.175±0.003	**0.236±0.004**	0.132±0.004	0.046±0.004	0.060±0.013	0.031±0.006	0.120±0.003
	Spearman ↑	0.144±0.007	**0.189±0.004**	0.110±0.004	0.035±0.005	0.052±0.004	0.028±0.003	0.101±0.004
	RMSE ↓	4.002±0.373	**3.492±0.079**	3.585±0.679	5.353±0.236	4.657±1.416	3.560±0.928	4.695±0.219
HVG50	PCC ↑	0.219±0.007	**0.291±0.003**	0.145±0.002	0.076±0.007	0.070±0.003	0.056±0.008	0.120±0.005
	Spearman ↑	0.183±0.009	**0.230±0.005**	0.113±0.001	0.055±0.005	0.059±0.004	0.046±0.007	0.100±0.005
	RMSE ↓	3.273±0.045	**2.323±0.021**	3.366±0.277	3.930±0.082	3.573±0.172	2.490±0.098	3.702±0.058
HVG100	PCC ↑	0.292±0.011	**0.292±0.004**	0.233±0.014	0.172±0.013	0.121±0.024	0.113±0.006	0.133±0.004
	Spearman ↑	0.224±0.010	**0.242±0.002**	0.179±0.011	0.118±0.010	0.099±0.016	0.090±0.005	0.112±0.005
	RMSE ↓	2.107±0.146	2.135±0.029	1.965±0.107	2.074±0.125	2.689±0.344	**1.634±0.134**	2.532±0.139
SVG20	PCC ↑	0.238±0.030	**0.356±0.006**	0.157±0.008	0.193±0.011	0.161±0.012	0.138±0.015	0.119±0.007
	Spearman ↑	0.294±0.020	**0.310±0.012**	0.184±0.005	0.184±0.010	0.133±0.009	0.126±0.006	0.097±0.005
	RMSE ↓	3.201±0.063	**2.964±0.025**	3.074±0.016	3.178±0.030	3.192±0.021	3.173±0.036	3.069±0.025
SVG50	PCC ↑	**0.378±0.003**	0.369±0.004	0.329±0.006	0.312±0.003	0.324±0.002	0.267±0.005	0.154±0.010
	Spearman ↑	**0.365±0.002**	0.340±0.005	0.291±0.003	0.265±0.003	0.247±0.002	0.192±0.006	0.131±0.005
	RMSE ↓	2.894±0.010	2.722±0.013	**2.695±0.014**	2.801±0.007	2.888±0.003	2.846±0.015	2.980±0.024
SVG100	PCC ↑	**0.364±0.002**	0.328±0.005	0.328±0.002	0.271±0.003	0.277±0.001	0.217±0.005	0.182±0.011
	Spearman ↑	**0.347±0.001**	0.306±0.005	0.285±0.001	0.234±0.003	0.229±0.001	0.173±0.003	0.151±0.007
	RMSE ↓	2.674±0.005	2.541±0.005	**2.500±0.013**	2.591±0.006	2.774±0.008	2.644±0.016	2.773±0.018
HEG20	PCC ↑	**0.413±0.004**	0.404±0.006	0.343±0.007	0.386±0.002	0.364±0.004	0.302±0.005	0.139±0.006
	Spearman ↑	**0.417±0.001**	0.371±0.009	0.317±0.004	0.339±0.002	0.269±0.001	0.220±0.004	0.114±0.010
	RMSE ↓	2.815±0.014	2.627±0.014	2.650±0.011	**2.625±0.010**	2.761±0.021	2.758±0.014	2.892±0.012
HEG50	PCC ↑	**0.376±0.001**	0.342±0.006	0.331±0.004	0.296±0.001	0.289±0.002	0.225±0.005	0.154±0.008
	Spearman ↑	**0.370±0.001**	0.327±0.007	0.302±0.002	0.274±0.001	0.236±0.001	0.180±0.004	0.129±0.004
	RMSE ↓	2.872±0.003	2.765±0.010	**2.685±0.010**	2.785±0.007	2.897±0.009	2.871±0.011	2.926±0.008
HEG100	PCC ↑	**0.371±0.001**	0.323±0.003	0.341±0.003	0.274±0.002	0.276±0.001	0.215±0.006	0.178±0.012
	Spearman ↑	**0.358±0.001**	0.307±0.004	0.304±0.002	0.253±0.002	0.236±0.001	0.178±0.005	0.151±0.006
	RMSE ↓	2.728±0.003	2.622±0.002	**2.525±0.016**	2.650±0.003	2.830±0.003	2.728±0.019	2.799±0.028
CancerCore89	PCC ↑	0.318±0.007	**0.323±0.004**	0.265±0.005	0.245±0.002	0.248±0.005	0.178±0.004	0.120±0.007
	Spearman ↑	**0.302±0.002**	0.291±0.005	0.235±0.003	0.199±0.002	0.192±0.001	0.145±0.003	0.097±0.006
	RMSE ↓	3.725±0.031	**3.491±0.010**	3.500±0.031	3.619±0.011	3.643±0.009	3.509±0.006	3.753±0.025

Table S39: TENX196 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.229±0.020	**0.378±0.018**	0.145±0.010	0.072±0.024	0.113±0.029	0.111±0.029	0.106±0.012
	Spearman ↑	0.174±0.018	**0.324±0.015**	0.119±0.009	0.049±0.014	0.097±0.041	0.112±0.023	0.085±0.013
	RMSE ↓	3.005±0.241	3.351±0.149	2.700±0.412	4.229±0.423	2.525±0.397	**2.230±0.243**	3.373±0.286
HVG50	PCC ↑	0.268±0.005	**0.429±0.006**	0.163±0.006	0.113±0.004	0.137±0.010	0.128±0.011	0.118±0.013
	Spearman ↑	0.205±0.008	**0.373±0.010**	0.123±0.004	0.069±0.005	0.114±0.005	0.124±0.008	0.099±0.017
	RMSE ↓	2.530±0.065	2.392±0.057	2.440±0.091	3.082±0.070	2.265±0.133	**1.940±0.062**	2.788±0.139
HVG100	PCC ↑	0.327±0.002	**0.426±0.005**	0.197±0.005	0.166±0.007	0.174±0.006	0.166±0.011	0.116±0.005
	Spearman ↑	0.252±0.006	**0.370±0.005**	0.145±0.001	0.111±0.009	0.149±0.006	0.156±0.010	0.092±0.005
	RMSE ↓	1.789±0.028	2.134±0.012	1.794±0.050	1.975±0.065	1.710±0.066	**1.510±0.056**	2.123±0.056
SVG20	PCC ↑	0.498±0.002	**0.548±0.004**	0.364±0.021	0.496±0.002	0.515±0.004	0.460±0.001	0.126±0.017
	Spearman ↑	**0.501±0.002**	0.492±0.004	0.354±0.015	0.407±0.002	0.464±0.001	0.415±0.002	0.106±0.020
	RMSE ↓	3.606±0.006	**2.967±0.011**	4.141±0.077	3.050±0.028	3.292±0.008	3.172±0.018	4.700±0.052
SVG50	PCC ↑	0.474±0.003	**0.524±0.004**	0.319±0.013	0.433±0.011	0.453±0.005	0.411±0.007	0.117±0.011
	Spearman ↑	**0.457±0.003**	0.457±0.004	0.281±0.014	0.342±0.009	0.408±0.005	0.367±0.004	0.090±0.014
	RMSE ↓	2.886±0.012	**2.402±0.017**	3.325±0.054	2.519±0.037	2.720±0.026	2.607±0.036	3.793±0.036
SVG100	PCC ↑	0.441±0.003	**0.476±0.004**	0.306±0.009	0.366±0.007	0.383±0.006	0.346±0.008	0.118±0.007
	Spearman ↑	0.420±0.003	**0.421±0.005**	0.255±0.009	0.291±0.006	0.345±0.006	0.311±0.007	0.095±0.005
	RMSE ↓	2.592±0.005	**2.262±0.015**	2.837±0.036	2.398±0.014	2.586±0.013	2.416±0.024	3.205±0.019
HEG20	PCC ↑	0.334±0.001	**0.342±0.002**	0.210±0.004	0.232±0.002	0.294±0.003	0.280±0.008	0.084±0.013
	Spearman ↑	**0.385±0.001**	0.376±0.004	0.237±0.004	0.264±0.001	0.266±0.003	0.274±0.011	0.064±0.013
	RMSE ↓	3.556±0.004	3.421±0.005	**3.332±0.019**	3.388±0.007	3.529±0.012	3.510±0.013	3.537±0.034
HEG50	PCC ↑	0.324±0.001	**0.347±0.001**	0.211±0.009	0.210±0.003	0.271±0.003	0.228±0.002	0.114±0.007
	Spearman ↑	0.352±0.001	**0.363±0.002**	0.212±0.010	0.221±0.002	0.253±0.003	0.224±0.001	0.100±0.008
	RMSE ↓	3.348±0.004	3.174±0.007	**3.148±0.008**	3.201±0.004	3.362±0.009	3.313±0.022	3.354±0.025
HEG100	PCC ↑	0.353±0.000	**0.366±0.001**	0.265±0.001	0.247±0.002	0.283±0.003	0.240±0.001	0.116±0.007
	Spearman ↑	0.363±0.000	**0.365±0.001**	0.245±0.002	0.233±0.002	0.271±0.003	0.236±0.003	0.101±0.006
	RMSE ↓	2.996±0.002	**2.769±0.004**	2.841±0.011	2.827±0.006	3.023±0.007	2.905±0.015	3.097±0.022
CancerCore89	PCC ↑	0.178±0.003	**0.286±0.001**	0.056±0.017	0.057±0.019	0.166±0.011	0.062±0.006	0.119±0.011
	Spearman ↑	0.157±0.003	**0.257±0.002**	0.051±0.026	0.035±0.019	0.130±0.011	0.045±0.005	0.094±0.020
	RMSE ↓	5.187±0.015	**4.342±0.004**	4.737±0.207	5.184±0.135	4.933±0.089	4.746±0.013	5.200±0.237

Table S40: TENX94 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.161±0.025	**0.235±0.006**	0.139±0.008	0.041±0.010	0.063±0.014	0.024±0.008	0.124±0.004
	Spearman ↑	0.118±0.020	**0.196±0.005**	0.116±0.008	0.037±0.008	0.049±0.010	0.025±0.005	0.106±0.004
	RMSE ↓	3.219±0.327	3.664±0.109	3.222±0.295	4.633±0.130	2.277±0.389	**2.142±0.311**	3.757±0.251
HVG50	PCC ↑	0.197±0.005	**0.273±0.017**	0.139±0.005	0.056±0.008	0.054±0.004	0.033±0.006	0.122±0.002
	Spearman ↑	0.146±0.010	**0.227±0.013**	0.110±0.004	0.041±0.006	0.044±0.005	0.028±0.006	0.103±0.003
	RMSE ↓	2.915±0.101	2.648±0.163	2.818±0.247	3.771±0.127	3.136±0.249	**2.130±0.159**	3.193±0.087
HVG100	PCC ↑	0.247±0.005	**0.277±0.003**	0.172±0.009	0.116±0.005	0.089±0.005	0.081±0.002	0.132±0.005
	Spearman ↑	0.183±0.006	**0.235±0.004**	0.135±0.008	0.080±0.003	0.076±0.004	0.068±0.003	0.113±0.005
	RMSE ↓	2.201±0.050	2.282±0.031	2.254±0.068	2.347±0.044	2.557±0.141	**1.595±0.099**	2.438±0.089
SVG20	PCC ↑	0.249±0.024	**0.357±0.005**	0.169±0.009	0.204±0.011	0.184±0.010	0.146±0.024	0.132±0.008
	Spearman ↑	0.310±0.012	**0.321±0.007**	0.202±0.007	0.200±0.009	0.150±0.006	0.137±0.015	0.104±0.008
	RMSE ↓	3.285±0.046	**3.045±0.034**	3.145±0.044	3.239±0.043	3.270±0.031	3.250±0.050	3.156±0.031
SVG50	PCC ↑	**0.360±0.004**	0.344±0.005	0.309±0.004	0.290±0.006	0.296±0.005	0.255±0.006	0.158±0.021
	Spearman ↑	**0.351±0.004**	0.321±0.006	0.276±0.003	0.247±0.005	0.229±0.004	0.190±0.005	0.130±0.016
	RMSE ↓	2.965±0.007	2.796±0.008	**2.767±0.013**	2.864±0.011	2.967±0.012	2.888±0.007	3.021±0.018
SVG100	PCC ↑	**0.344±0.001**	0.314±0.004	0.304±0.005	0.240±0.002	0.247±0.001	0.198±0.001	0.171±0.016
	Spearman ↑	**0.329±0.001**	0.295±0.004	0.264±0.004	0.206±0.001	0.203±0.001	0.159±0.001	0.140±0.011
	RMSE ↓	2.737±0.005	2.601±0.006	**2.541±0.011**	2.656±0.011	2.842±0.006	2.686±0.022	2.791±0.013
HEG20	PCC ↑	**0.372±0.006**	0.371±0.004	0.306±0.008	0.338±0.005	0.309±0.004	0.267±0.005	0.138±0.011
	Spearman ↑	**0.383±0.002**	0.339±0.004	0.290±0.007	0.301±0.002	0.227±0.002	0.186±0.002	0.110±0.012
	RMSE ↓	2.986±0.014	**2.782±0.006**	2.803±0.010	2.810±0.013	2.949±0.011	2.914±0.010	3.004±0.018
HEG50	PCC ↑	**0.361±0.002**	0.331±0.004	0.323±0.007	0.283±0.004	0.274±0.004	0.234±0.003	0.148±0.011
	Spearman ↑	**0.354±0.002**	0.311±0.004	0.293±0.003	0.254±0.003	0.214±0.002	0.179±0.002	0.125±0.008
	RMSE ↓	2.971±0.004	2.849±0.005	**2.767±0.020**	2.880±0.008	2.995±0.011	2.938±0.020	3.018±0.008
HEG100	PCC ↑	**0.351±0.001**	0.311±0.004	0.322±0.007	0.254±0.003	0.258±0.002	0.212±0.002	0.162±0.007
	Spearman ↑	**0.341±0.001**	0.297±0.004	0.286±0.005	0.232±0.002	0.219±0.001	0.175±0.002	0.135±0.005
	RMSE ↓	2.830±0.004	2.708±0.003	**2.600±0.018**	2.742±0.005	2.925±0.013	2.791±0.029	2.869±0.011
CancerCore89	PCC ↑	0.302±0.018	**0.326±0.002**	0.245±0.010	0.245±0.004	0.255±0.004	0.171±0.003	0.131±0.004
	Spearman ↑	**0.295±0.011**	0.291±0.003	0.220±0.006	0.195±0.002	0.189±0.008	0.136±0.003	0.100±0.003
	RMSE ↓	3.692±0.057	**3.438±0.002**	3.528±0.019	3.585±0.009	3.571±0.008	3.480±0.006	3.664±0.014

Table S41: TENX201 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.166±0.039	**0.342±0.012**	0.144±0.011	0.043±0.024	0.052±0.023	0.057±0.020	0.129±0.007
	Spearman ↑	0.138±0.027	**0.315±0.007**	0.123±0.012	0.038±0.024	0.049±0.025	0.058±0.017	0.112±0.010
	RMSE ↓	3.400±0.460	3.176±0.021	2.460±0.531	4.286±0.946	2.809±1.531	**2.165±0.714**	3.591±0.385
HVG50	PCC ↑	0.258±0.008	**0.353±0.013**	0.202±0.011	0.128±0.015	0.131±0.010	0.120±0.010	0.114±0.007
	Spearman ↑	0.212±0.008	**0.314±0.012**	0.163±0.009	0.105±0.010	0.125±0.006	0.110±0.006	0.093±0.006
	RMSE ↓	2.426±0.166	2.460±0.180	2.227±0.117	2.493±0.176	2.076±0.127	**1.789±0.162**	2.768±0.150
HVG100	PCC ↑	0.307±0.013	**0.370±0.007**	0.247±0.018	0.170±0.024	0.170±0.020	0.161±0.015	0.122±0.011
	Spearman ↑	0.249±0.013	**0.325±0.005**	0.196±0.016	0.134±0.021	0.158±0.017	0.142±0.012	0.101±0.010
	RMSE ↓	1.744±0.063	1.997±0.028	1.641±0.025	1.728±0.028	1.840±0.120	**1.496±0.048**	1.929±0.093
SVG20	PCC ↑	0.400±0.012	0.508±0.030	0.176±0.008	0.535±0.006	**0.549±0.013**	0.543±0.013	0.117±0.031
	Spearman ↑	0.451±0.008	0.440±0.037	0.241±0.008	**0.489±0.006**	0.455±0.007	0.449±0.014	0.101±0.022
	RMSE ↓	3.381±0.026	2.866±0.053	3.362±0.007	2.783±0.021	2.970±0.025	**2.770±0.049**	3.461±0.013
SVG50	PCC ↑	0.433±0.003	**0.476±0.010**	0.303±0.018	0.458±0.007	0.472±0.002	0.457±0.006	0.112±0.015
	Spearman ↑	**0.452±0.004**	0.434±0.013	0.310±0.012	0.423±0.005	0.419±0.003	0.391±0.006	0.089±0.010
	RMSE ↓	2.915±0.018	2.595±0.015	2.824±0.037	**2.576±0.023**	2.737±0.011	2.593±0.037	3.145±0.014
SVG100	PCC ↑	0.430±0.003	**0.442±0.011**	0.387±0.011	0.412±0.002	0.409±0.002	0.382±0.005	0.137±0.016
	Spearman ↑	**0.430±0.004**	0.408±0.017	0.349±0.011	0.368±0.003	0.377±0.003	0.333±0.005	0.117±0.016
	RMSE ↓	2.504±0.012	2.292±0.014	2.383±0.020	**2.288±0.011**	2.571±0.014	2.319±0.016	2.766±0.015
HEG20	PCC ↑	0.210±0.004	**0.256±0.008**	0.220±0.027	0.193±0.008	0.065±0.005	0.108±0.020	0.128±0.005
	Spearman ↑	**0.340±0.002**	0.296±0.012	0.270±0.017	0.256±0.003	0.129±0.005	0.173±0.013	0.108±0.003
	RMSE ↓	2.585±0.003	2.514±0.005	2.554±0.061	**2.506±0.012**	2.569±0.006	2.554±0.011	2.542±0.004
HEG50	PCC ↑	0.303±0.002	**0.319±0.010**	0.301±0.011	0.256±0.004	0.197±0.005	0.220±0.009	0.133±0.004
	Spearman ↑	**0.354±0.002**	0.324±0.013	0.308±0.008	0.264±0.003	0.197±0.003	0.202±0.006	0.111±0.004
	RMSE ↓	2.559±0.001	2.488±0.008	**2.416±0.018**	2.476±0.007	2.564±0.005	2.514±0.011	2.577±0.010
HEG100	PCC ↑	0.364±0.002	**0.374±0.012**	0.367±0.008	0.340±0.002	0.289±0.006	0.298±0.012	0.133±0.007
	Spearman ↑	**0.390±0.002**	0.357±0.015	0.352±0.005	0.325±0.002	0.280±0.004	0.261±0.010	0.110±0.008
	RMSE ↓	2.406±0.002	2.297±0.012	**2.254±0.008**	2.277±0.007	2.431±0.007	2.332±0.015	2.511±0.005
CancerCore89	PCC ↑	0.231±0.011	**0.311±0.006**	0.182±0.007	0.232±0.005	0.263±0.004	0.128±0.003	0.088±0.012
	Spearman ↑	0.260±0.012	**0.282±0.011**	0.199±0.002	0.203±0.005	0.250±0.002	0.125±0.003	0.066±0.011
	RMSE ↓	4.286±0.132	**3.710±0.013**	3.787±0.059	3.938±0.010	3.943±0.017	3.835±0.006	4.039±0.012

Table S42: TENX197 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.195±0.016	**0.301±0.019**	0.145±0.017	0.061±0.022	0.060±0.028	0.057±0.024	0.128±0.005
	Spearman ↑	0.148±0.018	**0.255±0.022**	0.122±0.015	0.054±0.018	0.056±0.025	0.051±0.022	0.110±0.006
	RMSE ↓	3.064±0.309	3.291±0.063	2.986±0.503	4.054±0.494	2.537±0.510	**2.147±0.262**	4.020±0.506
HVG50	PCC ↑	0.231±0.012	**0.334±0.007**	0.185±0.014	0.095±0.018	0.096±0.014	0.091±0.018	0.131±0.009
	Spearman ↑	0.174±0.014	**0.282±0.011**	0.150±0.015	0.084±0.018	0.092±0.011	0.084±0.016	0.113±0.009
	RMSE ↓	2.400±0.114	2.387±0.050	2.139±0.102	2.686±0.111	1.958±0.100	**1.742±0.138**	2.687±0.082
HVG100	PCC ↑	0.260±0.006	**0.336±0.002**	0.206±0.003	0.107±0.005	0.107±0.004	0.102±0.006	0.126±0.006
	Spearman ↑	0.189±0.005	**0.292±0.003**	0.165±0.003	0.094±0.005	0.108±0.004	0.094±0.007	0.107±0.006
	RMSE ↓	1.737±0.054	2.267±0.033	1.538±0.059	1.905±0.068	1.574±0.045	**1.399±0.035**	1.862±0.037
SVG20	PCC ↑	0.313±0.005	**0.410±0.006**	0.150±0.010	0.220±0.014	0.255±0.021	0.165±0.031	0.123±0.016
	Spearman ↑	0.335±0.005	**0.399±0.007**	0.187±0.013	0.220±0.015	0.257±0.022	0.187±0.028	0.099±0.021
	RMSE ↓	4.107±0.017	**3.581±0.036**	4.021±0.044	3.908±0.054	4.283±0.044	3.916±0.045	4.192±0.125
SVG50	PCC ↑	0.313±0.004	**0.390±0.005**	0.192±0.008	0.204±0.010	0.231±0.006	0.178±0.012	0.117±0.008
	Spearman ↑	0.325±0.003	**0.380±0.007**	0.211±0.013	0.189±0.009	0.238±0.005	0.182±0.012	0.093±0.008
	RMSE ↓	3.571±0.014	**3.089±0.009**	3.475±0.020	3.523±0.034	3.753±0.017	3.338±0.041	3.696±0.046
SVG100	PCC ↑	0.349±0.002	**0.380±0.004**	0.290±0.009	0.278±0.004	0.305±0.004	0.268±0.005	0.133±0.005
	Spearman ↑	0.358±0.002	**0.365±0.005**	0.275±0.015	0.269±0.003	0.312±0.004	0.262±0.004	0.111±0.009
	RMSE ↓	2.983±0.011	2.685±0.017	2.809±0.033	2.805±0.020	2.988±0.018	**2.631±0.012**	3.220±0.022
HEG20	PCC ↑	**0.333±0.008**	0.332±0.007	0.287±0.013	0.238±0.008	0.235±0.015	0.263±0.013	0.139±0.010
	Spearman ↑	**0.357±0.006**	0.328±0.006	0.295±0.009	0.257±0.009	0.195±0.014	0.247±0.007	0.114±0.008
	RMSE ↓	3.378±0.007	3.243±0.008	**3.093±0.018**	3.261±0.011	3.359±0.011	3.313±0.018	3.321±0.027
HEG50	PCC ↑	0.342±0.001	**0.346±0.005**	0.313±0.002	0.244±0.002	0.242±0.004	0.232±0.015	0.138±0.008
	Spearman ↑	**0.354±0.002**	0.341±0.005	0.305±0.002	0.251±0.001	0.216±0.003	0.218±0.019	0.116±0.008
	RMSE ↓	3.197±0.008	3.038±0.010	**2.909±0.023**	3.090±0.006	3.223±0.008	3.146±0.010	3.248±0.018
HEG100	PCC ↑	0.349±0.002	**0.355±0.005**	0.333±0.005	0.262±0.003	0.252±0.003	0.213±0.003	0.126±0.002
	Spearman ↑	**0.357±0.002**	0.345±0.006	0.318±0.005	0.261±0.003	0.243±0.004	0.206±0.002	0.103±0.003
	RMSE ↓	2.897±0.007	2.741±0.007	**2.657±0.020**	2.784±0.009	2.960±0.009	2.807±0.017	2.957±0.016
CancerCore89	PCC ↑	0.257±0.002	**0.308±0.003**	0.172±0.014	0.195±0.002	0.193±0.004	0.126±0.000	0.127±0.018
	Spearman ↑	0.282±0.002	**0.301±0.007**	0.186±0.014	0.189±0.004	0.214±0.002	0.131±0.000	0.099±0.017
	RMSE ↓	5.025±0.046	**4.505±0.017**	4.629±0.058	4.909±0.031	4.838±0.040	4.641±0.001	4.962±0.046

Table S43: TENX193 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.280±0.023	**0.355±0.017**	0.165±0.009	0.116±0.023	0.130±0.020	0.107±0.022	0.136±0.008
	Spearman ↑	0.255±0.029	**0.351±0.015**	0.139±0.012	0.103±0.022	0.127±0.017	0.103±0.018	0.119±0.012
	RMSE ↓	3.676±0.099	3.647±0.186	3.287±0.256	3.953±0.332	3.271±0.211	**3.068±0.179**	4.220±0.185
HVG50	PCC ↑	0.317±0.009	**0.415±0.011**	0.211±0.008	0.148±0.016	0.152±0.010	0.134±0.013	0.126±0.005
	Spearman ↑	0.271±0.009	**0.388±0.012**	0.173±0.009	0.126±0.015	0.155±0.007	0.129±0.011	0.109±0.006
	RMSE ↓	2.739±0.185	2.370±0.041	2.460±0.135	2.718±0.163	2.455±0.322	**2.257±0.259**	3.184±0.179
HVG100	PCC ↑	0.354±0.005	**0.427±0.011**	0.236±0.014	0.162±0.010	0.173±0.009	0.155±0.008	0.130±0.007
	Spearman ↑	0.282±0.011	**0.396±0.010**	0.188±0.013	0.135±0.010	0.170±0.009	0.144±0.007	0.114±0.009
	RMSE ↓	1.769±0.124	2.158±0.035	1.639±0.075	1.756±0.064	1.650±0.168	**1.518±0.127**	2.063±0.169
SVG20	PCC ↑	0.300±0.018	**0.484±0.007**	0.018±0.003	0.286±0.025	0.277±0.009	0.285±0.008	0.125±0.015
	Spearman ↑	0.343±0.010	**0.444±0.015**	0.071±0.008	0.259±0.022	0.266±0.005	0.281±0.010	0.086±0.012
	RMSE ↓	3.782±0.023	**3.169±0.012**	3.868±0.016	3.481±0.049	3.763±0.013	3.633±0.037	3.683±0.013
SVG50	PCC ↑	0.471±0.004	**0.506±0.003**	0.333±0.013	0.444±0.005	0.489±0.005	0.432±0.004	0.132±0.014
	Spearman ↑	0.488±0.003	**0.491±0.008**	0.323±0.016	0.412±0.004	0.465±0.003	0.398±0.004	0.107±0.013
	RMSE ↓	2.956±0.030	**2.661±0.029**	2.936±0.019	2.665±0.009	2.754±0.037	2.723±0.030	3.327±0.060
SVG100	PCC ↑	0.467±0.002	**0.488±0.007**	0.384±0.008	0.401±0.002	0.425±0.004	0.390±0.005	0.134±0.006
	Spearman ↑	0.470±0.001	**0.472±0.010**	0.340±0.006	0.364±0.001	0.400±0.003	0.351±0.005	0.112±0.008
	RMSE ↓	2.518±0.014	**2.288±0.014**	2.427±0.028	2.362±0.011	2.483±0.017	2.352±0.024	2.850±0.035
HEG20	PCC ↑	0.298±0.006	**0.350±0.007**	0.254±0.013	0.216±0.005	0.152±0.003	0.205±0.009	0.143±0.008
	Spearman ↑	**0.440±0.002**	0.420±0.017	0.308±0.011	0.311±0.002	0.219±0.002	0.286±0.003	0.111±0.006
	RMSE ↓	2.387±0.010	2.340±0.010	**2.315±0.012**	2.369±0.008	2.385±0.013	2.357±0.007	2.385±0.010
HEG50	PCC ↑	0.385±0.001	**0.406±0.004**	0.339±0.005	0.281±0.001	0.257±0.002	0.269±0.013	0.129±0.008
	Spearman ↑	**0.441±0.001**	0.426±0.011	0.344±0.005	0.317±0.001	0.269±0.002	0.278±0.009	0.110±0.009
	RMSE ↓	2.417±0.005	2.346±0.007	**2.289±0.005**	2.390±0.003	2.444±0.007	2.407±0.013	2.576±0.012
HEG100	PCC ↑	0.419±0.001	**0.434±0.003**	0.389±0.004	0.329±0.002	0.319±0.003	0.312±0.008	0.124±0.003
	Spearman ↑	**0.446±0.002**	0.434±0.009	0.375±0.003	0.336±0.003	0.317±0.004	0.296±0.005	0.106±0.002
	RMSE ↓	2.327±0.003	2.222±0.002	**2.187±0.009**	2.272±0.004	2.355±0.004	2.302±0.009	2.502±0.015
CancerCore89	PCC ↑	0.303±0.004	**0.371±0.005**	0.227±0.011	0.226±0.001	0.179±0.010	0.155±0.004	0.133±0.017
	Spearman ↑	0.316±0.003	**0.357±0.010**	0.235±0.007	0.197±0.002	0.178±0.006	0.151±0.003	0.111±0.012
	RMSE ↓	4.169±0.015	**3.764±0.004**	4.007±0.051	4.111±0.025	4.090±0.014	3.913±0.007	4.064±0.049

Table S44: TENX191 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.214±0.006	**0.344±0.029**	0.152±0.011	0.075±0.010	0.083±0.004	0.084±0.010	0.117±0.002
	Spearman ↑	0.179±0.005	**0.315±0.022**	0.128±0.012	0.066±0.010	0.080±0.004	0.086±0.007	0.096±0.004
	RMSE ↓	3.235±0.312	3.479±0.124	3.178±0.283	4.047±0.237	2.842±0.421	**2.384±0.261**	3.662±0.343
HVG50	PCC ↑	0.267±0.004	**0.382±0.005**	0.192±0.017	0.125±0.014	0.128±0.013	0.123±0.011	0.123±0.004
	Spearman ↑	0.216±0.006	**0.343±0.006**	0.149±0.015	0.099±0.009	0.125±0.010	0.119±0.010	0.101±0.005
	RMSE ↓	2.464±0.084	2.556±0.026	2.443±0.092	2.899±0.062	2.390±0.106	**1.948±0.085**	2.847±0.085
HVG100	PCC ↑	0.294±0.008	**0.391±0.003**	0.212±0.005	0.130±0.012	0.135±0.009	0.134±0.010	0.128±0.002
	Spearman ↑	0.224±0.008	**0.355±0.003**	0.160±0.005	0.096±0.012	0.140±0.009	0.126±0.010	0.106±0.003
	RMSE ↓	1.708±0.028	2.259±0.006	1.660±0.039	1.996±0.034	1.713±0.037	**1.451±0.016**	1.921±0.020
SVG20	PCC ↑	0.300±0.002	**0.420±0.006**	0.058±0.013	0.222±0.012	0.226±0.009	0.227±0.023	0.109±0.006
	Spearman ↑	0.304±0.002	**0.390±0.005**	0.077±0.017	0.182±0.015	0.229±0.011	0.218±0.021	0.076±0.009
	RMSE ↓	4.408±0.005	**3.626±0.017**	4.424±0.048	4.195±0.037	4.597±0.034	4.128±0.092	4.523±0.052
SVG50	PCC ↑	0.352±0.003	**0.401±0.002**	0.138±0.007	0.259±0.004	0.356±0.007	0.330±0.003	0.121±0.013
	Spearman ↑	0.361±0.003	**0.384±0.004**	0.137±0.011	0.251±0.003	0.356±0.005	0.328±0.003	0.087±0.013
	RMSE ↓	3.562±0.056	**3.051±0.037**	3.619±0.061	3.452±0.057	3.499±0.075	3.057±0.063	3.813±0.086
SVG100	PCC ↑	0.409±0.001	**0.414±0.005**	0.274±0.014	0.305±0.001	0.362±0.005	0.330±0.005	0.135±0.010
	Spearman ↑	**0.418±0.002**	0.406±0.005	0.239±0.014	0.278±0.002	0.364±0.004	0.322±0.005	0.102±0.009
	RMSE ↓	2.757±0.018	**2.475±0.009**	2.749±0.024	2.639±0.019	2.833±0.028	2.511±0.023	3.100±0.045
HEG20	PCC ↑	**0.381±0.004**	0.374±0.003	0.251±0.009	0.278±0.005	0.228±0.008	0.270±0.006	0.135±0.004
	Spearman ↑	**0.456±0.001**	0.430±0.007	0.302±0.009	0.356±0.002	0.251±0.008	0.286±0.008	0.116±0.004
	RMSE ↓	3.130±0.008	3.060±0.010	**2.958±0.019**	3.029±0.013	3.209±0.020	3.129±0.021	3.111±0.026
HEG50	PCC ↑	**0.402±0.001**	0.392±0.002	0.294±0.010	0.298±0.004	0.287±0.005	0.274±0.002	0.142±0.007
	Spearman ↑	**0.438±0.001**	0.417±0.004	0.305±0.011	0.333±0.004	0.290±0.005	0.269±0.006	0.121±0.006
	RMSE ↓	2.963±0.004	2.866±0.006	**2.761±0.014**	2.871±0.007	3.061±0.015	2.977±0.019	3.059±0.014
HEG100	PCC ↑	**0.398±0.001**	0.393±0.002	0.328±0.008	0.295±0.001	0.298±0.003	0.262±0.005	0.138±0.008
	Spearman ↑	**0.415±0.001**	0.399±0.004	0.319±0.009	0.306±0.000	0.298±0.004	0.257±0.005	0.115±0.010
	RMSE ↓	2.731±0.004	2.599±0.002	**2.542±0.008**	2.645±0.003	2.838±0.011	2.715±0.026	2.881±0.005
CancerCore89	PCC ↑	0.269±0.002	**0.299±0.001**	0.167±0.014	0.168±0.005	0.220±0.003	0.122±0.002	0.142±0.012
	Spearman ↑	0.294±0.002	**0.299±0.004**	0.164±0.017	0.166±0.005	0.230±0.002	0.128±0.002	0.125±0.013
	RMSE ↓	5.519±0.018	**4.811±0.012**	5.412±0.032	5.411±0.016	5.329±0.020	5.179±0.004	5.669±0.033

Table S45: TENX202 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.230±0.016	**0.344±0.010**	0.147±0.017	0.053±0.026	0.051±0.018	0.057±0.015	0.124±0.006
	Spearman ↑	0.161±0.026	**0.292±0.006**	0.129±0.017	0.047±0.029	0.057±0.022	0.059±0.018	0.106±0.009
	RMSE ↓	2.471±0.332	2.785±0.145	3.258±0.452	3.573±0.825	**1.591±0.183**	1.661±0.250	3.007±0.404
HVG50	PCC ↑	0.311±0.007	**0.349±0.007**	0.208±0.012	0.134±0.011	0.129±0.009	0.117±0.009	0.116±0.002
	Spearman ↑	0.233±0.015	**0.291±0.007**	0.169±0.011	0.117±0.012	0.126±0.008	0.106±0.009	0.097±0.002
	RMSE ↓	2.189±0.048	2.172±0.188	2.445±0.138	2.470±0.100	1.902±0.031	**1.733±0.032**	2.469±0.147
HVG100	PCC ↑	**0.339±0.006**	0.334±0.002	0.239±0.009	0.162±0.011	0.151±0.011	0.136±0.009	0.121±0.005
	Spearman ↑	0.247±0.008	**0.291±0.001**	0.189±0.008	0.133±0.011	0.138±0.010	0.121±0.009	0.100±0.005
	RMSE ↓	1.662±0.049	2.038±0.052	1.712±0.046	1.759±0.043	1.563±0.090	**1.458±0.048**	1.833±0.053
SVG20	PCC ↑	0.329±0.012	**0.339±0.007**	0.160±0.010	0.268±0.024	0.272±0.040	0.197±0.037	0.110±0.011
	Spearman ↑	**0.375±0.017**	0.314±0.014	0.175±0.013	0.261±0.018	0.254±0.041	0.187±0.031	0.088±0.012
	RMSE ↓	3.599±0.118	**3.250±0.137**	3.650±0.130	3.473±0.145	3.525±0.154	3.490±0.158	3.747±0.122
SVG50	PCC ↑	**0.389±0.001**	0.333±0.007	0.268±0.011	0.322±0.008	0.283±0.008	0.247±0.006	0.114±0.018
	Spearman ↑	**0.408±0.004**	0.322±0.006	0.242±0.011	0.300±0.008	0.283±0.006	0.223±0.006	0.088±0.018
	RMSE ↓	2.887±0.078	**2.669±0.020**	2.841±0.078	2.733±0.073	2.858±0.082	2.804±0.063	3.036±0.088
SVG100	PCC ↑	**0.390±0.003**	0.327±0.005	0.318±0.007	0.299±0.002	0.282±0.003	0.249±0.005	0.117±0.004
	Spearman ↑	**0.392±0.002**	0.316±0.003	0.279±0.006	0.278±0.002	0.265±0.003	0.223±0.006	0.095±0.001
	RMSE ↓	2.518±0.011	**2.398±0.006**	2.411±0.007	2.435±0.008	2.549±0.018	2.475±0.004	2.639±0.006
HEG20	PCC ↑	**0.249±0.003**	0.212±0.003	0.215±0.004	0.214±0.003	0.082±0.012	0.138±0.005	0.108±0.003
	Spearman ↑	**0.378±0.004**	0.283±0.002	0.264±0.007	0.275±0.004	0.102±0.006	0.186±0.005	0.090±0.007
	RMSE ↓	2.395±0.012	2.407±0.005	2.341±0.008	**2.330±0.006**	2.411±0.007	2.378±0.010	2.337±0.012
HEG50	PCC ↑	**0.305±0.002**	0.249±0.003	0.261±0.013	0.249±0.004	0.155±0.008	0.187±0.008	0.118±0.007
	Spearman ↑	**0.380±0.002**	0.290±0.003	0.272±0.006	0.274±0.002	0.170±0.006	0.201±0.005	0.093±0.003
	RMSE ↓	2.464±0.011	2.455±0.003	**2.344±0.018**	2.392±0.007	2.500±0.014	2.453±0.005	2.460±0.004
HEG100	PCC ↑	**0.329±0.001**	0.275±0.003	0.289±0.008	0.259±0.001	0.218±0.009	0.205±0.005	0.122±0.003
	Spearman ↑	**0.365±0.001**	0.291±0.002	0.284±0.005	0.267±0.002	0.220±0.010	0.212±0.003	0.100±0.003
	RMSE ↓	2.472±0.002	2.432±0.003	**2.317±0.006**	2.399±0.004	2.521±0.006	2.455±0.010	2.484±0.013
CancerCore89	PCC ↑	0.217±0.014	**0.250±0.003**	0.105±0.016	0.116±0.006	0.118±0.014	0.065±0.007	0.092±0.005
	Spearman ↑	**0.246±0.007**	0.226±0.003	0.097±0.013	0.092±0.009	0.112±0.006	0.061±0.006	0.069±0.002
	RMSE ↓	4.335±0.070	**3.763±0.018**	3.977±0.050	4.383±0.021	3.884±0.057	3.932±0.012	4.195±0.047

Table S46: TENX200 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.255±0.018	**0.339±0.005**	0.184±0.022	0.093±0.035	0.124±0.025	0.116±0.022	0.126±0.008
	Spearman ↑	0.199±0.023	**0.320±0.002**	0.156±0.018	0.081±0.029	0.111±0.022	0.112±0.021	0.107±0.007
	RMSE ↓	3.250±0.219	3.549±0.109	3.298±0.484	4.065±0.221	2.978±0.328	**2.517±0.241**	3.837±0.442
HVG50	PCC ↑	0.286±0.009	**0.368±0.002**	0.210±0.010	0.117±0.014	0.137±0.012	0.123±0.006	0.126±0.007
	Spearman ↑	0.207±0.010	**0.341±0.005**	0.168±0.006	0.099±0.008	0.128±0.006	0.118±0.005	0.107±0.008
	RMSE ↓	2.379±0.061	2.646±0.164	2.385±0.039	2.824±0.115	2.082±0.128	**1.837±0.112**	2.714±0.060
HVG100	PCC ↑	0.309±0.006	**0.373±0.005**	0.215±0.007	0.123±0.009	0.137±0.006	0.128±0.008	0.124±0.003
	Spearman ↑	0.216±0.003	**0.343±0.006**	0.168±0.005	0.095±0.006	0.129±0.004	0.122±0.006	0.103±0.001
	RMSE ↓	1.750±0.022	2.342±0.016	1.807±0.023	2.009±0.023	1.634±0.028	**1.465±0.029**	1.866±0.046
SVG20	PCC ↑	0.243±0.012	**0.423±0.006**	-0.003±0.015	0.236±0.007	0.251±0.014	0.246±0.007	0.126±0.009
	Spearman ↑	0.269±0.013	**0.378±0.010**	0.031±0.016	0.200±0.007	0.254±0.020	0.268±0.005	0.096±0.009
	RMSE ↓	4.337±0.028	**3.573±0.009**	4.374±0.030	3.930±0.030	4.309±0.049	4.079±0.038	4.212±0.032
SVG50	PCC ↑	0.377±0.002	**0.435±0.005**	0.259±0.019	0.395±0.006	0.411±0.003	0.373±0.002	0.140±0.007
	Spearman ↑	0.403±0.002	0.425±0.006	0.249±0.022	0.372±0.006	**0.431±0.003**	0.374±0.002	0.108±0.007
	RMSE ↓	3.491±0.020	3.024±0.021	3.350±0.052	**2.998±0.032**	3.259±0.030	3.092±0.032	3.673±0.035
SVG100	PCC ↑	0.373±0.005	**0.401±0.007**	0.304±0.017	0.338±0.007	0.336±0.008	0.311±0.011	0.137±0.010
	Spearman ↑	0.382±0.006	**0.389±0.009**	0.279±0.015	0.305±0.008	0.347±0.011	0.308±0.011	0.106±0.012
	RMSE ↓	2.896±0.057	**2.611±0.067**	2.755±0.075	2.621±0.058	2.853±0.062	2.644±0.057	3.054±0.065
HEG20	PCC ↑	0.225±0.003	**0.273±0.003**	0.141±0.005	0.160±0.006	0.067±0.003	0.061±0.017	0.133±0.005
	Spearman ↑	**0.322±0.004**	0.310±0.003	0.190±0.007	0.207±0.007	0.119±0.002	0.142±0.014	0.115±0.008
	RMSE ↓	3.290±0.006	3.191±0.004	3.178±0.016	3.203±0.008	3.317±0.004	3.289±0.013	**3.171±0.014**
HEG50	PCC ↑	0.290±0.002	**0.323±0.003**	0.246±0.013	0.214±0.002	0.164±0.005	0.152±0.018	0.122±0.010
	Spearman ↑	0.337±0.002	**0.337±0.004**	0.252±0.010	0.227±0.003	0.184±0.003	0.174±0.013	0.096±0.012
	RMSE ↓	3.128±0.002	2.980±0.006	**2.896±0.023**	3.001±0.005	3.149±0.007	3.090±0.031	3.101±0.009
HEG100	PCC ↑	0.327±0.003	**0.351±0.002**	0.321±0.007	0.272±0.004	0.221±0.006	0.212±0.006	0.148±0.002
	Spearman ↑	**0.358±0.003**	0.351±0.003	0.310±0.007	0.270±0.004	0.241±0.004	0.223±0.006	0.125±0.002
	RMSE ↓	2.885±0.004	2.706±0.003	**2.630±0.015**	2.714±0.005	2.910±0.006	2.805±0.008	2.914±0.006
CancerCore89	PCC ↑	0.225±0.006	**0.304±0.002**	0.143±0.007	0.193±0.006	0.127±0.005	0.090±0.002	0.117±0.005
	Spearman ↑	0.253±0.006	**0.287±0.003**	0.151±0.005	0.179±0.004	0.151±0.003	0.096±0.002	0.087±0.006
	RMSE ↓	4.892±0.034	**4.287±0.012**	4.681±0.046	4.821±0.023	4.702±0.031	4.523±0.004	4.602±0.048

Table S47: NCBI785 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.236±0.018	**0.335±0.028**	0.171±0.017	0.090±0.015	0.080±0.010	0.066±0.016	0.125±0.005
	Spearman ↑	0.190±0.016	**0.299±0.021**	0.147±0.018	0.078±0.019	0.077±0.004	0.064±0.015	0.107±0.007
	RMSE ↓	3.480±0.193	3.342±0.359	3.706±0.351	4.349±0.327	2.746±0.410	**2.528±0.222**	4.054±0.314
HVG50	PCC ↑	0.339±0.010	**0.368±0.015**	0.271±0.007	0.199±0.015	0.172±0.016	0.139±0.009	0.124±0.006
	Spearman ↑	0.285±0.009	**0.334±0.014**	0.229±0.011	0.174±0.010	0.168±0.013	0.136±0.009	0.106±0.005
	RMSE ↓	2.668±0.092	2.500±0.074	2.712±0.097	2.851±0.076	2.682±0.190	**2.220±0.109**	3.082±0.108
HVG100	PCC ↑	**0.376±0.010**	0.375±0.007	0.310±0.014	0.232±0.018	0.200±0.020	0.171±0.016	0.135±0.006
	Spearman ↑	0.320±0.021	**0.351±0.005**	0.264±0.013	0.214±0.019	0.197±0.019	0.167±0.016	0.120±0.007
	RMSE ↓	2.127±0.101	2.132±0.013	2.089±0.081	2.136±0.052	2.229±0.136	**1.881±0.102**	2.410±0.106
SVG20	PCC ↑	**0.566±0.006**	0.490±0.006	0.478±0.012	0.537±0.011	0.528±0.010	0.421±0.005	0.157±0.024
	Spearman ↑	**0.615±0.011**	0.516±0.013	0.504±0.011	0.565±0.016	0.550±0.017	0.445±0.009	0.150±0.022
	RMSE ↓	3.393±0.045	3.043±0.021	3.282±0.038	**2.925±0.017**	3.290±0.020	3.340±0.038	3.973±0.017
SVG50	PCC ↑	**0.514±0.002**	0.462±0.005	0.437±0.035	0.469±0.006	0.460±0.004	0.379±0.002	0.124±0.013
	Spearman ↑	**0.553±0.003**	0.476±0.003	0.446±0.037	0.486±0.009	0.472±0.005	0.383±0.001	0.114±0.010
	RMSE ↓	2.873±0.009	**2.599±0.011**	2.738±0.060	2.605±0.004	2.862±0.011	2.839±0.018	3.309±0.035
SVG100	PCC ↑	**0.494±0.005**	0.435±0.002	0.473±0.016	0.428±0.009	0.407±0.010	0.355±0.009	0.133±0.009
	Spearman ↑	**0.513±0.006**	0.434±0.003	0.456±0.016	0.434±0.009	0.413±0.010	0.355±0.009	0.119±0.012
	RMSE ↓	2.529±0.004	**2.309±0.005**	2.358±0.031	2.356±0.009	2.625±0.010	2.498±0.014	2.879±0.022
HEG20	PCC ↑	**0.475±0.002**	0.394±0.004	0.438±0.009	0.429±0.004	0.411±0.003	0.336±0.008	0.117±0.017
	Spearman ↑	**0.581±0.002**	0.451±0.003	0.501±0.011	0.540±0.003	0.470±0.001	0.403±0.003	0.100±0.021
	RMSE ↓	3.019±0.008	2.817±0.009	2.754±0.013	**2.732±0.006**	3.001±0.007	2.988±0.015	3.320±0.008
HEG50	PCC ↑	**0.461±0.002**	0.389±0.001	0.428±0.008	0.386±0.005	0.362±0.007	0.300±0.007	0.127±0.007
	Spearman ↑	**0.518±0.002**	0.413±0.001	0.449±0.010	0.451±0.005	0.392±0.006	0.334±0.006	0.114±0.004
	RMSE ↓	2.840±0.005	2.671±0.006	**2.585±0.012**	2.669±0.004	2.895±0.007	2.854±0.025	3.078±0.009
HEG100	PCC ↑	**0.469±0.001**	0.398±0.001	0.453±0.006	0.391±0.002	0.368±0.002	0.319±0.002	0.124±0.010
	Spearman ↑	**0.501±0.001**	0.410±0.001	0.454±0.008	0.426±0.002	0.384±0.002	0.332±0.002	0.109±0.011
	RMSE ↓	2.629±0.002	2.458±0.004	**2.394±0.014**	2.483±0.002	2.737±0.006	2.633±0.007	2.884±0.017
CancerCore89	PCC ↑	**0.331±0.003**	0.326±0.005	0.214±0.010	0.272±0.005	0.180±0.019	0.195±0.010	0.132±0.007
	Spearman ↑	**0.417±0.001**	0.358±0.004	0.248±0.011	0.328±0.007	0.217±0.016	0.230±0.008	0.119±0.005
	RMSE ↓	3.678±0.011	**3.361±0.016**	3.494±0.007	3.480±0.016	3.538±0.037	3.528±0.012	3.667±0.021

Table S48: TENX199 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.185±0.020	**0.234±0.012**	0.131±0.009	0.048±0.033	0.054±0.029	0.055±0.024	0.137±0.013
	Spearman ↑	0.161±0.026	**0.224±0.009**	0.106±0.010	0.038±0.028	0.045±0.024	0.054±0.022	0.117±0.011
	RMSE ↓	3.762±0.233	3.588±0.128	3.733±0.242	4.341±0.636	2.785±0.290	**2.510±0.163**	4.073±0.223
HVG50	PCC ↑	0.244±0.007	**0.266±0.007**	0.187±0.005	0.099±0.009	0.088±0.011	0.094±0.006	0.141±0.006
	Spearman ↑	0.205±0.010	**0.247±0.006**	0.153±0.006	0.082±0.007	0.080±0.013	0.093±0.007	0.123±0.007
	RMSE ↓	2.759±0.081	2.570±0.215	2.712±0.054	2.937±0.085	2.507±0.075	**2.176±0.039**	2.886±0.070
HVG100	PCC ↑	0.268±0.004	**0.270±0.004**	0.214±0.007	0.114±0.008	0.103±0.012	0.108±0.009	0.148±0.002
	Spearman ↑	0.221±0.010	**0.253±0.005**	0.178±0.008	0.093±0.010	0.100±0.012	0.103±0.009	0.128±0.005
	RMSE ↓	1.879±0.100	2.271±0.015	1.762±0.095	1.865±0.080	2.038±0.260	**1.615±0.110**	1.898±0.115
SVG20	PCC ↑	0.266±0.031	0.275±0.047	0.226±0.037	0.309±0.034	0.250±0.065	**0.335±0.024**	0.137±0.011
	Spearman ↑	0.304±0.044	0.240±0.051	0.251±0.032	0.294±0.033	0.290±0.068	**0.345±0.023**	0.104±0.014
	RMSE ↓	4.057±0.052	**3.553±0.011**	3.617±0.048	3.617±0.072	3.949±0.061	3.590±0.049	3.830±0.068
SVG50	PCC ↑	**0.351±0.009**	0.275±0.029	0.298±0.014	0.308±0.006	0.276±0.009	0.277±0.007	0.185±0.012
	Spearman ↑	**0.374±0.009**	0.265±0.031	0.296±0.011	0.298±0.005	0.300±0.011	0.279±0.010	0.160±0.012
	RMSE ↓	3.170±0.031	2.951±0.021	**2.921±0.064**	2.930±0.038	3.202±0.017	2.966±0.038	3.200±0.013
SVG100	PCC ↑	**0.353±0.001**	0.269±0.014	0.340±0.004	0.264±0.009	0.244±0.012	0.239±0.006	0.183±0.011
	Spearman ↑	**0.358±0.002**	0.264±0.018	0.320±0.002	0.255±0.011	0.252±0.015	0.241±0.007	0.161±0.012
	RMSE ↓	2.640±0.060	2.486±0.057	**2.421±0.068**	2.468±0.049	2.829±0.088	2.511±0.075	2.716±0.080
HEG20	PCC ↑	**0.316±0.000**	0.243±0.003	0.290±0.013	0.247±0.004	0.165±0.007	0.146±0.004	0.135±0.005
	Spearman ↑	**0.402±0.001**	0.298±0.004	0.338±0.008	0.339±0.002	0.204±0.007	0.234±0.003	0.124±0.009
	RMSE ↓	2.768±0.005	2.769±0.006	**2.616±0.030**	2.745±0.007	2.889±0.019	2.758±0.005	2.760±0.007
HEG50	PCC ↑	**0.322±0.001**	0.241±0.004	0.313±0.016	0.242±0.002	0.204±0.015	0.153±0.005	0.153±0.012
	Spearman ↑	**0.364±0.001**	0.267±0.003	0.325±0.018	0.287±0.002	0.220±0.015	0.207±0.004	0.135±0.012
	RMSE ↓	2.773±0.004	2.776±0.011	**2.546±0.017**	2.720±0.006	2.874±0.019	2.765±0.007	2.779±0.015
HEG100	PCC ↑	0.317±0.001	0.240±0.008	**0.323±0.007**	0.231±0.002	0.196±0.016	0.166±0.006	0.165±0.006
	Spearman ↑	**0.339±0.001**	0.251±0.008	0.322±0.006	0.253±0.001	0.207±0.017	0.197±0.003	0.147±0.007
	RMSE ↓	2.694±0.003	2.666±0.013	**2.458±0.014**	2.620±0.003	2.831±0.027	2.653±0.011	2.683±0.005
CancerCore89	PCC ↑	0.202±0.023	**0.224±0.013**	0.095±0.011	0.157±0.006	0.113±0.036	0.152±0.009	0.129±0.008
	Spearman ↑	**0.205±0.028**	0.189±0.016	0.095±0.014	0.126±0.004	0.114±0.036	0.132±0.011	0.106±0.009
	RMSE ↓	4.294±0.140	**3.876±0.011**	3.922±0.118	4.114±0.035	4.352±0.167	3.912±0.067	4.001±0.046

Table S49: NCBI783 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.220±0.016	**0.288±0.026**	0.174±0.017	0.092±0.021	0.090±0.022	0.063±0.016	0.124±0.003
	Spearman ↑	0.170±0.017	**0.260±0.026**	0.148±0.014	0.077±0.018	0.074±0.015	0.058±0.015	0.105±0.002
	RMSE ↓	3.396±0.158	3.658±0.052	3.709±0.350	4.325±0.310	3.061±0.090	**2.560±0.175**	3.858±0.313
HVG50	PCC ↑	0.231±0.011	**0.311±0.008**	0.195±0.019	0.089±0.016	0.082±0.017	0.065±0.019	0.123±0.003
	Spearman ↑	0.167±0.017	**0.286±0.008**	0.156±0.016	0.071±0.013	0.073±0.017	0.060±0.014	0.104±0.005
	RMSE ↓	2.666±0.076	2.984±0.056	2.631±0.121	3.460±0.084	2.508±0.166	**1.878±0.090**	2.695±0.135
HVG100	PCC ↑	0.250±0.013	**0.323±0.007**	0.209±0.015	0.100±0.017	0.091±0.016	0.070±0.015	0.123±0.002
	Spearman ↑	0.179±0.016	**0.299±0.005**	0.161±0.015	0.077±0.017	0.083±0.017	0.061±0.012	0.105±0.003
	RMSE ↓	2.216±0.036	2.524±0.030	2.107±0.050	2.805±0.142	2.249±0.048	**1.708±0.088**	2.213±0.039
SVG20	PCC ↑	0.395±0.004	**0.404±0.008**	0.292±0.013	0.359±0.012	0.399±0.006	0.301±0.013	0.104±0.005
	Spearman ↑	**0.435±0.006**	0.403±0.009	0.288±0.016	0.336±0.008	0.407±0.004	0.300±0.008	0.086±0.004
	RMSE ↓	4.493±0.041	**3.713±0.061**	4.287±0.034	3.803±0.083	4.279±0.052	3.905±0.092	4.767±0.036
SVG50	PCC ↑	**0.437±0.005**	0.410±0.005	0.418±0.005	0.392±0.009	0.399±0.006	0.318±0.003	0.106±0.009
	Spearman ↑	**0.460±0.005**	0.401±0.005	0.381±0.003	0.368±0.006	0.394±0.008	0.308±0.001	0.087±0.009
	RMSE ↓	3.557±0.039	**3.017±0.043**	3.297±0.041	3.092±0.065	3.497±0.063	3.228±0.043	3.995±0.019
SVG100	PCC ↑	**0.397±0.003**	0.362±0.003	0.387±0.006	0.321±0.002	0.331±0.004	0.260±0.008	0.107±0.002
	Spearman ↑	**0.408±0.003**	0.351±0.002	0.353±0.008	0.300±0.003	0.317±0.003	0.250±0.007	0.087±0.002
	RMSE ↓	3.153±0.012	**2.753±0.016**	2.926±0.011	2.883±0.006	3.204±0.006	2.965±0.028	3.437±0.011
HEG20	PCC ↑	**0.405±0.002**	0.316±0.006	0.373±0.003	0.329±0.004	0.292±0.006	0.249±0.006	0.135±0.011
	Spearman ↑	**0.446±0.002**	0.326±0.007	0.384±0.004	0.373±0.004	0.292±0.007	0.271±0.005	0.119±0.013
	RMSE ↓	4.165±0.006	3.774±0.009	**3.647±0.012**	3.815±0.013	4.304±0.018	4.082±0.024	4.252±0.006
HEG50	PCC ↑	**0.391±0.004**	0.324±0.002	0.370±0.004	0.307±0.006	0.301±0.006	0.225±0.004	0.119±0.005
	Spearman ↑	**0.417±0.004**	0.327±0.001	0.361±0.003	0.327±0.006	0.299±0.007	0.238±0.004	0.100±0.005
	RMSE ↓	3.683±0.010	3.300±0.012	**3.274±0.013**	3.393±0.019	3.800±0.023	3.605±0.014	3.815±0.011
HEG100	PCC ↑	**0.371±0.000**	0.316±0.001	0.356±0.001	0.276±0.005	0.274±0.003	0.202±0.007	0.114±0.009
	Spearman ↑	**0.387±0.000**	0.317±0.001	0.340±0.002	0.279±0.003	0.269±0.003	0.205±0.005	0.096±0.008
	RMSE ↓	3.297±0.004	**2.960±0.008**	2.984±0.014	3.083±0.016	3.431±0.019	3.217±0.032	3.432±0.008
CancerCore89	PCC ↑	0.238±0.003	**0.290±0.000**	0.147±0.005	0.175±0.004	0.146±0.013	0.115±0.015	0.130±0.018
	Spearman ↑	0.265±0.001	**0.287±0.001**	0.164±0.005	0.173±0.003	0.170±0.004	0.130±0.009	0.115±0.019
	RMSE ↓	5.267±0.013	**4.536±0.006**	5.153±0.041	4.945±0.017	5.073±0.039	4.889±0.076	5.170±0.048

Table S50: NCBI784 — Breast — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.219±0.035	**0.333±0.017**	0.177±0.015	0.078±0.033	0.081±0.035	0.065±0.031	0.136±0.006
	Spearman ↑	0.180±0.037	**0.288±0.013**	0.148±0.017	0.069±0.031	0.080±0.034	0.063±0.030	0.116±0.008
	RMSE ↓	3.633±0.212	3.370±0.220	3.819±0.171	4.926±0.411	3.887±0.773	**2.950±0.442**	4.251±0.194
HVG50	PCC ↑	0.309±0.014	**0.367±0.006**	0.224±0.007	0.139±0.016	0.112±0.014	0.100±0.013	0.143±0.007
	Spearman ↑	0.238±0.015	**0.329±0.008**	0.185±0.008	0.119±0.015	0.111±0.017	0.096±0.014	0.127±0.005
	RMSE ↓	2.562±0.109	2.502±0.045	2.700±0.113	3.118±0.178	2.478±0.147	**2.021±0.113**	2.903±0.133
HVG100	PCC ↑	**0.400±0.015**	0.396±0.010	0.320±0.021	0.238±0.023	0.196±0.023	0.167±0.015	0.150±0.007
	Spearman ↑	0.326±0.018	**0.365±0.009**	0.268±0.021	0.214±0.022	0.189±0.023	0.162±0.015	0.135±0.009
	RMSE ↓	1.956±0.034	2.079±0.027	1.928±0.007	1.974±0.032	1.982±0.042	**1.733±0.070**	2.269±0.057
SVG20	PCC ↑	**0.588±0.003**	0.503±0.008	0.454±0.015	0.559±0.005	0.540±0.020	0.417±0.010	0.195±0.044
	Spearman ↑	**0.642±0.003**	0.522±0.006	0.478±0.012	0.581±0.004	0.561±0.021	0.434±0.009	0.185±0.048
	RMSE ↓	3.097±0.035	2.838±0.022	3.087±0.043	**2.689±0.007**	2.974±0.055	3.087±0.025	3.702±0.049
SVG50	PCC ↑	**0.563±0.005**	0.510±0.003	0.509±0.016	0.532±0.008	0.508±0.019	0.415±0.005	0.162±0.008
	Spearman ↑	**0.599±0.006**	0.508±0.004	0.495±0.017	0.532±0.008	0.518±0.018	0.416±0.006	0.148±0.011
	RMSE ↓	2.803±0.019	2.517±0.008	2.684±0.029	**2.482±0.022**	2.781±0.035	2.768±0.032	3.350±0.022
SVG100	PCC ↑	**0.528±0.004**	0.460±0.004	0.512±0.004	0.468±0.006	0.454±0.011	0.380±0.004	0.156±0.014
	Spearman ↑	**0.541±0.004**	0.454±0.003	0.485±0.004	0.459±0.006	0.453±0.010	0.372±0.004	0.142±0.016
	RMSE ↓	2.497±0.014	**2.287±0.013**	2.351±0.013	2.306±0.018	2.549±0.024	2.460±0.029	2.982±0.021
HEG20	PCC ↑	**0.487±0.005**	0.388±0.005	0.442±0.008	0.410±0.007	0.398±0.006	0.316±0.009	0.168±0.015
	Spearman ↑	**0.591±0.006**	0.451±0.004	0.500±0.010	0.536±0.007	0.464±0.021	0.395±0.007	0.173±0.015
	RMSE ↓	2.978±0.025	2.865±0.025	**2.748±0.030**	2.804±0.035	2.986±0.031	3.027±0.040	3.247±0.005
HEG50	PCC ↑	**0.476±0.003**	0.389±0.003	0.448±0.007	0.386±0.004	0.380±0.014	0.292±0.009	0.148±0.013
	Spearman ↑	**0.537±0.003**	0.423±0.003	0.473±0.007	0.460±0.004	0.418±0.021	0.336±0.008	0.143±0.013
	RMSE ↓	2.812±0.004	2.700±0.010	**2.576±0.016**	2.690±0.009	2.863±0.018	2.887±0.014	3.078±0.012
HEG100	PCC ↑	**0.490±0.003**	0.399±0.001	0.468±0.004	0.398±0.004	0.391±0.013	0.312±0.007	0.164±0.006
	Spearman ↑	**0.526±0.003**	0.416±0.000	0.472±0.005	0.438±0.004	0.408±0.016	0.327±0.006	0.153±0.006
	RMSE ↓	2.581±0.007	2.445±0.005	**2.373±0.012**	2.462±0.009	2.675±0.029	2.645±0.022	2.888±0.009
CancerCore89	PCC ↑	**0.353±0.010**	0.334±0.004	0.208±0.022	0.277±0.003	0.127±0.006	0.183±0.005	0.152±0.004
	Spearman ↑	**0.440±0.008**	0.370±0.003	0.246±0.018	0.340±0.003	0.196±0.002	0.214±0.004	0.139±0.010
	RMSE ↓	3.835±0.042	**3.452±0.012**	3.741±0.061	3.580±0.015	3.663±0.024	3.675±0.022	3.834±0.024

Table S51: TENX194 — Breast — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.138±0.022	**0.239±0.005**	0.133±0.005	0.022±0.016	0.029±0.009	0.033±0.006	0.123±0.013
	Spearman ↑	0.101±0.018	**0.211±0.008**	0.112±0.005	0.019±0.014	0.029±0.011	0.037±0.006	0.104±0.011
	RMSE ↓	3.376±0.226	3.724±0.199	2.928±0.245	4.677±0.634	3.073±0.530	**2.330±0.366**	4.002±0.221
HVG50	PCC ↑	0.186±0.007	**0.260±0.003**	0.167±0.010	0.060±0.012	0.060±0.017	0.066±0.010	0.129±0.003
	Spearman ↑	0.147±0.005	**0.230±0.002**	0.139±0.008	0.055±0.011	0.064±0.021	0.066±0.008	0.111±0.003
	RMSE ↓	2.756±0.134	2.741±0.025	2.388±0.136	3.202±0.164	2.444±0.158	**2.066±0.146**	2.923±0.166
HVG100	PCC ↑	0.209±0.005	**0.258±0.006**	0.195±0.007	0.078±0.006	0.086±0.005	0.096±0.005	0.123±0.003
	Spearman ↑	0.165±0.005	**0.229±0.006**	0.164±0.005	0.072±0.006	0.092±0.007	0.096±0.004	0.102±0.004
	RMSE ↓	2.045±0.038	2.498±0.032	1.739±0.046	2.244±0.028	1.923±0.056	**1.634±0.076**	1.951±0.059
SVG20	PCC ↑	0.295±0.002	0.318±0.020	0.289±0.016	0.301±0.004	0.337±0.005	**0.375±0.004**	0.073±0.008
	Spearman ↑	0.350±0.003	0.316±0.023	0.311±0.016	0.303±0.004	0.385±0.003	**0.395±0.003**	0.041±0.012
	RMSE ↓	3.965±0.004	3.372±0.026	3.623±0.014	3.657±0.010	3.570±0.025	**3.336±0.013**	4.010±0.078
SVG50	PCC ↑	0.269±0.004	**0.290±0.012**	0.270±0.016	0.224±0.011	0.235±0.006	0.282±0.008	0.120±0.017
	Spearman ↑	**0.298±0.004**	0.274±0.012	0.278±0.016	0.221±0.012	0.260±0.003	0.298±0.010	0.109±0.021
	RMSE ↓	3.379±0.027	**2.951±0.021**	3.097±0.028	3.227±0.030	3.199±0.046	2.981±0.010	3.350±0.069
SVG100	PCC ↑	0.276±0.001	0.278±0.007	**0.305±0.006**	0.206±0.002	0.208±0.005	0.227±0.008	0.133±0.009
	Spearman ↑	0.287±0.002	0.261±0.008	**0.303±0.007**	0.201±0.002	0.218±0.005	0.231±0.006	0.104±0.009
	RMSE ↓	3.075±0.008	**2.793±0.007**	2.794±0.011	2.958±0.010	3.037±0.014	2.807±0.015	3.021±0.031
HEG20	PCC ↑	0.271±0.006	0.322±0.006	**0.330±0.004**	0.236±0.003	0.230±0.009	0.230±0.016	0.142±0.018
	Spearman ↑	0.304±0.007	0.292±0.010	**0.350±0.004**	0.248±0.003	0.218±0.008	0.249±0.014	0.108±0.022
	RMSE ↓	3.656±0.014	3.426±0.007	**3.233±0.011**	3.458±0.009	3.598±0.016	3.478±0.008	3.534±0.010
HEG50	PCC ↑	0.284±0.000	0.296±0.003	**0.328±0.007**	0.219±0.002	0.209±0.003	0.183±0.011	0.110±0.005
	Spearman ↑	0.293±0.001	0.270±0.006	**0.327±0.006**	0.218±0.002	0.201±0.003	0.181±0.011	0.095±0.010
	RMSE ↓	3.417±0.004	3.219±0.009	**3.060±0.018**	3.295±0.007	3.414±0.014	3.253±0.016	3.330±0.021
HEG100	PCC ↑	0.283±0.001	0.284±0.005	**0.318±0.004**	0.209±0.002	0.201±0.003	0.192±0.006	0.132±0.009
	Spearman ↑	0.289±0.001	0.263±0.006	**0.314±0.004**	0.206±0.002	0.199±0.003	0.185±0.007	0.108±0.009
	RMSE ↓	3.136±0.002	2.934±0.008	**2.832±0.009**	3.035±0.004	3.170±0.005	2.980±0.010	3.067±0.017

Table S52: TENX158 — Skin — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.161±0.011	**0.213±0.019**	0.132±0.014	0.029±0.011	0.030±0.013	0.038±0.020	0.121±0.008
	Spearman ↑	0.126±0.010	**0.147±0.006**	0.112±0.010	0.023±0.008	0.028±0.014	0.028±0.018	0.103±0.009
	RMSE ↓	4.201±0.290	3.284±0.221	4.371±0.030	5.290±0.069	4.424±0.401	**3.192±0.417**	4.504±0.171
HVG50	PCC ↑	0.192±0.008	**0.223±0.008**	0.169±0.006	0.050±0.013	0.050±0.007	0.069±0.014	0.121±0.002
	Spearman ↑	0.147±0.012	**0.161±0.012**	0.135±0.008	0.034±0.011	0.045±0.007	0.054±0.013	0.104±0.002
	RMSE ↓	3.507±0.097	2.863±0.139	3.306±0.108	4.361±0.105	3.718±0.126	**2.609±0.195**	3.579±0.098
HVG100	PCC ↑	0.200±0.005	**0.234±0.007**	0.177±0.005	0.049±0.011	0.056±0.007	0.073±0.006	0.122±0.001
	Spearman ↑	0.144±0.006	**0.161±0.006**	0.139±0.005	0.030±0.010	0.048±0.006	0.054±0.005	0.103±0.002
	RMSE ↓	2.841±0.075	2.431±0.065	2.760±0.044	3.721±0.066	3.224±0.113	**2.135±0.167**	2.988±0.047
SVG20	PCC ↑	0.351±0.008	**0.431±0.014**	0.231±0.042	0.321±0.020	0.373±0.011	0.386±0.031	0.162±0.022
	Spearman ↑	**0.364±0.016**	0.328±0.029	0.263±0.035	0.293±0.016	0.336±0.008	0.313±0.006	0.140±0.020
	RMSE ↓	4.003±0.075	**3.155±0.108**	4.323±0.053	4.095±0.039	3.851±0.156	3.300±0.212	4.361±0.071
SVG50	PCC ↑	0.379±0.008	**0.420±0.004**	0.358±0.015	0.354±0.006	0.353±0.007	0.365±0.020	0.168±0.005
	Spearman ↑	**0.374±0.009**	0.337±0.023	0.356±0.011	0.322±0.006	0.333±0.006	0.292±0.009	0.149±0.004
	RMSE ↓	3.317±0.108	**2.810±0.097**	3.492±0.060	3.350±0.034	3.367±0.115	2.859±0.126	3.691±0.049
SVG100	PCC ↑	0.392±0.010	**0.398±0.011**	0.395±0.008	0.345±0.013	0.327±0.008	0.343±0.018	0.165±0.003
	Spearman ↑	0.361±0.008	0.322±0.015	**0.370±0.004**	0.309±0.010	0.311±0.005	0.268±0.017	0.145±0.001
	RMSE ↓	2.773±0.053	**2.458±0.047**	2.912±0.035	2.820±0.058	3.018±0.049	2.486±0.049	3.127±0.039
HEG20	PCC ↑	0.183±0.014	**0.253±0.009**	0.173±0.010	0.188±0.004	0.014±0.007	0.040±0.025	0.122±0.007
	Spearman ↑	**0.252±0.008**	0.249±0.014	0.214±0.007	0.187±0.003	0.049±0.004	0.060±0.012	0.102±0.008
	RMSE ↓	3.813±0.021	3.632±0.009	**3.549±0.018**	3.620±0.012	3.837±0.015	3.700±0.025	3.669±0.023
HEG50	PCC ↑	0.234±0.003	**0.255±0.005**	0.250±0.008	0.212±0.004	0.072±0.007	0.093±0.018	0.124±0.007
	Spearman ↑	0.250±0.002	0.241±0.007	**0.260±0.007**	0.204±0.003	0.070±0.005	0.059±0.013	0.100±0.006
	RMSE ↓	3.471±0.013	3.364±0.005	**3.172±0.009**	3.347±0.013	3.583±0.012	3.406±0.019	3.386±0.031
HEG100	PCC ↑	0.258±0.003	0.267±0.003	**0.290±0.004**	0.207±0.004	0.093±0.004	0.133±0.021	0.125±0.006
	Spearman ↑	0.266±0.003	0.253±0.007	**0.283±0.005**	0.200±0.003	0.085±0.004	0.095±0.025	0.108±0.005
	RMSE ↓	3.157±0.010	3.054±0.005	**2.888±0.008**	3.066±0.010	3.292±0.013	3.066±0.026	3.111±0.006
CancerCore89	PCC ↑	0.203±0.002	**0.232±0.001**	0.181±0.003	0.074±0.001	0.071±0.001	0.080±0.005	0.125±0.000
	Spearman ↑	0.193±0.001	**0.202±0.003**	0.160±0.003	0.067±0.001	0.072±0.002	0.060±0.006	0.104±0.001
	RMSE ↓	3.674±0.021	**3.173±0.009**	3.347±0.010	3.842±0.008	3.738±0.015	3.198±0.124	3.508±0.022

Table S53: TENX115 — Skin — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.223±0.032	**0.245±0.012**	0.161±0.034	0.151±0.021	0.134±0.038	0.095±0.039	0.120±0.009
	Spearman ↑	0.196±0.030	**0.212±0.018**	0.134±0.031	0.106±0.024	0.124±0.022	0.084±0.026	0.100±0.009
	RMSE ↓	3.822±0.319	3.798±0.154	3.654±0.247	4.206±0.587	3.831±0.706	**2.993±0.340**	3.417±0.140
HVG50	PCC ↑	0.284±0.027	**0.307±0.012**	0.207±0.025	0.182±0.026	0.168±0.019	0.131±0.015	0.128±0.004
	Spearman ↑	0.220±0.019	**0.256±0.011**	0.157±0.018	0.118±0.020	0.135±0.012	0.105±0.012	0.106±0.007
	RMSE ↓	2.357±0.232	2.574±0.178	2.435±0.199	2.585±0.298	2.291±0.231	**1.802±0.134**	2.417±0.081
HVG100	PCC ↑	0.304±0.008	**0.317±0.012**	0.240±0.007	0.180±0.007	0.163±0.003	0.132±0.004	0.130±0.005
	Spearman ↑	0.218±0.009	**0.255±0.010**	0.175±0.005	0.117±0.006	0.129±0.005	0.101±0.006	0.108±0.005
	RMSE ↓	1.741±0.107	2.075±0.085	1.778±0.069	1.894±0.088	1.849±0.077	**1.426±0.057**	1.912±0.084
SVG20	PCC ↑	**0.562±0.013**	0.512±0.018	0.421±0.021	0.537±0.014	0.467±0.024	0.403±0.010	0.173±0.007
	Spearman ↑	**0.553±0.005**	0.450±0.026	0.404±0.013	0.469±0.003	0.338±0.019	0.320±0.010	0.146±0.004
	RMSE ↓	2.793±0.075	2.600±0.078	3.021±0.148	**2.441±0.053**	2.880±0.053	2.800±0.103	3.403±0.191
SVG50	PCC ↑	**0.524±0.013**	0.457±0.016	0.438±0.015	0.485±0.016	0.404±0.020	0.363±0.016	0.183±0.008
	Spearman ↑	**0.507±0.007**	0.395±0.013	0.397±0.012	0.421±0.008	0.308±0.016	0.296±0.010	0.160±0.007
	RMSE ↓	2.503±0.052	2.366±0.044	2.626±0.040	**2.271±0.051**	2.647±0.051	2.527±0.041	2.993±0.029
SVG100	PCC ↑	**0.471±0.005**	0.406±0.009	0.410±0.004	0.415±0.006	0.344±0.006	0.305±0.009	0.164±0.008
	Spearman ↑	**0.451±0.003**	0.358±0.011	0.359±0.001	0.353±0.004	0.271±0.003	0.251±0.006	0.139±0.007
	RMSE ↓	2.315±0.011	2.240±0.018	2.399±0.004	**2.175±0.012**	2.512±0.013	2.371±0.020	2.695±0.008
HEG20	PCC ↑	**0.438±0.006**	0.430±0.012	0.294±0.012	0.411±0.005	0.138±0.014	0.302±0.014	0.116±0.006
	Spearman ↑	**0.510±0.002**	0.435±0.025	0.337±0.010	0.456±0.002	0.164±0.004	0.276±0.004	0.083±0.006
	RMSE ↓	2.496±0.023	2.347±0.011	2.548±0.031	**2.328±0.012**	2.719±0.009	2.497±0.024	2.578±0.012
HEG50	PCC ↑	**0.439±0.002**	0.393±0.012	0.325±0.010	0.389±0.003	0.217±0.003	0.284±0.006	0.133±0.004
	Spearman ↑	**0.478±0.002**	0.392±0.019	0.337±0.010	0.412±0.001	0.201±0.005	0.252±0.003	0.110±0.004
	RMSE ↓	2.555±0.008	2.450±0.012	2.499±0.023	**2.433±0.009**	2.791±0.006	2.589±0.006	2.686±0.015
HEG100	PCC ↑	**0.431±0.002**	0.375±0.009	0.364±0.006	0.352±0.002	0.275±0.008	0.265±0.005	0.143±0.002
	Spearman ↑	**0.438±0.001**	0.367±0.014	0.337±0.005	0.347±0.001	0.238±0.009	0.233±0.008	0.122±0.002
	RMSE ↓	2.476±0.007	2.392±0.010	**2.340±0.020**	2.366±0.010	2.693±0.010	2.482±0.016	2.655±0.005
CancerCore89	PCC ↑	**0.253±0.001**	0.242±0.003	0.124±0.010	0.190±0.011	-0.019±0.016	0.100±0.019	0.112±0.008
	Spearman ↑	**0.312±0.003**	0.289±0.005	0.159±0.011	0.189±0.010	0.050±0.025	0.098±0.003	0.089±0.017
	RMSE ↓	4.808±0.020	4.639±0.011	4.739±0.045	**4.610±0.018**	5.042±0.050	4.774±0.018	4.657±0.106

Table S54: TENX117 — Skin — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.168±0.017	**0.212±0.012**	0.138±0.015	0.103±0.034	0.099±0.025	0.082±0.011	0.113±0.005
	Spearman ↑	0.157±0.017	**0.162±0.017**	0.123±0.006	0.073±0.018	0.091±0.023	0.066±0.012	0.095±0.004
	RMSE ↓	4.147±0.238	3.560±0.122	4.056±0.132	4.790±0.485	4.308±0.183	**2.879±0.259**	4.041±0.099
HVG50	PCC ↑	0.199±0.009	**0.232±0.016**	0.165±0.005	0.125±0.013	0.106±0.008	0.089±0.013	0.122±0.003
	Spearman ↑	0.177±0.009	**0.179±0.021**	0.133±0.003	0.078±0.008	0.103±0.011	0.072±0.009	0.101±0.005
	RMSE ↓	3.372±0.134	2.959±0.019	3.387±0.020	3.788±0.096	4.071±0.133	**2.449±0.092**	3.254±0.027
HVG100	PCC ↑	0.247±0.006	**0.307±0.019**	0.219±0.004	0.159±0.008	0.111±0.006	0.127±0.007	0.132±0.004
	Spearman ↑	0.209±0.005	**0.241±0.017**	0.171±0.003	0.107±0.004	0.108±0.005	0.099±0.005	0.109±0.005
	RMSE ↓	2.521±0.060	2.092±0.028	2.660±0.047	2.643±0.102	3.574±0.063	**1.897±0.064**	2.669±0.058
SVG20	PCC ↑	0.475±0.009	0.472±0.012	0.472±0.014	**0.567±0.013**	0.492±0.014	0.430±0.011	0.133±0.022
	Spearman ↑	**0.543±0.011**	0.483±0.015	0.490±0.013	0.535±0.012	0.539±0.010	0.434±0.010	0.118±0.018
	RMSE ↓	3.976±0.040	3.552±0.021	3.737±0.026	**3.274±0.036**	4.006±0.070	3.640±0.026	4.395±0.029
SVG50	PCC ↑	0.504±0.010	0.473±0.011	**0.578±0.013**	0.523±0.008	0.468±0.014	0.421±0.012	0.150±0.016
	Spearman ↑	0.532±0.009	0.479±0.010	**0.535±0.014**	0.498±0.008	0.480±0.013	0.414±0.011	0.132±0.014
	RMSE ↓	3.237±0.030	2.971±0.052	2.880±0.025	**2.786±0.032**	3.444±0.032	3.091±0.020	3.654±0.045
SVG100	PCC ↑	0.479±0.001	0.423±0.007	**0.542±0.005**	0.463±0.005	0.444±0.004	0.391±0.008	0.134±0.008
	Spearman ↑	0.485±0.002	0.412±0.006	**0.502±0.001**	0.442±0.001	0.421±0.002	0.372±0.004	0.113±0.007
	RMSE ↓	2.778±0.028	2.595±0.042	2.522±0.020	**2.497±0.036**	3.036±0.034	2.684±0.037	3.142±0.043
HEG20	PCC ↑	0.461±0.003	0.416±0.005	**0.464±0.004**	0.422±0.003	0.319±0.003	0.336±0.005	0.113±0.009
	Spearman ↑	**0.539±0.002**	0.474±0.007	0.479±0.004	0.512±0.002	0.352±0.002	0.370±0.001	0.100±0.007
	RMSE ↓	3.181±0.003	3.022±0.029	**2.853±0.007**	2.902±0.013	3.235±0.011	3.142±0.020	3.440±0.010
HEG50	PCC ↑	0.458±0.002	0.416±0.006	**0.484±0.003**	0.423±0.005	0.354±0.005	0.327±0.004	0.136±0.013
	Spearman ↑	**0.500±0.003**	0.443±0.007	0.491±0.006	0.474±0.005	0.364±0.004	0.347±0.003	0.117±0.013
	RMSE ↓	3.032±0.007	2.886±0.015	**2.673±0.003**	2.794±0.018	3.190±0.014	3.020±0.011	3.309±0.008
HEG100	PCC ↑	0.451±0.001	0.391±0.006	**0.494±0.002**	0.416±0.002	0.371±0.003	0.336±0.005	0.131±0.005
	Spearman ↑	0.476±0.002	0.401±0.007	**0.483±0.003**	0.441±0.001	0.367±0.003	0.340±0.004	0.113±0.003
	RMSE ↓	2.799±0.003	2.663±0.016	**2.481±0.003**	2.593±0.005	3.035±0.007	2.788±0.013	3.070±0.017
CancerCore89	PCC ↑	**0.284±0.003**	0.233±0.015	0.128±0.016	0.246±0.011	-0.028±0.013	0.208±0.013	0.118±0.019
	Spearman ↑	**0.353±0.002**	0.305±0.017	0.159±0.016	0.280±0.011	0.064±0.004	0.249±0.015	0.101±0.014
	RMSE ↓	5.037±0.010	4.820±0.017	**4.724±0.048**	4.758±0.035	5.130±0.031	4.918±0.022	4.919±0.052

Table S55: JF-B1 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.162±0.007	0.147±0.024	**0.178±0.010**	0.158±0.006	0.102±0.016	0.101±0.010	0.133±0.002
	Spearman ↑	0.148±0.005	**0.156±0.023**	0.151±0.008	0.108±0.009	0.080±0.013	0.081±0.006	0.115±0.004
	RMSE ↓	4.684±0.236	**2.833±0.295**	4.199±0.273	3.627±0.358	5.709±0.113	4.020±0.270	4.207±0.268
HVG50	PCC ↑	0.195±0.034	0.194±0.044	**0.222±0.028**	0.172±0.026	0.099±0.026	0.117±0.022	0.139±0.007
	Spearman ↑	0.167±0.025	**0.184±0.031**	0.182±0.020	0.113±0.019	0.077±0.025	0.092±0.016	0.120±0.008
	RMSE ↓	3.330±0.362	**2.405±0.380**	3.133±0.227	2.511±0.399	4.826±0.121	2.870±0.274	3.165±0.265
HVG100	PCC ↑	0.234±0.010	0.262±0.025	**0.268±0.015**	0.191±0.008	0.118±0.010	0.135±0.008	0.149±0.003
	Spearman ↑	0.195±0.008	**0.242±0.025**	0.217±0.009	0.137±0.006	0.100±0.008	0.110±0.005	0.129±0.003
	RMSE ↓	2.376±0.112	1.965±0.035	2.288±0.142	**1.683±0.043**	4.248±0.064	2.145±0.107	2.322±0.082
SVG20	PCC ↑	0.531±0.018	0.497±0.051	0.498±0.016	**0.557±0.025**	0.466±0.019	0.420±0.025	0.191±0.011
	Spearman ↑	**0.531±0.013**	0.474±0.040	0.480±0.017	0.514±0.019	0.442±0.019	0.378±0.020	0.175±0.014
	RMSE ↓	3.367±0.219	3.072±0.229	3.277±0.290	**2.763±0.154**	4.243±0.306	3.308±0.209	4.064±0.260
SVG50	PCC ↑	0.456±0.004	0.433±0.026	**0.471±0.007**	0.463±0.012	0.377±0.016	0.345±0.004	0.174±0.009
	Spearman ↑	**0.448±0.008**	0.410±0.028	0.446±0.007	0.424±0.014	0.339±0.017	0.306±0.006	0.154±0.011
	RMSE ↓	2.949±0.013	2.699±0.071	2.780±0.010	**2.502±0.044**	3.881±0.082	2.942±0.037	3.411±0.019
SVG100	PCC ↑	0.366±0.004	0.346±0.030	**0.402±0.002**	0.334±0.004	0.237±0.004	0.257±0.005	0.162±0.005
	Spearman ↑	0.352±0.005	0.329±0.033	**0.372±0.003**	0.303±0.007	0.208±0.006	0.224±0.006	0.143±0.005
	RMSE ↓	2.639±0.035	2.422±0.096	2.457±0.030	**2.247±0.045**	3.691±0.032	2.641±0.035	2.874±0.045
HEG20	PCC ↑	0.381±0.011	**0.402±0.039**	0.315±0.016	0.393±0.009	0.294±0.007	0.269±0.016	0.135±0.006
	Spearman ↑	0.421±0.012	**0.432±0.038**	0.364±0.013	0.418±0.006	0.271±0.009	0.242±0.016	0.110±0.006
	RMSE ↓	3.279±0.046	3.796±0.087	3.047±0.029	**3.010±0.058**	3.631±0.028	3.271±0.065	3.353±0.033
HEG50	PCC ↑	0.357±0.005	**0.372±0.026**	0.355±0.007	0.343±0.007	0.250±0.008	0.238±0.011	0.141±0.004
	Spearman ↑	0.376±0.007	**0.392±0.027**	0.376±0.007	0.362±0.008	0.217±0.008	0.217±0.008	0.118±0.003
	RMSE ↓	3.164±0.021	3.326±0.020	**2.871±0.015**	2.938±0.020	3.620±0.015	3.151±0.044	3.268±0.018
HEG100	PCC ↑	0.342±0.005	0.332±0.024	**0.363±0.005**	0.312±0.006	0.237±0.008	0.211±0.016	0.145±0.006
	Spearman ↑	0.346±0.006	0.340±0.024	**0.360±0.006**	0.314±0.006	0.218±0.005	0.192±0.016	0.125±0.005
	RMSE ↓	2.903±0.019	2.903±0.013	**2.623±0.011**	2.680±0.031	3.517±0.012	2.870±0.076	3.004±0.014

Table S56: TENX122 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.126±0.004	**0.168±0.037**	0.130±0.004	0.021±0.002	0.034±0.002	0.030±0.005	0.122±0.006
	Spearman ↑	0.093±0.009	**0.137±0.031**	0.114±0.003	0.020±0.002	0.035±0.002	0.030±0.005	0.105±0.006
	RMSE ↓	4.079±0.531	**1.898±0.161**	4.989±0.102	5.461±0.125	4.800±0.578	3.264±0.475	4.704±0.099
HVG50	PCC ↑	0.144±0.025	**0.273±0.012**	0.151±0.015	0.038±0.017	0.060±0.019	0.052±0.011	0.127±0.001
	Spearman ↑	0.108±0.020	**0.199±0.012**	0.126±0.014	0.035±0.014	0.056±0.019	0.046±0.012	0.110±0.001
	RMSE ↓	3.013±0.124	**1.631±0.086**	3.051±0.052	4.135±0.149	3.203±0.428	1.990±0.088	2.840±0.043
HVG100	PCC ↑	0.156±0.012	**0.298±0.008**	0.159±0.007	0.042±0.009	0.065±0.010	0.055±0.005	0.122±0.004
	Spearman ↑	0.105±0.007	**0.214±0.005**	0.130±0.006	0.034±0.007	0.057±0.007	0.046±0.006	0.103±0.004
	RMSE ↓	2.443±0.090	1.490±0.065	2.457±0.087	3.514±0.085	2.258±0.229	**1.388±0.026**	2.415±0.062
SVG20	PCC ↑	0.419±0.009	**0.459±0.005**	0.282±0.019	0.321±0.005	0.439±0.003	0.415±0.007	0.160±0.028
	Spearman ↑	**0.459±0.004**	0.444±0.004	0.289±0.024	0.333±0.004	0.436±0.003	0.395±0.005	0.133±0.031
	RMSE ↓	4.038±0.055	**3.254±0.022**	4.566±0.055	4.487±0.020	3.635±0.034	3.445±0.067	4.822±0.042
SVG50	PCC ↑	0.370±0.002	**0.397±0.007**	0.293±0.013	0.260±0.002	0.328±0.002	0.300±0.002	0.126±0.011
	Spearman ↑	**0.377±0.000**	0.362±0.006	0.279±0.016	0.251±0.001	0.320±0.003	0.279±0.001	0.097±0.011
	RMSE ↓	3.464±0.006	**2.656±0.021**	3.724±0.024	3.826±0.008	3.314±0.020	3.025±0.008	4.015±0.027
SVG100	PCC ↑	0.337±0.004	**0.352±0.002**	0.300±0.005	0.208±0.007	0.259±0.005	0.230±0.002	0.134±0.003
	Spearman ↑	**0.316±0.004**	0.306±0.002	0.263±0.005	0.181±0.005	0.247±0.004	0.212±0.002	0.109±0.002
	RMSE ↓	2.877±0.017	**2.214±0.020**	2.992±0.008	3.212±0.005	2.773±0.013	2.410±0.047	3.370±0.034
HEG20	PCC ↑	**0.420±0.004**	0.420±0.006	0.345±0.016	0.358±0.006	0.358±0.003	0.313±0.008	0.164±0.009
	Spearman ↑	**0.436±0.003**	0.397±0.002	0.343±0.013	0.337±0.005	0.355±0.005	0.308±0.009	0.148±0.008
	RMSE ↓	4.301±0.015	**3.666±0.066**	4.364±0.066	4.311±0.019	4.200±0.056	3.999±0.015	4.876±0.027
HEG50	PCC ↑	0.411±0.001	**0.419±0.002**	0.376±0.008	0.328±0.002	0.339±0.003	0.296±0.002	0.168±0.006
	Spearman ↑	**0.410±0.001**	0.380±0.003	0.343±0.010	0.302±0.002	0.329±0.003	0.281±0.002	0.149±0.008
	RMSE ↓	3.546±0.006	**2.968±0.024**	3.500±0.021	3.638±0.004	3.507±0.025	3.220±0.037	4.090±0.010
HEG100	PCC ↑	0.370±0.002	**0.381±0.002**	0.345±0.004	0.260±0.001	0.279±0.001	0.242±0.002	0.144±0.012
	Spearman ↑	**0.351±0.001**	0.328±0.002	0.301±0.006	0.230±0.002	0.266±0.001	0.225±0.002	0.124±0.012
	RMSE ↓	3.042±0.014	**2.417±0.020**	3.003±0.008	3.251±0.008	3.069±0.012	2.725±0.020	3.517±0.038

Table S57: TENX123 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.177±0.017	**0.214±0.025**	0.147±0.016	0.038±0.023	0.057±0.016	0.041±0.017	0.124±0.002
	Spearman ↑	0.124±0.024	**0.194±0.020**	0.128±0.015	0.035±0.020	0.058±0.017	0.042±0.016	0.105±0.002
	RMSE ↓	3.540±0.648	**2.150±0.209**	4.342±0.472	5.322±0.424	4.502±0.332	3.504±0.092	4.516±0.506
HVG50	PCC ↑	0.198±0.013	**0.299±0.029**	0.164±0.008	0.046±0.010	0.066±0.009	0.052±0.008	0.123±0.003
	Spearman ↑	0.144±0.014	**0.230±0.023**	0.133±0.007	0.037±0.007	0.065±0.009	0.049±0.006	0.104±0.003
	RMSE ↓	3.341±0.178	**1.797±0.094**	3.401±0.189	4.435±0.223	3.628±0.158	2.732±0.141	3.629±0.285
HVG100	PCC ↑	0.236±0.006	**0.351±0.009**	0.192±0.004	0.071±0.006	0.089±0.007	0.074±0.007	0.123±0.004
	Spearman ↑	0.169±0.009	**0.260±0.008**	0.153±0.005	0.054±0.006	0.085±0.007	0.066±0.006	0.103±0.003
	RMSE ↓	2.398±0.068	**1.589±0.031**	2.386±0.134	3.349±0.044	2.430±0.041	1.654±0.138	2.635±0.050
SVG20	PCC ↑	0.489±0.012	**0.555±0.002**	0.306±0.012	0.359±0.021	0.499±0.007	0.441±0.010	0.123±0.009
	Spearman ↑	0.472±0.020	**0.490±0.005**	0.318±0.013	0.360±0.020	0.445±0.013	0.389±0.011	0.094±0.007
	RMSE ↓	3.587±0.087	**2.760±0.095**	4.562±0.031	4.261±0.052	3.131±0.152	3.032±0.113	4.885±0.082
SVG50	PCC ↑	0.458±0.004	**0.506±0.003**	0.333±0.006	0.320±0.007	0.409±0.004	0.362±0.006	0.119±0.013
	Spearman ↑	0.433±0.005	**0.437±0.004**	0.315±0.009	0.301±0.006	0.370±0.003	0.319±0.001	0.090±0.017
	RMSE ↓	3.197±0.022	**2.448±0.014**	3.699±0.047	3.639±0.025	3.012±0.008	2.802±0.041	4.072±0.033
SVG100	PCC ↑	0.424±0.004	**0.468±0.002**	0.320±0.004	0.254±0.003	0.311±0.004	0.257±0.003	0.127±0.003
	Spearman ↑	0.388±0.002	**0.399±0.001**	0.287±0.005	0.224±0.003	0.289±0.003	0.231±0.003	0.099±0.002
	RMSE ↓	2.884±0.008	**2.149±0.015**	3.157±0.054	3.283±0.012	2.960±0.007	2.733±0.054	3.528±0.023
HEG20	PCC ↑	0.429±0.007	**0.471±0.005**	0.300±0.004	0.265±0.006	0.286±0.007	0.243±0.003	0.135±0.011
	Spearman ↑	**0.454±0.006**	0.448±0.004	0.299±0.005	0.265±0.007	0.300±0.007	0.244±0.006	0.117±0.010
	RMSE ↓	4.399±0.033	**3.490±0.028**	4.318±0.041	4.512±0.023	4.521±0.067	4.322±0.019	4.853±0.035
HEG50	PCC ↑	0.425±0.005	**0.476±0.002**	0.310±0.002	0.247±0.003	0.282±0.004	0.213±0.005	0.147±0.011
	Spearman ↑	0.426±0.004	**0.429±0.002**	0.290±0.002	0.230±0.003	0.285±0.004	0.207±0.004	0.130±0.011
	RMSE ↓	3.624±0.030	**2.749±0.015**	3.674±0.021	3.858±0.022	3.771±0.013	3.631±0.083	4.108±0.048
HEG100	PCC ↑	0.420±0.007	**0.459±0.003**	0.317±0.002	0.234±0.003	0.271±0.002	0.217±0.005	0.138±0.007
	Spearman ↑	**0.400±0.004**	0.393±0.002	0.288±0.003	0.211±0.002	0.267±0.002	0.205±0.004	0.118±0.008
	RMSE ↓	3.040±0.036	**2.300±0.008**	3.156±0.004	3.352±0.014	3.254±0.011	2.985±0.052	3.573±0.032

Table S58: JF-A2 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.132±0.001	0.093±0.028	**0.174±0.012**	0.082±0.015	-0.003±0.022	0.047±0.008	0.140±0.010
	Spearman ↑	0.133±0.008	0.099±0.035	**0.159±0.013**	0.083±0.017	-0.005±0.022	0.047±0.007	0.125±0.012
	RMSE ↓	4.654±0.377	**3.454±0.372**	4.037±0.313	4.534±0.152	5.533±0.146	4.186±0.359	4.497±0.359
HVG50	PCC ↑	0.142±0.005	0.113±0.015	**0.186±0.005**	0.082±0.006	-0.042±0.012	0.046±0.004	0.139±0.003
	Spearman ↑	0.137±0.004	0.116±0.017	**0.166±0.005**	0.083±0.007	-0.041±0.011	0.046±0.003	0.124±0.002
	RMSE ↓	3.762±0.074	**2.478±0.110**	3.269±0.073	3.537±0.098	4.829±0.073	3.511±0.064	3.599±0.084
HVG100	PCC ↑	0.163±0.010	0.154±0.017	**0.212±0.006**	0.095±0.011	-0.046±0.014	0.059±0.006	0.142±0.005
	Spearman ↑	0.142±0.010	0.150±0.020	**0.183±0.006**	0.086±0.010	-0.039±0.014	0.052±0.005	0.124±0.004
	RMSE ↓	2.720±0.103	2.121±0.082	2.462±0.095	**2.050±0.162**	4.250±0.053	2.690±0.151	2.405±0.147
SVG20	PCC ↑	**0.374±0.009**	0.290±0.022	0.339±0.015	0.361±0.003	0.221±0.019	0.215±0.011	0.157±0.004
	Spearman ↑	**0.360±0.014**	0.284±0.021	0.317±0.013	0.324±0.007	0.202±0.012	0.191±0.012	0.141±0.002
	RMSE ↓	3.917±0.055	3.506±0.121	3.464±0.031	**3.286±0.058**	4.654±0.082	3.923±0.058	3.908±0.086
SVG50	PCC ↑	0.290±0.007	0.242±0.023	**0.316±0.011**	0.244±0.010	0.092±0.051	0.157±0.015	0.156±0.007
	Spearman ↑	0.275±0.006	0.236±0.024	**0.288±0.009**	0.223±0.010	0.090±0.047	0.141±0.015	0.139±0.005
	RMSE ↓	3.431±0.055	2.910±0.227	3.078±0.024	**2.754±0.054**	4.366±0.118	3.511±0.073	3.231±0.082
SVG100	PCC ↑	0.243±0.009	0.202±0.014	**0.288±0.009**	0.175±0.008	0.042±0.034	0.125±0.003	0.161±0.005
	Spearman ↑	0.228±0.009	0.199±0.017	**0.257±0.008**	0.167±0.007	0.041±0.032	0.111±0.001	0.143±0.004
	RMSE ↓	2.910±0.050	2.347±0.092	2.657±0.032	**2.265±0.086**	4.051±0.079	3.005±0.034	2.660±0.063
HEG20	PCC ↑	0.207±0.013	0.228±0.032	0.228±0.025	**0.230±0.019**	0.120±0.019	0.087±0.006	0.131±0.007
	Spearman ↑	**0.247±0.011**	0.246±0.034	0.245±0.017	0.224±0.016	0.116±0.017	0.093±0.008	0.108±0.007
	RMSE ↓	3.930±0.025	4.188±0.043	**3.552±0.042**	3.610±0.034	4.176±0.023	3.921±0.025	3.786±0.028
HEG50	PCC ↑	0.213±0.004	0.192±0.018	**0.255±0.005**	0.196±0.009	0.079±0.006	0.093±0.004	0.132±0.002
	Spearman ↑	0.223±0.004	0.201±0.017	**0.250±0.004**	0.187±0.007	0.054±0.006	0.087±0.005	0.111±0.003
	RMSE ↓	3.645±0.009	3.649±0.051	**3.275±0.009**	3.417±0.022	3.937±0.013	3.662±0.006	3.520±0.011
HEG100	PCC ↑	0.204±0.003	0.166±0.014	**0.245±0.004**	0.161±0.004	0.035±0.006	0.073±0.005	0.132±0.002
	Spearman ↑	0.199±0.003	0.170±0.015	**0.228±0.004**	0.155±0.003	0.020±0.004	0.061±0.005	0.112±0.002
	RMSE ↓	3.307±0.007	3.189±0.036	**3.006±0.009**	3.107±0.004	3.726±0.009	3.301±0.017	3.171±0.009

Table S59: JF-A1 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.151±0.007	0.164±0.014	**0.172±0.011**	0.095±0.017	0.069±0.014	0.042±0.008	0.132±0.003
	Spearman ↑	0.135±0.005	**0.155±0.017**	0.149±0.012	0.072±0.014	0.075±0.015	0.043±0.009	0.114±0.002
	RMSE ↓	4.043±0.109	**2.708±0.394**	3.605±0.109	4.090±0.171	5.472±0.132	3.391±0.119	3.814±0.075
HVG50	PCC ↑	0.154±0.002	0.155±0.010	**0.180±0.004**	0.073±0.004	0.055±0.015	0.040±0.004	0.131±0.002
	Spearman ↑	0.137±0.003	0.141±0.007	**0.157±0.005**	0.062±0.005	0.055±0.015	0.038±0.005	0.113±0.002
	RMSE ↓	3.180±0.076	**2.176±0.105**	2.895±0.055	3.225±0.065	4.820±0.037	2.699±0.096	3.105±0.088
HVG100	PCC ↑	0.164±0.007	0.169±0.019	**0.183±0.006**	0.062±0.007	0.022±0.007	0.038±0.004	0.131±0.003
	Spearman ↑	0.141±0.007	0.151±0.015	**0.162±0.005**	0.055±0.006	0.026±0.009	0.036±0.004	0.113±0.003
	RMSE ↓	2.217±0.119	**1.685±0.131**	2.102±0.095	2.105±0.093	4.051±0.182	1.965±0.093	2.075±0.134
SVG20	PCC ↑	**0.337±0.042**	0.294±0.019	0.218±0.053	0.292±0.051	0.228±0.061	0.205±0.010	0.166±0.009
	Spearman ↑	**0.338±0.044**	0.283±0.019	0.226±0.047	0.240±0.061	0.223±0.063	0.201±0.014	0.145±0.006
	RMSE ↓	3.790±0.065	3.453±0.046	3.706±0.109	**3.240±0.071**	4.327±0.085	3.439±0.029	3.910±0.055
SVG50	PCC ↑	**0.327±0.034**	0.286±0.017	0.298±0.041	0.277±0.037	0.251±0.022	0.172±0.012	0.166±0.007
	Spearman ↑	**0.327±0.037**	0.284±0.011	0.297±0.039	0.252±0.043	0.255±0.029	0.171±0.016	0.148±0.007
	RMSE ↓	3.422±0.030	3.216±0.063	3.214±0.057	**3.088±0.023**	4.214±0.049	3.288±0.123	3.435±0.061
SVG100	PCC ↑	0.302±0.009	0.260±0.013	**0.305±0.015**	0.229±0.003	0.209±0.006	0.134±0.005	0.155±0.002
	Spearman ↑	**0.302±0.010**	0.258±0.006	0.302±0.013	0.222±0.004	0.221±0.006	0.137±0.005	0.137±0.002
	RMSE ↓	3.042±0.019	2.851±0.045	2.822±0.023	**2.757±0.034**	3.872±0.044	2.964±0.020	3.022±0.042
HEG20	PCC ↑	0.277±0.005	**0.295±0.017**	0.253±0.017	0.268±0.005	0.206±0.009	0.120±0.015	0.155±0.006
	Spearman ↑	0.331±0.006	**0.334±0.022**	0.301±0.017	0.293±0.010	0.222±0.010	0.139±0.012	0.144±0.008
	RMSE ↓	3.907±0.012	4.240±0.046	**3.587±0.021**	3.674±0.023	4.251±0.005	3.938±0.036	3.791±0.013
HEG50	PCC ↑	**0.274±0.001**	0.261±0.005	0.270±0.009	0.253±0.009	0.190±0.013	0.114±0.009	0.138±0.006
	Spearman ↑	**0.303±0.003**	0.277±0.007	0.301±0.009	0.265±0.008	0.191±0.012	0.125±0.009	0.119±0.005
	RMSE ↓	3.565±0.009	3.704±0.030	**3.264±0.015**	3.361±0.026	3.918±0.014	3.534±0.064	3.439±0.011
HEG100	PCC ↑	0.277±0.006	0.253±0.011	**0.282±0.009**	0.232±0.004	0.192±0.004	0.107±0.009	0.143±0.007
	Spearman ↑	0.288±0.006	0.260±0.008	**0.296±0.010**	0.238±0.005	0.198±0.004	0.112±0.011	0.124±0.007
	RMSE ↓	3.207±0.017	3.133±0.024	**2.945±0.011**	2.994±0.028	3.687±0.005	3.165±0.056	3.104±0.016

Table S60: JF-C1 — Skin — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.179±0.012	**0.190±0.049**	0.133±0.007	0.103±0.013	0.094±0.022	0.063±0.012	0.135±0.005
	Spearman ↑	0.166±0.019	**0.181±0.052**	0.115±0.006	0.088±0.022	0.096±0.021	0.058±0.011	0.118±0.006
	RMSE ↓	3.818±0.381	**2.902±0.323**	3.700±0.342	3.786±0.354	4.789±0.491	3.401±0.479	3.795±0.378
HVG50	PCC ↑	0.209±0.006	**0.242±0.016**	0.182±0.017	0.117±0.011	0.130±0.010	0.094±0.005	0.138±0.005
	Spearman ↑	0.184±0.009	**0.222±0.021**	0.147±0.015	0.087±0.006	0.125±0.011	0.085±0.008	0.119±0.005
	RMSE ↓	3.086±0.154	**2.292±0.174**	2.775±0.086	2.536±0.261	4.072±0.350	2.748±0.309	2.861±0.171
HVG100	PCC ↑	0.258±0.008	**0.306±0.011**	0.222±0.012	0.136±0.012	0.135±0.005	0.108±0.009	0.145±0.008
	Spearman ↑	0.225±0.006	**0.278±0.014**	0.175±0.011	0.109±0.011	0.135±0.008	0.100±0.010	0.125±0.007
	RMSE ↓	2.141±0.069	1.727±0.062	2.064±0.056	**1.718±0.039**	2.867±0.139	1.795±0.089	2.196±0.041
SVG20	PCC ↑	0.432±0.110	0.456±0.100	0.092±0.022	**0.475±0.081**	0.433±0.100	0.362±0.079	0.170±0.031
	Spearman ↑	0.449±0.123	0.458±0.091	0.058±0.011	0.417±0.093	**0.458±0.101**	0.353±0.063	0.160±0.030
	RMSE ↓	3.881±0.579	3.160±0.395	3.852±0.167	**2.757±0.251**	3.998±0.739	3.492±0.529	4.446±0.233
SVG50	PCC ↑	**0.456±0.020**	0.451±0.027	0.296±0.016	0.423±0.037	0.411±0.006	0.331±0.021	0.197±0.008
	Spearman ↑	**0.464±0.018**	0.442±0.035	0.268±0.020	0.379±0.036	0.412±0.006	0.309±0.023	0.178±0.010
	RMSE ↓	2.950±0.050	2.593±0.108	2.994±0.070	**2.453±0.069**	3.128±0.100	2.756±0.118	3.467±0.031
SVG100	PCC ↑	**0.414±0.014**	0.394±0.023	0.339±0.003	0.353±0.012	0.325±0.007	0.275±0.019	0.167±0.019
	Spearman ↑	**0.408±0.014**	0.383±0.029	0.298±0.004	0.324±0.015	0.318±0.008	0.254±0.017	0.147±0.017
	RMSE ↓	2.623±0.030	2.388±0.031	2.510±0.026	**2.293±0.045**	2.939±0.018	2.473±0.053	2.911±0.019
HEG20	PCC ↑	**0.393±0.008**	0.256±0.043	0.200±0.026	0.366±0.013	0.286±0.004	0.287±0.005	0.110±0.004
	Spearman ↑	**0.445±0.006**	0.294±0.052	0.213±0.025	0.442±0.013	0.299±0.004	0.285±0.006	0.099±0.007
	RMSE ↓	3.431±0.043	4.056±0.041	3.324±0.040	**3.145±0.059**	3.566±0.041	3.337±0.032	3.439±0.036
HEG50	PCC ↑	**0.395±0.005**	0.303±0.036	0.277±0.007	0.335±0.007	0.271±0.005	0.260±0.009	0.131±0.014
	Spearman ↑	**0.426±0.006**	0.333±0.044	0.283±0.006	0.399±0.013	0.275±0.009	0.260±0.010	0.118±0.017
	RMSE ↓	3.188±0.018	3.542±0.014	**2.937±0.027**	2.987±0.024	3.365±0.026	3.136±0.025	3.224±0.023
HEG100	PCC ↑	**0.362±0.007**	0.299±0.027	0.295±0.003	0.281±0.010	0.232±0.001	0.212±0.010	0.140±0.007
	Spearman ↑	**0.376±0.008**	0.317±0.037	0.292±0.004	0.321±0.015	0.225±0.003	0.208±0.011	0.125±0.008
	RMSE ↓	2.909±0.024	3.000±0.031	**2.631±0.023**	2.733±0.027	3.186±0.021	2.857±0.051	2.901±0.017

Table S61: TENX111 — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.161±0.019	**0.209±0.013**	0.132±0.008	0.058±0.011	0.063±0.020	0.040±0.018	0.121±0.005
	Spearman ↑	0.138±0.019	**0.176±0.011**	0.113±0.008	0.047±0.008	0.057±0.017	0.037±0.014	0.104±0.004
	RMSE ↓	3.789±0.197	3.282±0.249	3.697±0.324	4.865±0.367	4.380±0.688	**2.912±0.634**	4.289±0.197
HVG50	PCC ↑	0.228±0.005	**0.238±0.003**	0.166±0.005	0.119±0.007	0.102±0.007	0.083±0.004	0.126±0.004
	Spearman ↑	0.186±0.005	**0.210±0.004**	0.135±0.004	0.092±0.005	0.094±0.006	0.075±0.004	0.108±0.004
	RMSE ↓	2.769±0.049	2.628±0.045	3.074±0.062	2.952±0.075	3.703±0.074	**2.073±0.022**	3.063±0.041
HVG100	PCC ↑	**0.272±0.010**	0.255±0.004	0.228±0.007	0.175±0.013	0.140±0.010	0.119±0.011	0.130±0.003
	Spearman ↑	**0.229±0.011**	0.227±0.005	0.176±0.005	0.139±0.010	0.130±0.009	0.107±0.010	0.110±0.002
	RMSE ↓	2.206±0.045	2.162±0.029	2.169±0.064	1.998±0.027	3.062±0.036	**1.785±0.084**	2.477±0.063
SVG20	PCC ↑	0.499±0.017	0.490±0.027	0.379±0.052	**0.560±0.015**	0.525±0.016	0.450±0.016	0.129±0.014
	Spearman ↑	**0.559±0.016**	0.500±0.029	0.387±0.047	0.535±0.019	0.528±0.018	0.442±0.016	0.110±0.015
	RMSE ↓	3.594±0.038	3.321±0.064	3.431±0.099	**2.987±0.057**	3.492±0.049	3.397±0.033	4.078±0.009
SVG50	PCC ↑	0.491±0.004	0.458±0.004	0.475±0.014	**0.514±0.004**	0.485±0.006	0.439±0.005	0.148±0.009
	Spearman ↑	**0.525±0.004**	0.457±0.005	0.463±0.012	0.498±0.004	0.492±0.004	0.432±0.005	0.130±0.011
	RMSE ↓	3.088±0.007	2.880±0.018	2.879±0.040	**2.658±0.005**	3.144±0.008	2.922±0.012	3.576±0.012
SVG100	PCC ↑	0.447±0.002	0.412±0.002	**0.453±0.008**	0.441±0.002	0.405±0.003	0.373±0.006	0.160±0.002
	Spearman ↑	**0.458±0.002**	0.407±0.003	0.423±0.006	0.420±0.002	0.404±0.002	0.361±0.004	0.142±0.003
	RMSE ↓	2.690±0.006	2.514±0.011	2.499±0.024	**2.374±0.007**	2.972±0.008	2.539±0.009	3.066±0.007
HEG20	PCC ↑	**0.518±0.001**	0.443±0.004	0.460±0.019	0.490±0.001	0.496±0.003	0.417±0.012	0.122±0.004
	Spearman ↑	**0.575±0.001**	0.473±0.003	0.482±0.019	0.550±0.001	0.499±0.001	0.443±0.008	0.102±0.003
	RMSE ↓	3.233±0.008	3.116±0.020	2.955±0.029	**2.842±0.005**	3.187±0.007	3.112±0.006	3.647±0.010
HEG50	PCC ↑	0.467±0.003	0.411±0.004	**0.471±0.006**	0.448±0.002	0.431±0.004	0.370±0.005	0.147±0.002
	Spearman ↑	**0.501±0.003**	0.422±0.005	0.462±0.007	0.471±0.003	0.438±0.004	0.380±0.003	0.124±0.006
	RMSE ↓	3.082±0.001	2.926±0.011	**2.743±0.007**	2.765±0.001	3.128±0.004	2.968±0.011	3.414±0.005
HEG100	PCC ↑	0.432±0.001	0.385±0.001	**0.449±0.005**	0.415±0.001	0.389±0.001	0.345±0.004	0.161±0.001
	Spearman ↑	**0.453±0.000**	0.387±0.002	0.428±0.006	0.418±0.001	0.390±0.001	0.344±0.003	0.144±0.000
	RMSE ↓	2.836±0.002	2.677±0.005	**2.535±0.006**	2.566±0.002	3.005±0.009	2.724±0.007	3.113±0.006
CancerCore89	PCC ↑	**0.255±0.001**	0.246±0.001	0.250±0.011	0.251±0.002	0.205±0.006	0.138±0.003	0.123±0.010
	Spearman ↑	**0.302±0.000**	0.271±0.003	0.251±0.008	0.259±0.001	0.239±0.003	0.157±0.002	0.105±0.008
	RMSE ↓	4.805±0.004	4.432±0.006	**4.299±0.034**	4.561±0.010	4.603±0.012	4.442±0.006	4.872±0.021

Table S62: X5K-COAD — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.103±0.033	0.077±0.012	**0.145±0.018**	0.062±0.037	0.032±0.020	0.019±0.017	0.134±0.011
	Spearman ↑	0.096±0.034	0.071±0.012	**0.127±0.018**	0.057±0.039	0.032±0.020	0.018±0.015	0.116±0.012
	RMSE ↓	4.526±0.518	**4.090±0.553**	4.133±0.495	4.515±0.189	5.840±0.117	4.176±0.693	4.489±0.547
HVG50	PCC ↑	0.114±0.037	0.087±0.031	**0.160±0.021**	0.073±0.042	0.034±0.017	0.026±0.021	0.136±0.008
	Spearman ↑	0.104±0.033	0.076±0.026	**0.135±0.016**	0.059±0.031	0.034±0.017	0.026±0.020	0.118±0.007
	RMSE ↓	3.693±0.309	**3.213±0.365**	3.450±0.355	3.240±0.281	5.156±0.034	3.544±0.408	3.773±0.439
HVG100	PCC ↑	0.121±0.024	0.088±0.020	**0.167±0.016**	0.069±0.020	0.037±0.012	0.025±0.017	0.135±0.006
	Spearman ↑	0.109±0.020	0.075±0.016	**0.141±0.013**	0.059±0.017	0.037±0.012	0.024±0.017	0.117±0.006
	RMSE ↓	2.986±0.263	2.657±0.317	2.807±0.244	**2.485±0.343**	4.530±0.018	2.947±0.331	3.033±0.255
SVG20	PCC ↑	0.200±0.006	0.169±0.011	**0.238±0.007**	0.180±0.016	0.143±0.023	0.114±0.009	0.184±0.016
	Spearman ↑	0.215±0.008	0.170±0.013	**0.222±0.005**	0.176±0.008	0.149±0.023	0.120±0.010	0.173±0.016
	RMSE ↓	4.931±0.066	4.514±0.238	4.428±0.078	**4.282±0.240**	5.831±0.104	4.859±0.147	5.008±0.142
SVG50	PCC ↑	0.208±0.007	0.167±0.016	**0.250±0.006**	0.171±0.006	0.142±0.009	0.109±0.008	0.200±0.013
	Spearman ↑	0.219±0.010	0.165±0.018	**0.231±0.007**	0.167±0.015	0.144±0.009	0.115±0.010	0.190±0.014
	RMSE ↓	4.069±0.123	3.751±0.241	3.675±0.084	**3.576±0.277**	5.050±0.096	4.124±0.103	4.122±0.068
SVG100	PCC ↑	0.209±0.010	0.161±0.018	**0.246±0.007**	0.162±0.013	0.141±0.003	0.104±0.008	0.184±0.004
	Spearman ↑	0.214±0.012	0.156±0.016	**0.230±0.008**	0.160±0.018	0.138±0.002	0.106±0.009	0.173±0.004
	RMSE ↓	3.472±0.047	3.218±0.104	3.161±0.049	**3.137±0.130**	4.396±0.059	3.548±0.048	3.510±0.025
HEG20	PCC ↑	**0.194±0.003**	0.123±0.022	0.181±0.006	0.083±0.014	0.013±0.008	-0.007±0.019	0.132±0.004
	Spearman ↑	**0.238±0.002**	0.153±0.023	0.187±0.006	0.123±0.008	0.019±0.009	-0.004±0.018	0.112±0.002
	RMSE ↓	3.681±0.014	3.628±0.035	**3.403±0.014**	3.712±0.016	3.856±0.009	3.745±0.016	3.548±0.014
HEG50	PCC ↑	**0.213±0.004**	0.135±0.016	0.210±0.005	0.107±0.005	0.005±0.010	-0.000±0.025	0.130±0.001
	Spearman ↑	**0.237±0.004**	0.149±0.018	0.206±0.006	0.133±0.004	0.013±0.011	0.003±0.027	0.112±0.002
	RMSE ↓	3.439±0.017	3.384±0.028	**3.164±0.017**	3.443±0.021	3.643±0.020	3.514±0.023	3.340±0.017
HEG100	PCC ↑	0.212±0.006	0.139±0.016	**0.215±0.005**	0.108±0.014	0.033±0.003	-0.007±0.013	0.132±0.001
	Spearman ↑	**0.224±0.006**	0.146±0.017	0.204±0.005	0.128±0.010	0.033±0.005	-0.007±0.015	0.113±0.001
	RMSE ↓	3.182±0.012	3.131±0.023	**2.947±0.007**	3.182±0.019	3.412±0.014	3.273±0.016	3.093±0.015
CancerCore89	PCC ↑	0.100±0.001	0.071±0.004	**0.157±0.004**	0.064±0.007	0.020±0.002	-0.007±0.003	0.130±0.002
	Spearman ↑	0.100±0.000	0.070±0.005	**0.147±0.004**	0.064±0.004	0.018±0.002	-0.001±0.003	0.110±0.002
	RMSE ↓	3.809±0.010	3.720±0.009	**3.520±0.002**	3.593±0.033	4.506±0.007	3.690±0.005	3.632±0.015

Table S63: TENX139 — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.186±0.022**	0.184±0.018	0.162±0.016	0.106±0.026	0.087±0.026	0.058±0.018	0.135±0.010
	Spearman ↑	**0.173±0.025**	0.165±0.020	0.139±0.014	0.083±0.022	0.089±0.025	0.059±0.016	0.119±0.011
	RMSE ↓	3.992±0.164	3.794±0.119	3.925±0.210	4.349±0.225	4.444±0.166	**3.129±0.197**	4.191±0.150
HVG50	PCC ↑	**0.230±0.012**	0.224±0.012	0.197±0.014	0.151±0.017	0.136±0.017	0.100±0.010	0.129±0.009
	Spearman ↑	**0.209±0.014**	0.199±0.012	0.162±0.010	0.116±0.011	0.129±0.017	0.093±0.011	0.111±0.010
	RMSE ↓	3.136±0.109	2.727±0.180	3.178±0.167	3.115±0.172	3.838±0.097	**2.537±0.158**	3.340±0.116
HVG100	PCC ↑	**0.248±0.007**	0.221±0.007	0.238±0.009	0.170±0.006	0.141±0.008	0.117±0.006	0.134±0.008
	Spearman ↑	**0.223±0.006**	0.197±0.007	0.187±0.008	0.130±0.006	0.131±0.008	0.105±0.006	0.116±0.010
	RMSE ↓	2.591±0.043	2.316±0.054	2.517±0.078	2.355±0.064	3.361±0.106	**2.093±0.041**	2.760±0.045
SVG20	PCC ↑	**0.510±0.008**	0.438±0.014	0.440±0.009	0.497±0.013	0.466±0.006	0.377±0.006	0.137±0.028
	Spearman ↑	**0.529±0.010**	0.442±0.017	0.422±0.011	0.479±0.015	0.461±0.004	0.371±0.005	0.117±0.026
	RMSE ↓	3.597±0.115	3.348±0.090	3.476±0.146	**3.025±0.106**	3.674±0.132	3.482±0.091	4.244±0.131
SVG50	PCC ↑	0.453±0.002	0.401±0.006	0.432±0.002	**0.456±0.003**	0.400±0.003	0.348±0.005	0.140±0.009
	Spearman ↑	**0.465±0.003**	0.395±0.013	0.412±0.003	0.436±0.006	0.378±0.004	0.329±0.006	0.120±0.008
	RMSE ↓	3.145±0.015	2.938±0.008	2.956±0.015	**2.742±0.012**	3.314±0.013	3.042±0.016	3.457±0.019
SVG100	PCC ↑	0.397±0.002	0.344±0.006	**0.420±0.003**	0.382±0.003	0.325±0.004	0.303±0.003	0.165±0.004
	Spearman ↑	**0.395±0.004**	0.334±0.010	0.382±0.004	0.357±0.006	0.305±0.005	0.276±0.005	0.146±0.006
	RMSE ↓	2.838±0.010	2.660±0.007	2.613±0.007	**2.558±0.016**	3.156±0.006	2.700±0.017	3.010±0.013
HEG20	PCC ↑	0.335±0.005	0.296±0.010	0.304±0.023	**0.361±0.011**	0.248±0.010	0.236±0.009	0.148±0.004
	Spearman ↑	**0.401±0.007**	0.329±0.015	0.339±0.020	0.392±0.011	0.266±0.008	0.262±0.009	0.126±0.004
	RMSE ↓	3.553±0.008	3.368±0.023	3.256±0.008	**3.204±0.025**	3.525±0.010	3.477±0.019	3.527±0.008
HEG50	PCC ↑	0.348±0.001	0.305±0.006	**0.356±0.002**	0.338±0.002	0.254±0.002	0.249±0.002	0.136±0.008
	Spearman ↑	**0.382±0.001**	0.319±0.015	0.361±0.002	0.358±0.002	0.263±0.002	0.248±0.003	0.117±0.008
	RMSE ↓	3.318±0.008	3.161±0.005	**2.986±0.002**	3.067±0.005	3.366±0.007	3.228±0.006	3.336±0.013
HEG100	PCC ↑	0.322±0.002	0.278±0.005	**0.338±0.003**	0.282±0.002	0.220±0.003	0.219±0.005	0.140±0.003
	Spearman ↑	**0.339±0.002**	0.284±0.010	0.331±0.003	0.294±0.003	0.214±0.003	0.209±0.005	0.120±0.004
	RMSE ↓	3.075±0.003	2.956±0.005	**2.801±0.010**	2.906±0.003	3.221±0.005	2.968±0.022	3.095±0.008
CancerCore89	PCC ↑	0.189±0.002	0.196±0.001	**0.207±0.011**	0.151±0.001	0.081±0.004	0.069±0.000	0.125±0.004
	Spearman ↑	**0.205±0.002**	0.197±0.005	0.203±0.009	0.153±0.001	0.084±0.003	0.075±0.000	0.103±0.004
	RMSE ↓	4.298±0.019	4.067±0.008	**3.834±0.006**	4.139±0.006	4.219±0.013	3.973±0.000	4.077±0.009

Table S64: TENX148 — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.215±0.011	**0.249±0.009**	0.175±0.020	0.136±0.015	0.134±0.010	0.096±0.013	0.146±0.011
	Spearman ↑	0.199±0.014	**0.237±0.008**	0.156±0.013	0.103±0.008	0.132±0.010	0.090±0.011	0.126±0.011
	RMSE ↓	4.116±0.072	3.846±0.131	4.008±0.259	4.590±0.156	4.429±0.243	**3.384±0.193**	4.152±0.100
HVG50	PCC ↑	0.254±0.005	**0.270±0.022**	0.214±0.002	0.178±0.011	0.165±0.006	0.122±0.005	0.147±0.007
	Spearman ↑	0.219±0.005	**0.238±0.012**	0.172±0.003	0.124±0.005	0.148±0.005	0.105±0.006	0.123±0.006
	RMSE ↓	3.145±0.147	2.926±0.249	3.255±0.118	3.073±0.233	3.420±0.180	**2.571±0.224**	3.349±0.119
HVG100	PCC ↑	**0.296±0.012**	0.291±0.002	0.281±0.011	0.218±0.014	0.189±0.016	0.152±0.012	0.150±0.006
	Spearman ↑	0.247±0.008	**0.256±0.002**	0.206±0.010	0.153±0.010	0.164±0.011	0.128±0.009	0.125±0.008
	RMSE ↓	2.408±0.060	2.306±0.015	2.323±0.032	2.077±0.093	2.846±0.113	**2.008±0.053**	2.719±0.063
SVG20	PCC ↑	0.491±0.005	0.474±0.005	0.314±0.012	**0.508±0.007**	0.482±0.005	0.395±0.003	0.141±0.026
	Spearman ↑	**0.496±0.006**	0.461±0.006	0.358±0.011	0.468±0.005	0.417±0.001	0.358±0.009	0.119±0.020
	RMSE ↓	3.633±0.038	3.415±0.042	3.791±0.021	**3.144±0.037**	3.635±0.059	3.497±0.062	4.125±0.027
SVG50	PCC ↑	0.451±0.002	0.435±0.003	0.330±0.013	**0.452±0.003**	0.424±0.002	0.363±0.004	0.173±0.023
	Spearman ↑	**0.435±0.001**	0.404±0.007	0.336±0.011	0.395±0.003	0.362±0.000	0.320±0.003	0.143±0.023
	RMSE ↓	3.081±0.017	2.838±0.020	3.277±0.018	**2.748±0.014**	3.262±0.013	2.968±0.035	3.528±0.015
SVG100	PCC ↑	0.428±0.002	0.410±0.005	0.409±0.018	**0.436±0.005**	0.391±0.003	0.343±0.002	0.175±0.011
	Spearman ↑	**0.411±0.003**	0.378±0.008	0.361±0.012	0.369±0.005	0.348±0.004	0.308±0.004	0.152±0.010
	RMSE ↓	2.722±0.016	2.488±0.025	2.654±0.036	**2.365±0.015**	2.952±0.013	2.566±0.033	3.064±0.033
HEG20	PCC ↑	0.408±0.002	0.350±0.009	**0.419±0.006**	0.408±0.003	0.329±0.003	0.336±0.007	0.115±0.019
	Spearman ↑	**0.463±0.002**	0.375±0.009	0.434±0.006	0.447±0.003	0.344±0.001	0.360±0.004	0.084±0.020
	RMSE ↓	3.501±0.017	3.393±0.021	**3.117±0.011**	3.149±0.047	3.482±0.003	3.387±0.015	3.642±0.011
HEG50	PCC ↑	0.416±0.001	0.367±0.010	**0.418±0.013**	0.413±0.009	0.358±0.001	0.351±0.008	0.158±0.007
	Spearman ↑	**0.448±0.002**	0.377±0.012	0.411±0.016	0.432±0.003	0.363±0.000	0.350±0.008	0.138±0.005
	RMSE ↓	3.212±0.004	3.069±0.011	**2.855±0.017**	2.921±0.067	3.233±0.005	3.076±0.020	3.382±0.008
HEG100	PCC ↑	0.397±0.005	0.357±0.006	**0.421±0.010**	0.388±0.007	0.342±0.005	0.326±0.007	0.141±0.014
	Spearman ↑	**0.415±0.005**	0.360±0.007	0.395±0.012	0.390±0.004	0.341±0.005	0.319±0.006	0.121±0.016
	RMSE ↓	2.937±0.010	2.775±0.004	**2.608±0.005**	2.679±0.042	3.041±0.010	2.818±0.024	3.105±0.015
CancerCore89	PCC ↑	0.237±0.002	**0.259±0.002**	0.251±0.012	0.211±0.008	0.177±0.006	0.111±0.006	0.120±0.009
	Spearman ↑	0.250±0.001	**0.254±0.004**	0.248±0.010	0.198±0.002	0.168±0.006	0.112±0.006	0.109±0.010
	RMSE ↓	5.123±0.002	4.796±0.007	**4.689±0.061**	5.010±0.035	5.144±0.031	4.825±0.014	4.999±0.048

Table S65: TENX149 — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.209±0.011	**0.259±0.012**	0.153±0.011	0.085±0.003	0.121±0.016	0.093±0.014	0.137±0.003
	Spearman ↑	0.181±0.010	**0.227±0.011**	0.130±0.011	0.070±0.003	0.103±0.011	0.083±0.010	0.117±0.004
	RMSE ↓	3.865±0.278	3.355±0.117	4.015±0.233	4.866±0.008	4.072±0.437	**2.906±0.358**	4.635±0.193
HVG50	PCC ↑	0.260±0.018	**0.273±0.006**	0.200±0.018	0.136±0.013	0.172±0.020	0.138±0.019	0.150±0.011
	Spearman ↑	0.222±0.017	**0.233±0.007**	0.161±0.010	0.105±0.011	0.146±0.018	0.117±0.016	0.128±0.012
	RMSE ↓	3.086±0.100	2.763±0.048	3.324±0.095	3.624±0.022	3.544±0.101	**2.413±0.088**	3.536±0.086
HVG100	PCC ↑	0.269±0.009	**0.283±0.010**	0.236±0.014	0.163±0.010	0.168±0.008	0.136±0.007	0.147±0.008
	Spearman ↑	0.223±0.006	**0.244±0.008**	0.183±0.010	0.125±0.008	0.145±0.007	0.112±0.006	0.124±0.009
	RMSE ↓	2.598±0.059	2.327±0.043	2.642±0.104	2.738±0.013	3.151±0.097	**2.098±0.049**	2.917±0.049
SVG20	PCC ↑	0.498±0.003	0.469±0.004	0.278±0.022	0.443±0.003	**0.525±0.000**	0.443±0.008	0.159±0.019
	Spearman ↑	**0.541±0.002**	0.479±0.009	0.307±0.014	0.436±0.003	0.533±0.004	0.441±0.011	0.141±0.015
	RMSE ↓	3.879±0.036	3.596±0.005	4.207±0.072	3.682±0.007	3.846±0.019	**3.499±0.029**	4.565±0.027
SVG50	PCC ↑	0.452±0.010	0.414±0.005	0.324±0.033	0.399±0.006	**0.457±0.010**	0.402±0.014	0.169±0.005
	Spearman ↑	**0.471±0.011**	0.409±0.010	0.327±0.028	0.384±0.006	0.449±0.011	0.392±0.012	0.151±0.005
	RMSE ↓	3.295±0.026	3.106±0.005	3.496±0.084	3.163±0.012	3.404±0.052	**2.962±0.068**	3.894±0.033
SVG100	PCC ↑	**0.424±0.002**	0.394±0.007	0.393±0.009	0.368±0.007	0.393±0.003	0.359±0.007	0.165±0.014
	Spearman ↑	**0.419±0.002**	0.378±0.010	0.348±0.008	0.341±0.006	0.373±0.002	0.334±0.006	0.147±0.013
	RMSE ↓	2.809±0.007	2.646±0.014	2.796±0.022	2.706±0.011	3.057±0.013	**2.564±0.030**	3.238±0.024
HEG20	PCC ↑	**0.451±0.002**	0.368±0.009	0.391±0.008	0.391±0.003	0.367±0.003	0.349±0.005	0.150±0.014
	Spearman ↑	**0.484±0.001**	0.389±0.010	0.398±0.009	0.440±0.003	0.387±0.003	0.369±0.006	0.138±0.015
	RMSE ↓	4.068±0.006	3.873±0.025	**3.702±0.012**	3.838±0.008	4.133±0.007	3.893±0.025	4.377±0.010
HEG50	PCC ↑	**0.425±0.002**	0.362±0.004	0.419±0.004	0.376±0.003	0.367±0.003	0.348±0.003	0.129±0.007
	Spearman ↑	**0.451±0.003**	0.375±0.006	0.405±0.005	0.404±0.003	0.379±0.004	0.355±0.004	0.114±0.005
	RMSE ↓	3.554±0.007	3.410±0.006	**3.214±0.021**	3.380±0.006	3.623±0.002	3.367±0.014	3.844±0.024
HEG100	PCC ↑	0.402±0.002	0.353±0.007	**0.414±0.010**	0.343±0.004	0.348±0.001	0.321±0.004	0.144±0.010
	Spearman ↑	**0.414±0.002**	0.358±0.009	0.380±0.007	0.353±0.003	0.346±0.001	0.315±0.004	0.129±0.011
	RMSE ↓	3.107±0.006	2.911±0.007	**2.804±0.021**	2.979±0.006	3.284±0.004	2.897±0.007	3.386±0.017
CancerCore89	PCC ↑	0.208±0.004	**0.224±0.003**	0.167±0.003	0.140±0.003	0.118±0.011	0.078±0.003	0.121±0.011
	Spearman ↑	**0.226±0.004**	0.224±0.006	0.168±0.002	0.136±0.003	0.110±0.004	0.082±0.003	0.106±0.009
	RMSE ↓	5.849±0.034	**5.275±0.014**	5.498±0.076	5.735±0.009	5.620±0.048	5.405±0.008	5.785±0.044

Table S66: TENX147 — Colon — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.205±0.012	**0.238±0.003**	0.167±0.005	0.103±0.010	0.118±0.012	0.082±0.007	0.132±0.009
	Spearman ↑	0.181±0.011	**0.212±0.004**	0.139±0.003	0.076±0.004	0.107±0.006	0.076±0.007	0.112±0.011
	RMSE ↓	4.057±0.262	3.676±0.072	4.072±0.223	4.699±0.378	4.333±0.790	**3.174±0.389**	4.488±0.212
HVG50	PCC ↑	0.271±0.010	**0.286±0.005**	0.221±0.009	0.170±0.006	0.174±0.013	0.137±0.012	0.147±0.008
	Spearman ↑	0.229±0.011	**0.250±0.004**	0.175±0.011	0.125±0.006	0.153±0.013	0.118±0.009	0.123±0.007
	RMSE ↓	3.046±0.056	2.789±0.072	3.332±0.050	3.309±0.278	3.518±0.041	**2.496±0.057**	3.455±0.088
HVG100	PCC ↑	**0.311±0.004**	0.302±0.010	0.282±0.004	0.226±0.007	0.200±0.004	0.173±0.006	0.157±0.009
	Spearman ↑	0.257±0.004	**0.261±0.007**	0.212±0.004	0.168±0.006	0.177±0.005	0.145±0.005	0.134±0.010
	RMSE ↓	2.403±0.056	2.351±0.017	2.503±0.062	2.362±0.218	3.064±0.035	**1.936±0.025**	2.772±0.076
SVG20	PCC ↑	0.483±0.029	0.488±0.022	0.236±0.042	0.492±0.045	**0.529±0.019**	0.449±0.023	0.212±0.029
	Spearman ↑	0.522±0.028	0.496±0.025	0.295±0.032	0.469±0.043	**0.533±0.018**	0.452±0.020	0.186±0.026
	RMSE ↓	3.815±0.103	3.475±0.077	4.191±0.054	**3.238±0.160**	3.762±0.136	3.464±0.074	4.319±0.023
SVG50	PCC ↑	0.493±0.011	0.451±0.007	0.394±0.037	0.442±0.009	**0.494±0.010**	0.425±0.010	0.229±0.006
	Spearman ↑	**0.506±0.009**	0.453±0.005	0.396±0.026	0.425±0.009	0.478±0.007	0.412±0.009	0.205±0.010
	RMSE ↓	3.056±0.035	2.951±0.034	3.288±0.090	2.999±0.018	3.240±0.048	**2.826±0.044**	3.724±0.043
SVG100	PCC ↑	**0.460±0.003**	0.414±0.008	0.439±0.006	0.402±0.005	0.432±0.002	0.383±0.005	0.195±0.011
	Spearman ↑	**0.459±0.003**	0.406±0.008	0.400±0.007	0.380±0.005	0.422±0.002	0.365±0.005	0.174±0.010
	RMSE ↓	2.716±0.004	2.617±0.010	2.688±0.005	2.650±0.008	3.005±0.004	**2.526±0.006**	3.221±0.006
HEG20	PCC ↑	**0.485±0.001**	0.369±0.004	0.433±0.013	0.425±0.007	0.400±0.002	0.367±0.009	0.172±0.008
	Spearman ↑	**0.518±0.002**	0.395±0.008	0.447±0.013	0.478±0.007	0.416±0.002	0.404±0.010	0.156±0.010
	RMSE ↓	3.876±0.007	3.721±0.016	**3.379±0.019**	3.631±0.016	4.013±0.009	3.704±0.027	4.155±0.035
HEG50	PCC ↑	0.450±0.002	0.367±0.004	**0.457±0.008**	0.398±0.005	0.396±0.003	0.370±0.002	0.170±0.018
	Spearman ↑	**0.468±0.002**	0.378±0.005	0.438±0.011	0.423±0.005	0.395±0.003	0.375±0.002	0.154±0.018
	RMSE ↓	3.381±0.005	3.229±0.005	**2.952±0.024**	3.214±0.010	3.507±0.008	3.181±0.013	3.661±0.016
HEG100	PCC ↑	0.423±0.002	0.361±0.004	**0.454±0.008**	0.367±0.006	0.366±0.002	0.356±0.003	0.173±0.009
	Spearman ↑	**0.432±0.001**	0.362±0.005	0.419±0.008	0.374±0.005	0.363±0.002	0.348±0.003	0.156±0.008
	RMSE ↓	3.008±0.005	2.815±0.006	**2.674±0.006**	2.879±0.010	3.216±0.004	2.770±0.028	3.256±0.016
CancerCore89	PCC ↑	0.244±0.001	0.237±0.001	**0.245±0.005**	0.192±0.007	0.196±0.008	0.130±0.007	0.163±0.007
	Spearman ↑	**0.269±0.002**	0.254±0.001	0.253±0.003	0.198±0.006	0.210±0.018	0.143±0.006	0.153±0.011
	RMSE ↓	5.908±0.006	**5.406±0.010**	5.548±0.054	5.816±0.021	5.830±0.007	5.492±0.018	5.895±0.034

Table S67: TENX114 — Colon — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.175±0.004	**0.226±0.005**	0.153±0.008	0.074±0.020	0.086±0.017	0.077±0.014	0.128±0.002
	Spearman ↑	0.141±0.005	**0.190±0.013**	0.135±0.004	0.058±0.015	0.075±0.021	0.068±0.013	0.110±0.002
	RMSE ↓	3.587±0.125	3.606±0.147	3.567±0.204	4.549±0.173	3.195±0.434	**2.525±0.109**	3.969±0.198
HVG50	PCC ↑	0.220±0.007	**0.289±0.017**	0.187±0.009	0.102±0.014	0.105±0.008	0.096±0.012	0.131±0.003
	Spearman ↑	0.169±0.006	**0.248±0.016**	0.157±0.008	0.078±0.013	0.102±0.009	0.089±0.011	0.113±0.003
	RMSE ↓	2.739±0.042	2.592±0.212	2.819±0.093	3.310±0.114	2.674±0.104	**1.915±0.055**	3.013±0.113
HVG100	PCC ↑	0.274±0.005	**0.303±0.011**	0.227±0.013	0.146±0.011	0.130±0.007	0.130±0.006	0.140±0.005
	Spearman ↑	0.203±0.006	**0.264±0.011**	0.188±0.010	0.114±0.011	0.125±0.008	0.117±0.007	0.121±0.006
	RMSE ↓	2.011±0.139	2.317±0.013	2.121±0.112	2.275±0.123	2.329±0.105	**1.608±0.115**	2.242±0.143
SVG20	PCC ↑	0.367±0.017	**0.467±0.003**	0.122±0.020	0.318±0.008	0.311±0.003	0.294±0.008	0.155±0.017
	Spearman ↑	0.415±0.018	**0.485±0.005**	0.184±0.019	0.275±0.008	0.343±0.004	0.318±0.010	0.139±0.014
	RMSE ↓	4.135±0.032	**3.508±0.015**	4.362±0.016	3.829±0.044	4.293±0.010	3.883±0.016	4.440±0.037
SVG50	PCC ↑	0.449±0.003	**0.457±0.003**	0.290±0.008	0.398±0.011	0.445±0.007	0.400±0.007	0.167±0.016
	Spearman ↑	**0.462±0.003**	0.461±0.002	0.305±0.009	0.373±0.010	0.450±0.005	0.393±0.007	0.148±0.017
	RMSE ↓	3.217±0.009	**2.914±0.028**	3.523±0.019	3.005±0.026	3.152±0.008	2.951±0.044	3.777±0.023
SVG100	PCC ↑	**0.426±0.003**	0.413±0.003	0.398±0.002	0.392±0.008	0.381±0.003	0.354±0.002	0.184±0.008
	Spearman ↑	**0.425±0.005**	0.402±0.005	0.369±0.003	0.342±0.007	0.392±0.004	0.337±0.003	0.168±0.011
	RMSE ↓	2.702±0.023	2.511±0.027	2.776±0.037	**2.463±0.038**	2.843±0.023	2.527±0.014	3.196±0.031
HEG20	PCC ↑	**0.429±0.008**	0.331±0.004	0.382±0.014	0.369±0.012	0.379±0.012	0.333±0.012	0.201±0.017
	Spearman ↑	**0.461±0.010**	0.365±0.005	0.401±0.013	0.429±0.011	0.407±0.013	0.361±0.013	0.187±0.019
	RMSE ↓	3.890±0.037	3.734±0.038	**3.527±0.030**	3.630±0.041	3.910±0.039	3.812±0.031	3.997±0.023
HEG50	PCC ↑	**0.399±0.001**	0.328±0.007	0.384±0.006	0.344±0.002	0.346±0.002	0.290±0.004	0.178±0.012
	Spearman ↑	**0.416±0.001**	0.343±0.011	0.377±0.006	0.364±0.002	0.360±0.003	0.299±0.004	0.158±0.013
	RMSE ↓	3.440±0.005	3.267±0.012	**3.150±0.029**	3.230±0.010	3.503±0.006	3.391±0.022	3.631±0.011
HEG100	PCC ↑	0.398±0.001	0.351±0.005	**0.402±0.002**	0.354±0.002	0.350±0.001	0.300±0.002	0.184±0.005
	Spearman ↑	**0.404±0.001**	0.354±0.007	0.381±0.004	0.345±0.002	0.357±0.001	0.296±0.002	0.166±0.008
	RMSE ↓	2.998±0.005	2.832±0.014	2.845±0.023	**2.819±0.008**	3.097±0.008	2.943±0.014	3.236±0.012

Table S68: TENX125 — Lymphoid — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.131±0.012	**0.137±0.010**	0.109±0.015	0.062±0.012	0.069±0.025	0.024±0.015	0.120±0.009
	Spearman ↑	0.123±0.013	**0.132±0.012**	0.099±0.009	0.049±0.013	0.056±0.018	0.024±0.011	0.102±0.008
	RMSE ↓	4.428±0.222	3.881±0.122	4.079±0.153	5.052±0.195	4.753±0.271	**3.523±0.314**	4.349±0.175
HVG50	PCC ↑	**0.167±0.010**	0.151±0.008	0.132±0.010	0.101±0.016	0.102±0.007	0.048±0.008	0.123±0.003
	Spearman ↑	**0.148±0.009**	0.136±0.008	0.107±0.007	0.071±0.009	0.078±0.006	0.041±0.005	0.103±0.004
	RMSE ↓	3.314±0.088	2.733±0.180	3.256±0.135	3.352±0.276	3.899±0.042	**2.634±0.186**	3.288±0.050
HVG100	PCC ↑	0.203±0.006	0.168±0.005	**0.203±0.005**	0.143±0.008	0.109±0.005	0.063±0.004	0.128±0.002
	Spearman ↑	**0.167±0.005**	0.151±0.005	0.150±0.002	0.095±0.006	0.082±0.004	0.048±0.003	0.107±0.002
	RMSE ↓	2.343±0.053	2.173±0.028	2.125±0.106	1.990±0.044	3.379±0.040	**1.825±0.070**	2.486±0.059
SVG20	PCC ↑	**0.397±0.002**	0.245±0.006	0.351±0.010	0.350±0.006	0.336±0.006	0.171±0.006	0.129±0.009
	Spearman ↑	**0.405±0.002**	0.264±0.010	0.326±0.009	0.363±0.004	0.319±0.003	0.159±0.002	0.109±0.009
	RMSE ↓	3.997±0.031	3.753±0.046	**3.633±0.010**	3.670±0.061	4.111±0.048	3.879±0.056	4.190±0.023
SVG50	PCC ↑	**0.369±0.003**	0.234±0.004	0.358±0.007	0.326±0.004	0.308±0.004	0.173±0.005	0.149±0.011
	Spearman ↑	**0.358±0.003**	0.235±0.006	0.313±0.005	0.313±0.003	0.275±0.004	0.149±0.004	0.128±0.011
	RMSE ↓	3.440±0.025	3.214±0.020	**3.141±0.017**	3.164±0.031	3.670±0.009	3.336±0.044	3.639±0.026
SVG100	PCC ↑	0.320±0.001	0.194±0.002	**0.327±0.004**	0.275±0.000	0.246±0.001	0.148±0.002	0.140±0.004
	Spearman ↑	**0.304±0.001**	0.192±0.006	0.280±0.004	0.254±0.001	0.219±0.002	0.125±0.002	0.119±0.003
	RMSE ↓	3.096±0.001	2.835±0.017	**2.797±0.012**	2.854±0.003	3.517±0.010	2.965±0.028	3.248±0.016
HEG20	PCC ↑	**0.330±0.001**	0.215±0.001	0.289±0.006	0.267±0.001	0.242±0.001	0.105±0.003	0.125±0.004
	Spearman ↑	**0.360±0.001**	0.247±0.007	0.300±0.006	0.323±0.001	0.268±0.001	0.125±0.002	0.104±0.003
	RMSE ↓	3.919±0.002	3.828±0.007	**3.525±0.008**	3.842±0.004	3.987±0.003	3.916±0.017	3.886±0.009
HEG50	PCC ↑	**0.312±0.000**	0.187±0.005	0.285±0.002	0.244±0.001	0.238±0.001	0.105±0.003	0.127±0.003
	Spearman ↑	**0.326±0.001**	0.206±0.010	0.283±0.003	0.284±0.001	0.241±0.001	0.119±0.002	0.108±0.004
	RMSE ↓	3.735±0.001	3.559±0.010	**3.313±0.012**	3.638±0.001	3.847±0.006	3.688±0.011	3.719±0.003
HEG100	PCC ↑	**0.294±0.000**	0.165±0.004	0.283±0.004	0.224±0.000	0.217±0.001	0.108±0.004	0.124±0.003
	Spearman ↑	**0.294±0.001**	0.176±0.008	0.263±0.004	0.243±0.001	0.208±0.001	0.109±0.003	0.106±0.004
	RMSE ↓	3.377±0.001	3.130±0.019	**2.967±0.013**	3.224±0.004	3.599±0.003	3.252±0.027	3.400±0.005

Table S69: TENX124 — Lymphoid — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.150±0.008**	0.146±0.011	0.135±0.002	0.068±0.008	0.068±0.009	0.036±0.001	0.119±0.004
	Spearman ↑	**0.135±0.011**	0.127±0.014	0.116±0.003	0.051±0.005	0.070±0.007	0.032±0.001	0.101±0.005
	RMSE ↓	4.085±0.273	3.756±0.199	3.789±0.411	4.741±0.220	4.406±0.361	**3.315±0.325**	4.032±0.324
HVG50	PCC ↑	**0.214±0.007**	0.180±0.007	0.164±0.002	0.145±0.012	0.118±0.011	0.095±0.006	0.130±0.005
	Spearman ↑	**0.178±0.007**	0.149±0.013	0.133±0.003	0.095±0.004	0.100±0.006	0.077±0.004	0.108±0.005
	RMSE ↓	2.834±0.091	2.493±0.059	2.982±0.191	2.630±0.014	3.708±0.105	**2.314±0.129**	2.989±0.145
HVG100	PCC ↑	**0.224±0.005**	0.179±0.008	0.190±0.005	0.152±0.008	0.117±0.005	0.098±0.006	0.130±0.004
	Spearman ↑	**0.172±0.006**	0.142±0.013	0.143±0.004	0.092±0.006	0.091±0.005	0.072±0.004	0.108±0.004
	RMSE ↓	2.177±0.059	2.124±0.049	2.165±0.069	2.028±0.032	3.222±0.091	**1.762±0.080**	2.354±0.078
SVG20	PCC ↑	**0.425±0.011**	0.294±0.010	0.343±0.011	0.406±0.012	0.374±0.006	0.296±0.009	0.179±0.007
	Spearman ↑	**0.413±0.013**	0.273±0.007	0.306±0.013	0.354±0.016	0.323±0.005	0.242±0.007	0.156±0.007
	RMSE ↓	3.838±0.038	3.472±0.042	3.915±0.063	**3.339±0.030**	3.948±0.030	3.657±0.062	4.491±0.062
SVG50	PCC ↑	**0.405±0.004**	0.296±0.006	0.355±0.004	0.367±0.003	0.335±0.004	0.276±0.003	0.181±0.008
	Spearman ↑	**0.390±0.004**	0.271±0.005	0.324±0.004	0.333±0.005	0.302±0.006	0.227±0.004	0.159±0.007
	RMSE ↓	3.311±0.021	3.047±0.015	3.231±0.007	**3.036±0.027**	3.589±0.006	3.211±0.028	3.699±0.019
SVG100	PCC ↑	**0.364±0.002**	0.250±0.005	0.326±0.004	0.312±0.002	0.283±0.003	0.220±0.005	0.158±0.003
	Spearman ↑	**0.346±0.002**	0.226±0.005	0.291±0.003	0.284±0.002	0.255±0.002	0.186±0.006	0.137±0.003
	RMSE ↓	3.030±0.005	**2.800±0.017**	2.856±0.011	2.847±0.006	3.405±0.008	2.975±0.019	3.286±0.016
HEG20	PCC ↑	**0.389±0.001**	0.258±0.003	0.289±0.009	0.320±0.000	0.276±0.001	0.200±0.004	0.127±0.005
	Spearman ↑	**0.427±0.000**	0.267±0.006	0.310±0.009	0.384±0.000	0.287±0.002	0.225±0.002	0.102±0.003
	RMSE ↓	3.921±0.003	3.735±0.034	**3.500±0.006**	3.741±0.008	4.054±0.007	3.962±0.012	3.972±0.021
HEG50	PCC ↑	**0.365±0.000**	0.240±0.002	0.294±0.001	0.297±0.001	0.282±0.002	0.191±0.001	0.138±0.003
	Spearman ↑	**0.386±0.000**	0.245±0.005	0.298±0.001	0.339±0.001	0.288±0.001	0.200±0.002	0.114±0.002
	RMSE ↓	3.632±0.001	3.425±0.017	**3.250±0.008**	3.486±0.001	3.781±0.007	3.637±0.026	3.684±0.012
HEG100	PCC ↑	**0.336±0.001**	0.213±0.003	0.298±0.003	0.269±0.001	0.251±0.001	0.176±0.002	0.140±0.003
	Spearman ↑	**0.342±0.001**	0.211±0.004	0.281±0.002	0.285±0.001	0.248±0.001	0.169±0.003	0.119±0.002
	RMSE ↓	3.251±0.002	3.004±0.024	**2.912±0.007**	3.098±0.006	3.487±0.009	3.195±0.008	3.334±0.008

Table S70: TENX143 — Lymphoid — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.081±0.013	0.099±0.004	0.115±0.002	0.012±0.004	0.004±0.003	0.010±0.001	**0.119±0.003**
	Spearman ↑	0.068±0.004	0.089±0.005	0.098±0.002	0.010±0.003	0.003±0.002	0.010±0.002	**0.102±0.003**
	RMSE ↓	4.134±0.399	4.237±0.147	3.871±0.411	5.000±0.500	3.142±1.213	**2.238±0.427**	4.646±0.336
HVG50	PCC ↑	0.097±0.007	0.104±0.006	0.119±0.003	0.007±0.002	0.003±0.003	0.008±0.001	**0.121±0.001**
	Spearman ↑	0.069±0.004	0.089±0.008	0.098±0.002	0.006±0.002	0.002±0.003	0.008±0.000	**0.103±0.001**
	RMSE ↓	3.701±0.505	3.475±0.097	3.282±0.344	4.445±0.309	4.008±0.878	**1.886±0.362**	3.981±0.325
HVG100	PCC ↑	0.107±0.004	0.106±0.005	**0.124±0.002**	0.007±0.002	0.005±0.001	0.010±0.001	0.120±0.001
	Spearman ↑	0.070±0.003	0.085±0.006	0.100±0.001	0.006±0.001	0.004±0.001	0.010±0.001	**0.103±0.000**
	RMSE ↓	2.725±0.152	2.777±0.102	2.434±0.095	3.492±0.162	3.250±0.451	**1.425±0.145**	2.995±0.136
SVG20	PCC ↑	0.149±0.007	0.091±0.007	**0.193±0.011**	0.107±0.006	0.032±0.011	0.060±0.011	0.121±0.016
	Spearman ↑	0.164±0.008	0.087±0.008	**0.184±0.011**	0.113±0.009	0.031±0.009	0.066±0.008	0.095±0.015
	RMSE ↓	4.997±0.030	4.750±0.055	**4.549±0.063**	4.914±0.044	5.028±0.031	4.987±0.056	4.736±0.035
SVG50	PCC ↑	0.159±0.003	0.095±0.007	**0.194±0.003**	0.106±0.002	0.049±0.010	0.061±0.005	0.129±0.007
	Spearman ↑	0.168±0.004	0.094±0.007	**0.186±0.002**	0.116±0.004	0.053±0.009	0.060±0.008	0.106±0.009
	RMSE ↓	4.370±0.013	4.115±0.043	**3.989±0.023**	4.313±0.011	4.434±0.009	4.348±0.012	4.158±0.017
SVG100	PCC ↑	0.162±0.001	0.088±0.004	**0.191±0.001**	0.102±0.003	0.062±0.003	0.055±0.005	0.125±0.004
	Spearman ↑	0.167±0.001	0.088±0.006	**0.182±0.001**	0.110±0.002	0.069±0.003	0.055±0.004	0.103±0.004
	RMSE ↓	3.862±0.003	3.613±0.031	**3.552±0.018**	3.818±0.003	3.959±0.007	3.841±0.016	3.705±0.008
HEG20	PCC ↑	0.177±0.001	0.090±0.006	**0.215±0.002**	0.131±0.002	0.091±0.002	0.117±0.006	0.117±0.003
	Spearman ↑	0.193±0.001	0.089±0.008	**0.209±0.002**	0.152±0.002	0.093±0.004	0.117±0.004	0.097±0.002
	RMSE ↓	4.029±0.007	3.996±0.004	**3.700±0.004**	3.991±0.005	4.065±0.005	4.040±0.014	3.868±0.005
HEG50	PCC ↑	0.163±0.002	0.080±0.005	**0.195±0.002**	0.105±0.001	0.071±0.000	0.087±0.010	0.131±0.006
	Spearman ↑	0.169±0.001	0.078±0.005	**0.185±0.002**	0.117±0.001	0.073±0.001	0.087±0.006	0.108±0.006
	RMSE ↓	3.828±0.004	3.729±0.016	**3.568±0.006**	3.804±0.002	3.884±0.004	3.821±0.013	3.664±0.004
HEG100	PCC ↑	0.160±0.001	0.076±0.004	**0.187±0.001**	0.095±0.002	0.059±0.002	0.075±0.005	0.123±0.001
	Spearman ↑	0.161±0.001	0.077±0.005	**0.177±0.001**	0.103±0.002	0.063±0.001	0.074±0.003	0.102±0.002
	RMSE ↓	3.542±0.003	3.426±0.014	**3.314±0.009**	3.522±0.003	3.625±0.001	3.536±0.022	3.389±0.004

Table S71: TENX133 — Lymphoid — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.157±0.004	**0.168±0.021**	0.137±0.006	0.015±0.007	0.028±0.008	0.020±0.008	0.121±0.002
	Spearman ↑	**0.131±0.010**	0.123±0.023	0.114±0.003	0.013±0.006	0.027±0.009	0.020±0.009	0.104±0.003
	RMSE ↓	4.939±0.171	**2.887±0.073**	3.970±1.491	5.852±0.023	6.021±0.091	4.781±0.324	5.248±0.097
HVG50	PCC ↑	**0.178±0.002**	0.176±0.026	0.147±0.003	0.019±0.007	0.021±0.008	0.016±0.011	0.119±0.001
	Spearman ↑	**0.146±0.003**	0.121±0.031	0.122±0.003	0.014±0.006	0.020±0.009	0.015±0.010	0.101±0.001
	RMSE ↓	4.094±0.117	**2.503±0.126**	3.283±1.051	4.900±0.035	5.010±0.060	3.787±0.129	4.331±0.048
HVG100	PCC ↑	**0.191±0.002**	0.182±0.025	0.151±0.002	0.019±0.005	0.015±0.005	0.012±0.012	0.120±0.002
	Spearman ↑	**0.152±0.003**	0.130±0.029	0.125±0.003	0.013±0.004	0.014±0.005	0.008±0.012	0.102±0.002
	RMSE ↓	3.479±0.070	**2.283±0.097**	2.846±0.828	4.121±0.055	4.231±0.112	2.901±0.197	3.489±0.066
SVG20	PCC ↑	**0.242±0.002**	0.186±0.031	0.202±0.003	0.136±0.003	0.138±0.002	0.089±0.009	0.124±0.006
	Spearman ↑	**0.268±0.002**	0.196±0.049	0.195±0.003	0.142±0.003	0.146±0.003	0.092±0.010	0.106±0.005
	RMSE ↓	5.147±0.021	**4.387±0.068**	4.573±0.046	4.991±0.008	5.196±0.036	4.848±0.040	5.062±0.041
SVG50	PCC ↑	**0.225±0.001**	0.185±0.028	0.198±0.002	0.098±0.001	0.103±0.003	0.067±0.007	0.122±0.006
	Spearman ↑	**0.242±0.001**	0.182±0.041	0.185±0.003	0.098±0.001	0.107±0.003	0.066±0.008	0.104±0.006
	RMSE ↓	4.335±0.017	**3.685±0.029**	3.921±0.010	4.343±0.016	4.535±0.017	4.069±0.091	4.333±0.042
SVG100	PCC ↑	**0.216±0.001**	0.185±0.025	0.182±0.006	0.067±0.001	0.071±0.002	0.053±0.006	0.122±0.001
	Spearman ↑	**0.222±0.002**	0.171±0.034	0.162±0.014	0.063±0.001	0.071±0.002	0.051±0.007	0.103±0.002
	RMSE ↓	3.647±0.036	**3.073±0.071**	3.188±0.465	3.792±0.011	3.998±0.046	3.403±0.157	3.707±0.010
HEG20	PCC ↑	**0.246±0.002**	0.174±0.043	0.204±0.007	0.139±0.002	0.131±0.003	0.091±0.006	0.121±0.005
	Spearman ↑	**0.269±0.002**	0.179±0.065	0.194±0.009	0.143±0.002	0.138±0.005	0.094±0.006	0.102±0.007
	RMSE ↓	5.185±0.006	**4.540±0.098**	4.590±0.065	4.984±0.015	5.306±0.031	4.942±0.059	5.187±0.028
HEG50	PCC ↑	**0.228±0.002**	0.183±0.029	0.198±0.002	0.101±0.003	0.105±0.003	0.074±0.003	0.123±0.002
	Spearman ↑	**0.245±0.002**	0.181±0.042	0.184±0.002	0.100±0.003	0.108±0.004	0.075±0.003	0.104±0.001
	RMSE ↓	4.401±0.012	**3.774±0.075**	3.969±0.009	4.351±0.013	4.618±0.004	4.185±0.116	4.413±0.015
HEG100	PCC ↑	**0.217±0.001**	0.184±0.023	0.185±0.001	0.071±0.001	0.072±0.002	0.055±0.002	0.122±0.004
	Spearman ↑	**0.228±0.002**	0.175±0.033	0.170±0.001	0.067±0.001	0.072±0.002	0.053±0.002	0.103±0.005
	RMSE ↓	3.747±0.008	**3.193±0.055**	3.470±0.014	3.823±0.015	4.088±0.014	3.523±0.060	3.724±0.035

Table S72: TENX160 — Ovary — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.225±0.004	**0.260±0.010**	0.166±0.010	0.074±0.004	0.107±0.004	0.071±0.020	0.133±0.009
	Spearman ↑	0.223±0.007	**0.229±0.009**	0.148±0.015	0.065±0.003	0.097±0.009	0.070±0.017	0.111±0.006
	RMSE ↓	4.238±0.085	**3.505±0.019**	3.950±0.079	4.871±0.332	3.905±0.133	3.737±0.212	4.313±0.135
HVG50	PCC ↑	0.227±0.003	**0.255±0.002**	0.163±0.003	0.062±0.004	0.086±0.003	0.062±0.006	0.128±0.003
	Spearman ↑	0.196±0.006	**0.222±0.002**	0.139±0.004	0.057±0.004	0.086±0.002	0.063±0.006	0.108±0.003
	RMSE ↓	2.996±0.191	**2.491±0.003**	2.871±0.233	3.226±0.212	2.765±0.241	2.499±0.190	3.188±0.206
HVG100	PCC ↑	0.244±0.004	**0.267±0.006**	0.181±0.008	0.121±0.006	0.110±0.003	0.076±0.006	0.128±0.003
	Spearman ↑	0.201±0.002	**0.232±0.005**	0.152±0.007	0.096±0.005	0.103±0.003	0.074±0.007	0.107±0.004
	RMSE ↓	2.377±0.055	2.218±0.007	2.282±0.066	2.382±0.006	2.321±0.033	**1.935±0.067**	2.550±0.079
SVG20	PCC ↑	**0.348±0.001**	0.341±0.005	0.235±0.007	0.237±0.014	0.336±0.003	0.167±0.003	0.144±0.008
	Spearman ↑	**0.349±0.002**	0.310±0.005	0.216±0.006	0.208±0.013	0.301±0.004	0.156±0.002	0.126±0.006
	RMSE ↓	4.321±0.055	**3.732±0.011**	4.615±0.035	4.097±0.040	4.017±0.037	3.759±0.107	4.877±0.028
SVG50	PCC ↑	**0.367±0.007**	0.338±0.007	0.255±0.007	0.318±0.007	0.335±0.010	0.178±0.007	0.141±0.008
	Spearman ↑	**0.357±0.007**	0.308±0.006	0.226±0.007	0.283±0.006	0.299±0.008	0.166±0.008	0.122±0.008
	RMSE ↓	3.405±0.058	**3.006±0.012**	3.586±0.070	3.131±0.012	3.315±0.074	3.128±0.037	3.811±0.053
SVG100	PCC ↑	**0.452±0.013**	0.377±0.017	0.387±0.017	0.358±0.017	0.415±0.010	0.264±0.010	0.172±0.012
	Spearman ↑	**0.427±0.008**	0.343±0.016	0.339±0.015	0.319±0.016	0.369±0.009	0.240±0.009	0.151±0.012
	RMSE ↓	2.441±0.136	**2.269±0.023**	2.387±0.148	2.344±0.023	2.517±0.109	2.382±0.106	2.820±0.129
HEG20	PCC ↑	**0.321±0.001**	0.275±0.012	0.275±0.009	0.294±0.012	0.295±0.002	0.203±0.011	0.138±0.015
	Spearman ↑	**0.468±0.001**	0.332±0.011	0.341±0.006	0.379±0.011	0.330±0.001	0.222±0.002	0.128±0.008
	RMSE ↓	2.040±0.006	2.050±0.013	2.011±0.015	**1.991±0.013**	2.046±0.004	2.078±0.011	2.050±0.016
HEG50	PCC ↑	**0.337±0.003**	0.296±0.010	0.301±0.004	0.301±0.010	0.291±0.001	0.211±0.012	0.155±0.004
	Spearman ↑	**0.447±0.003**	0.336±0.010	0.345±0.002	0.361±0.010	0.330±0.002	0.229±0.005	0.122±0.001
	RMSE ↓	2.010±0.004	1.978±0.012	**1.953±0.003**	1.959±0.012	2.037±0.003	2.045±0.012	2.048±0.005
HEG100	PCC ↑	**0.343±0.001**	0.301±0.007	0.320±0.004	0.280±0.007	0.297±0.003	0.214±0.007	0.173±0.007
	Spearman ↑	**0.420±0.001**	0.325±0.007	0.342±0.004	0.318±0.007	0.323±0.003	0.227±0.004	0.137±0.007
	RMSE ↓	1.967±0.004	1.899±0.008	**1.896±0.005**	1.924±0.008	2.001±0.005	2.001±0.004	1.988±0.005
CancerCore89	PCC ↑	0.256±0.000	**0.279±0.004**	0.225±0.002	0.133±0.011	0.163±0.003	0.127±0.004	0.161±0.006
	Spearman ↑	**0.267±0.000**	0.266±0.003	0.212±0.001	0.131±0.006	0.167±0.002	0.123±0.003	0.130±0.006
	RMSE ↓	3.208±0.002	**2.899±0.006**	3.029±0.005	3.280±0.017	3.210±0.008	3.029±0.005	3.173±0.010

Table S73: X5K-OV — Ovary — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.082±0.015	**0.210±0.010**	0.131±0.005	0.040±0.026	0.008±0.006	0.004±0.003	0.124±0.001
	Spearman ↑	0.075±0.013	**0.177±0.009**	0.113±0.005	0.039±0.026	0.009±0.006	0.004±0.003	0.106±0.001
	RMSE ↓	4.735±0.243	**3.968±0.020**	4.031±0.078	4.885±0.673	5.915±0.151	4.237±0.403	4.603±0.157
HVG50	PCC ↑	0.093±0.013	**0.206±0.007**	0.139±0.006	0.051±0.012	0.006±0.003	0.003±0.003	0.122±0.001
	Spearman ↑	0.086±0.012	**0.175±0.006**	0.122±0.006	0.052±0.012	0.007±0.004	0.004±0.003	0.105±0.001
	RMSE ↓	3.893±0.258	**3.374±0.012**	3.473±0.210	3.748±0.278	5.132±0.042	3.760±0.299	3.797±0.255
HVG100	PCC ↑	0.107±0.009	**0.197±0.004**	0.141±0.004	0.057±0.006	0.008±0.002	0.002±0.002	0.123±0.001
	Spearman ↑	0.097±0.008	**0.170±0.003**	0.125±0.004	0.056±0.006	0.008±0.001	0.002±0.001	0.105±0.001
	RMSE ↓	3.311±0.204	3.247±0.006	**3.059±0.190**	3.092±0.244	4.445±0.031	3.271±0.214	3.179±0.202
SVG20	PCC ↑	0.189±0.011	**0.190±0.013**	0.176±0.012	0.153±0.017	0.015±0.011	0.010±0.011	0.128±0.007
	Spearman ↑	**0.159±0.016**	0.158±0.012	0.158±0.008	0.118±0.011	0.020±0.012	0.009±0.011	0.110±0.007
	RMSE ↓	4.243±0.290	3.793±0.026	3.846±0.290	**3.646±0.434**	5.428±0.438	4.330±0.284	4.211±0.308
SVG50	PCC ↑	**0.190±0.009**	0.162±0.009	0.189±0.008	0.142±0.009	0.020±0.007	0.013±0.014	0.126±0.002
	Spearman ↑	0.163±0.012	0.139±0.008	**0.167±0.005**	0.112±0.011	0.022±0.009	0.013±0.014	0.108±0.001
	RMSE ↓	3.504±0.184	3.239±0.014	3.273±0.238	**3.108±0.352**	4.694±0.326	3.595±0.166	3.470±0.173
SVG100	PCC ↑	0.180±0.015	0.138±0.012	**0.185±0.011**	0.131±0.009	0.022±0.010	0.010±0.014	0.125±0.002
	Spearman ↑	0.157±0.014	0.122±0.010	**0.163±0.008**	0.102±0.012	0.021±0.008	0.009±0.014	0.107±0.002
	RMSE ↓	3.156±0.133	2.972±0.016	2.985±0.175	**2.929±0.258**	4.114±0.244	3.239±0.096	3.080±0.099
HEG20	PCC ↑	**0.187±0.002**	0.112±0.003	0.144±0.004	0.138±0.008	0.012±0.002	0.005±0.006	0.124±0.003
	Spearman ↑	**0.241±0.002**	0.116±0.003	0.154±0.005	0.114±0.004	0.009±0.003	0.007±0.007	0.107±0.003
	RMSE ↓	2.932±0.027	2.957±0.004	2.840±0.030	2.971±0.023	3.014±0.030	2.965±0.030	**2.824±0.027**
HEG50	PCC ↑	**0.183±0.003**	0.110±0.002	0.159±0.001	0.150±0.002	0.018±0.002	0.003±0.004	0.121±0.001
	Spearman ↑	**0.208±0.003**	0.107±0.001	0.157±0.002	0.107±0.005	0.016±0.002	0.005±0.003	0.104±0.001
	RMSE ↓	2.853±0.021	2.829±0.002	**2.715±0.020**	2.861±0.006	2.967±0.022	2.888±0.021	2.745±0.022
HEG100	PCC ↑	**0.188±0.003**	0.127±0.002	0.175±0.003	0.145±0.009	0.016±0.001	0.001±0.003	0.121±0.001
	Spearman ↑	**0.197±0.003**	0.119±0.002	0.163±0.002	0.108±0.007	0.015±0.001	0.001±0.002	0.104±0.001
	RMSE ↓	2.742±0.015	2.661±0.003	**2.594±0.013**	2.740±0.004	2.897±0.015	2.796±0.023	2.645±0.017
CancerCore89	PCC ↑	0.095±0.001	**0.144±0.001**	0.133±0.001	0.046±0.002	0.001±0.002	0.000±0.001	0.121±0.001
	Spearman ↑	0.093±0.001	**0.132±0.001**	0.122±0.001	0.044±0.002	0.003±0.002	0.000±0.001	0.104±0.001
	RMSE ↓	3.658±0.003	3.443±0.002	**3.433±0.009**	3.457±0.034	4.381±0.005	3.665±0.017	3.481±0.005

Table S74: TENX187 — Ovary — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.158±0.015	**0.224±0.005**	0.123±0.001	0.046±0.007	0.046±0.008	0.055±0.008	0.123±0.006
	Spearman ↑	0.163±0.011	**0.194±0.005**	0.104±0.002	0.037±0.008	0.045±0.008	0.056±0.006	0.104±0.006
	RMSE ↓	5.039±0.205	**4.114±0.011**	4.355±0.140	5.397±0.100	5.048±0.131	4.230±0.130	5.174±0.118
HVG50	PCC ↑	0.185±0.006	**0.220±0.006**	0.136±0.007	0.048±0.006	0.044±0.007	0.058±0.003	0.124±0.003
	Spearman ↑	0.167±0.007	**0.188±0.005**	0.108±0.006	0.036±0.005	0.043±0.008	0.059±0.003	0.105±0.003
	RMSE ↓	3.858±0.063	3.298±0.010	3.382±0.127	4.376±0.068	4.120±0.178	**3.181±0.162**	4.131±0.124
HVG100	PCC ↑	0.183±0.003	**0.208±0.003**	0.137±0.004	0.032±0.004	0.035±0.003	0.051±0.005	0.123±0.004
	Spearman ↑	0.153±0.003	**0.177±0.003**	0.107±0.004	0.023±0.005	0.033±0.004	0.050±0.005	0.103±0.004
	RMSE ↓	3.112±0.064	3.057±0.004	2.784±0.065	3.679±0.093	3.551±0.114	**2.556±0.095**	3.307±0.105
SVG20	PCC ↑	**0.251±0.009**	0.204±0.003	0.022±0.022	0.101±0.005	0.108±0.009	0.181±0.028	0.128±0.009
	Spearman ↑	**0.275±0.011**	0.188±0.003	0.068±0.022	0.100±0.003	0.095±0.009	0.171±0.009	0.091±0.007
	RMSE ↓	4.954±0.015	**4.410±0.007**	4.936±0.029	5.190±0.022	5.211±0.007	4.493±0.078	4.878±0.072
SVG50	PCC ↑	0.309±0.029	0.308±0.048	0.165±0.054	0.140±0.059	0.296±0.067	**0.334±0.030**	0.151±0.016
	Spearman ↑	0.328±0.030	0.299±0.044	0.177±0.044	0.127±0.067	0.306±0.069	**0.328±0.026**	0.126±0.022
	RMSE ↓	3.693±0.124	3.287±0.089	3.732±0.146	4.037±0.171	3.678±0.291	**3.136±0.139**	3.959±0.026
SVG100	PCC ↑	0.329±0.001	0.317±0.002	0.257±0.016	0.209±0.006	0.313±0.004	**0.331±0.004**	0.166±0.005
	Spearman ↑	**0.342±0.002**	0.312±0.002	0.251±0.019	0.210±0.005	0.325±0.003	0.321±0.003	0.139±0.007
	RMSE ↓	3.123±0.009	2.850±0.003	3.095±0.031	3.294±0.019	3.157±0.020	**2.710±0.052**	3.486±0.024
HEG20	PCC ↑	**0.366±0.006**	0.310±0.007	0.333±0.009	0.320±0.004	0.313±0.003	0.306±0.004	0.156±0.023
	Spearman ↑	**0.410±0.006**	0.325±0.006	0.339±0.009	0.339±0.004	0.334±0.003	0.319±0.005	0.125±0.023
	RMSE ↓	3.499±0.016	3.375±0.013	**3.139±0.008**	3.238±0.008	3.396±0.016	3.291±0.023	3.559±0.030
HEG50	PCC ↑	**0.385±0.001**	0.319±0.005	0.354±0.010	0.329±0.004	0.343±0.001	0.330±0.007	0.159±0.007
	Spearman ↑	**0.406±0.001**	0.319±0.005	0.340±0.009	0.322±0.004	0.345±0.003	0.320±0.008	0.140±0.009
	RMSE ↓	3.207±0.004	3.101±0.009	**2.918±0.021**	3.013±0.012	3.164±0.008	2.995±0.035	3.381±0.027
HEG100	PCC ↑	**0.369±0.001**	0.327±0.007	0.345±0.009	0.309±0.002	0.333±0.003	0.326±0.002	0.172±0.014
	Spearman ↑	**0.389±0.001**	0.323±0.006	0.328±0.010	0.300±0.001	0.335±0.003	0.313±0.003	0.149±0.015
	RMSE ↓	2.948±0.003	2.790±0.011	**2.705±0.013**	2.805±0.005	2.964±0.012	2.747±0.037	3.075±0.023
CancerCore89	PCC ↑	**0.210±0.001**	0.201±0.008	0.134±0.005	0.053±0.001	0.058±0.000	0.079±0.007	0.129±0.001
	Spearman ↑	**0.211±0.001**	0.188±0.007	0.123±0.008	0.055±0.001	0.058±0.000	0.076±0.008	0.107±0.001
	RMSE ↓	3.717±0.006	3.471±0.014	**3.447±0.024**	3.979±0.005	3.944±0.009	3.505±0.112	3.804±0.032

Table S75: TENX142 — Ovary — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.170±0.021	**0.237±0.016**	0.152±0.017	0.063±0.021	0.058±0.018	0.038±0.014	0.124±0.002
	Spearman ↑	0.157±0.026	**0.204±0.014**	0.129±0.014	0.051±0.018	0.053±0.019	0.038±0.012	0.105±0.002
	RMSE ↓	4.422±0.187	3.721±0.031	4.437±0.198	5.127±0.333	4.496±0.741	**3.444±0.515**	4.694±0.190
HVG50	PCC ↑	0.206±0.008	**0.257±0.008**	0.177±0.009	0.094±0.010	0.078±0.009	0.063±0.006	0.126±0.002
	Spearman ↑	0.181±0.007	**0.221±0.007**	0.145±0.007	0.072±0.008	0.071±0.004	0.059±0.003	0.109±0.003
	RMSE ↓	3.396±0.126	2.854±0.012	3.323±0.196	3.767±0.167	3.406±0.314	**2.630±0.084**	3.539±0.129
HVG100	PCC ↑	0.223±0.002	**0.258±0.006**	0.195±0.004	0.097±0.005	0.080±0.008	0.070±0.005	0.128±0.004
	Spearman ↑	0.190±0.005	**0.223±0.006**	0.160±0.005	0.076±0.005	0.069±0.006	0.062±0.003	0.111±0.004
	RMSE ↓	2.614±0.058	2.509±0.009	2.426±0.034	2.794±0.027	3.033±0.059	**2.070±0.082**	2.718±0.050
SVG20	PCC ↑	0.284±0.019	**0.313±0.025**	0.218±0.030	0.253±0.016	0.261±0.024	0.245±0.018	0.130±0.007
	Spearman ↑	**0.307±0.014**	0.275±0.024	0.213±0.023	0.232±0.011	0.208±0.029	0.187±0.019	0.110±0.006
	RMSE ↓	4.406±0.051	**3.735±0.055**	3.975±0.042	4.196±0.054	4.309±0.068	4.139±0.062	4.253±0.020
SVG50	PCC ↑	**0.296±0.004**	0.283±0.008	0.253±0.006	0.237±0.006	0.239±0.010	0.225±0.005	0.128±0.001
	Spearman ↑	**0.306±0.003**	0.254±0.007	0.238±0.005	0.220±0.003	0.195±0.006	0.178±0.002	0.108±0.001
	RMSE ↓	3.833±0.009	**3.328±0.014**	3.464±0.012	3.671±0.012	3.801±0.020	3.653±0.016	3.771±0.013
SVG100	PCC ↑	**0.286±0.000**	0.246±0.004	0.263±0.007	0.203±0.001	0.190±0.001	0.185±0.001	0.138±0.006
	Spearman ↑	**0.291±0.001**	0.225±0.004	0.241±0.006	0.188±0.001	0.162±0.002	0.154±0.002	0.114±0.005
	RMSE ↓	3.307±0.022	**2.950±0.007**	3.020±0.020	3.198±0.019	3.356±0.022	3.196±0.024	3.246±0.019
HEG20	PCC ↑	**0.272±0.006**	0.218±0.002	0.204±0.007	0.239±0.001	0.156±0.003	0.168±0.015	0.125±0.004
	Spearman ↑	**0.302±0.004**	0.214±0.001	0.211±0.006	0.232±0.001	0.144±0.004	0.141±0.008	0.104±0.002
	RMSE ↓	3.957±0.019	3.829±0.003	**3.635±0.010**	3.804±0.008	3.932±0.005	3.882±0.027	3.823±0.012
HEG50	PCC ↑	**0.298±0.000**	0.240±0.001	0.265±0.011	0.235±0.001	0.185±0.003	0.185±0.008	0.132±0.003
	Spearman ↑	**0.310±0.001**	0.227±0.001	0.250±0.010	0.225±0.001	0.164±0.003	0.154±0.007	0.112±0.003
	RMSE ↓	3.689±0.010	3.525±0.002	**3.352±0.003**	3.546±0.005	3.691±0.006	3.610±0.012	3.632±0.004
HEG100	PCC ↑	**0.294±0.001**	0.242±0.002	0.276±0.003	0.215±0.002	0.187±0.002	0.179±0.004	0.138±0.003
	Spearman ↑	**0.299±0.000**	0.226±0.002	0.253±0.003	0.204±0.001	0.163±0.002	0.150±0.004	0.116±0.003
	RMSE ↓	3.367±0.007	3.168±0.003	**3.061±0.003**	3.249±0.007	3.425±0.003	3.279±0.020	3.332±0.007
CancerCore89	PCC ↑	0.182±0.009	**0.219±0.003**	0.157±0.005	0.123±0.001	0.100±0.002	0.102±0.003	0.121±0.003
	Spearman ↑	0.199±0.007	**0.205±0.002**	0.153±0.004	0.113±0.002	0.094±0.002	0.086±0.004	0.101±0.001
	RMSE ↓	4.287±0.038	**3.746±0.005**	3.839±0.025	4.170±0.005	4.025±0.016	3.879±0.022	4.014±0.026

Table S76: XV1-KID — Kidney — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.231±0.007	**0.239±0.013**	0.166±0.013	0.118±0.012	0.131±0.009	0.092±0.015	0.134±0.006
	Spearman ↑	**0.214±0.006**	0.174±0.022	0.150±0.009	0.108±0.008	0.129±0.009	0.088±0.014	0.116±0.006
	RMSE ↓	3.963±0.072	**2.901±0.132**	4.470±0.255	4.623±0.203	4.140±0.491	3.144±0.236	4.463±0.093
HVG50	PCC ↑	**0.266±0.009**	0.249±0.013	0.203±0.013	0.152±0.016	0.145±0.013	0.118±0.012	0.140±0.004
	Spearman ↑	**0.237±0.010**	0.193±0.020	0.166±0.010	0.120±0.011	0.139±0.012	0.106±0.009	0.121±0.006
	RMSE ↓	3.154±0.036	2.566±0.033	3.285±0.079	3.290±0.089	3.301±0.081	**2.444±0.039**	3.592±0.104
HVG100	PCC ↑	**0.283±0.002**	0.247±0.010	0.228±0.007	0.162±0.004	0.161±0.005	0.136±0.006	0.138±0.003
	Spearman ↑	**0.246±0.003**	0.199±0.015	0.181±0.006	0.129±0.005	0.147±0.006	0.121±0.006	0.120±0.003
	RMSE ↓	2.330±0.035	**1.977±0.044**	2.243±0.029	2.223±0.037	2.613±0.027	1.994±0.075	2.484±0.026
SVG20	PCC ↑	**0.377±0.006**	0.307±0.014	0.286±0.010	0.334±0.007	0.342±0.006	0.276±0.003	0.142±0.007
	Spearman ↑	**0.393±0.006**	0.288±0.026	0.263±0.011	0.307±0.007	0.331±0.004	0.268±0.002	0.123±0.010
	RMSE ↓	3.594±0.082	**3.097±0.071**	3.676±0.127	3.202±0.063	3.501±0.110	3.367±0.059	3.904±0.102
SVG50	PCC ↑	**0.353±0.001**	0.294±0.015	0.304±0.006	0.287±0.003	0.298±0.003	0.241±0.005	0.153±0.005
	Spearman ↑	**0.348±0.002**	0.266±0.025	0.264±0.005	0.254±0.003	0.281±0.004	0.224±0.005	0.136±0.007
	RMSE ↓	3.108±0.025	**2.720±0.047**	2.986±0.063	2.835±0.007	3.137±0.038	2.870±0.028	3.294±0.042
SVG100	PCC ↑	**0.332±0.002**	0.268±0.012	0.300±0.006	0.253±0.003	0.269±0.003	0.220±0.002	0.146±0.006
	Spearman ↑	**0.324±0.002**	0.246±0.021	0.255±0.007	0.224±0.003	0.252±0.003	0.202±0.001	0.128±0.006
	RMSE ↓	2.899±0.018	**2.571±0.039**	2.683±0.022	2.676±0.017	3.044±0.018	2.674±0.024	3.061±0.018
HEG20	PCC ↑	**0.288±0.001**	0.182±0.012	0.252±0.002	0.207±0.001	0.209±0.002	0.161±0.003	0.124±0.003
	Spearman ↑	**0.320±0.001**	0.188±0.013	0.263±0.002	0.258±0.001	0.231±0.003	0.187±0.002	0.106±0.002
	RMSE ↓	3.886±0.001	3.602±0.008	**3.509±0.016**	3.747±0.005	3.904±0.012	3.852±0.014	3.807±0.015
HEG50	PCC ↑	**0.298±0.000**	0.212±0.013	0.268±0.002	0.220±0.001	0.227±0.002	0.187±0.002	0.128±0.003
	Spearman ↑	**0.314±0.000**	0.212±0.016	0.256±0.001	0.242±0.001	0.231±0.002	0.195±0.002	0.113±0.003
	RMSE ↓	3.614±0.001	3.317±0.016	**3.220±0.019**	3.428±0.011	3.652±0.012	3.513±0.032	3.611±0.028
HEG100	PCC ↑	**0.297±0.000**	0.224±0.014	0.271±0.003	0.208±0.001	0.225±0.001	0.185±0.002	0.134±0.002
	Spearman ↑	**0.303±0.000**	0.221±0.019	0.248±0.003	0.212±0.001	0.224±0.001	0.182±0.001	0.117±0.003
	RMSE ↓	3.252±0.001	2.959±0.022	**2.911±0.011**	3.054±0.006	3.349±0.004	3.100±0.014	3.289±0.008
CancerCore89	PCC ↑	0.197±0.000	**0.198±0.013**	0.179±0.004	0.114±0.001	0.099±0.001	0.060±0.000	0.126±0.003
	Spearman ↑	**0.210±0.001**	0.189±0.016	0.168±0.004	0.111±0.000	0.113±0.001	0.066±0.000	0.110±0.005
	RMSE ↓	4.608±0.007	**4.070±0.048**	4.217±0.069	4.607±0.007	4.300±0.018	4.268±0.001	4.689±0.030

Table S77: TENX105 — Kidney — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.246±0.012	**0.255±0.007**	0.167±0.008	0.101±0.011	0.103±0.021	0.056±0.006	0.135±0.006
	Spearman ↑	**0.217±0.020**	0.203±0.006	0.138±0.006	0.081±0.008	0.095±0.019	0.052±0.006	0.117±0.005
	RMSE ↓	4.062±0.206	3.608±0.109	**2.631±0.248**	5.009±0.080	4.288±0.468	3.564±0.348	4.294±0.311
HVG50	PCC ↑	**0.279±0.008**	0.267±0.010	0.183±0.011	0.128±0.013	0.108±0.020	0.061±0.005	0.142±0.004
	Spearman ↑	**0.241±0.011**	0.228±0.012	0.145±0.009	0.100±0.011	0.103±0.019	0.057±0.005	0.123±0.003
	RMSE ↓	3.373±0.087	3.064±0.032	**2.546±0.151**	3.974±0.069	3.609±0.293	3.013±0.105	3.463±0.050
HVG100	PCC ↑	**0.287±0.001**	0.259±0.005	0.191±0.005	0.121±0.002	0.094±0.010	0.063±0.002	0.141±0.004
	Spearman ↑	**0.240±0.002**	0.225±0.009	0.149±0.003	0.098±0.002	0.087±0.009	0.055±0.002	0.123±0.004
	RMSE ↓	2.784±0.051	2.595±0.075	**2.081±0.040**	3.263±0.026	3.037±0.163	2.500±0.058	2.895±0.034
SVG20	PCC ↑	**0.422±0.002**	0.353±0.005	0.306±0.017	0.350±0.006	0.358±0.008	0.209±0.014	0.158±0.013
	Spearman ↑	**0.449±0.005**	0.335±0.006	0.295±0.017	0.337±0.009	0.380±0.008	0.213±0.015	0.138±0.012
	RMSE ↓	4.262±0.021	**3.705±0.041**	3.962±0.086	3.924±0.018	4.162±0.044	4.085±0.027	4.653±0.026
SVG50	PCC ↑	**0.409±0.002**	0.320±0.004	0.331±0.009	0.326±0.005	0.317±0.007	0.201±0.012	0.158±0.002
	Spearman ↑	**0.429±0.003**	0.309±0.005	0.311±0.010	0.321±0.006	0.330±0.007	0.209±0.012	0.141±0.003
	RMSE ↓	3.652±0.043	3.287±0.050	**3.247±0.042**	3.385±0.030	3.678±0.055	3.566±0.031	3.868±0.039
SVG100	PCC ↑	**0.375±0.000**	0.282±0.004	0.308±0.004	0.270±0.000	0.258±0.002	0.165±0.005	0.151±0.005
	Spearman ↑	**0.383±0.001**	0.270±0.006	0.278±0.004	0.260±0.001	0.260±0.002	0.169±0.005	0.134±0.004
	RMSE ↓	3.228±0.003	2.921±0.017	**2.811±0.011**	3.034±0.010	3.312±0.010	3.200±0.021	3.372±0.016
HEG20	PCC ↑	**0.369±0.005**	0.245±0.003	0.296±0.005	0.274±0.010	0.253±0.011	0.186±0.003	0.139±0.009
	Spearman ↑	**0.406±0.007**	0.251±0.004	0.306±0.006	0.315±0.010	0.272±0.012	0.214±0.004	0.130±0.011
	RMSE ↓	4.264±0.020	3.995±0.025	**3.727±0.013**	4.010±0.025	4.327±0.025	4.243±0.023	4.239±0.015
HEG50	PCC ↑	**0.374±0.001**	0.253±0.005	0.314±0.003	0.275±0.004	0.257±0.005	0.182±0.007	0.140±0.009
	Spearman ↑	**0.400±0.001**	0.256±0.007	0.309±0.004	0.300±0.003	0.272±0.005	0.202±0.005	0.125±0.011
	RMSE ↓	3.776±0.007	3.527±0.017	**3.249±0.009**	3.555±0.010	3.860±0.010	3.763±0.041	3.804±0.023
HEG100	PCC ↑	**0.358±0.001**	0.253±0.004	0.297±0.004	0.245±0.000	0.230±0.002	0.152±0.009	0.138±0.009
	Spearman ↑	**0.375±0.001**	0.251±0.006	0.279±0.004	0.253±0.001	0.237±0.002	0.161±0.008	0.121±0.010
	RMSE ↓	3.375±0.004	3.117±0.021	**2.903±0.014**	3.200±0.004	3.491±0.008	3.385±0.033	3.415±0.015
CancerCore89	PCC ↑	**0.235±0.004**	0.234±0.003	0.147±0.009	0.079±0.005	0.074±0.022	0.027±0.005	0.116±0.008
	Spearman ↑	**0.252±0.003**	0.230±0.004	0.133±0.008	0.074±0.005	0.072±0.021	0.027±0.005	0.098±0.009
	RMSE ↓	5.681±0.050	4.730±0.053	**4.322±0.189**	5.862±0.006	5.259±0.131	5.040±0.079	5.682±0.054

Table S78: TENX106 — Kidney — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.187±0.007	**0.245±0.006**	0.158±0.015	0.052±0.017	0.058±0.017	0.039±0.005	0.120±0.004
	Spearman ↑	0.143±0.020	**0.161±0.004**	0.132±0.013	0.039±0.013	0.054±0.015	0.038±0.006	0.101±0.005
	RMSE ↓	3.923±0.264	**2.844±0.110**	3.969±0.281	5.431±0.165	5.806±0.086	3.895±0.210	4.463±0.347
HVG50	PCC ↑	0.253±0.014	**0.280±0.014**	0.204±0.015	0.101±0.018	0.097±0.010	0.076±0.016	0.119±0.002
	Spearman ↑	0.195±0.009	**0.212±0.022**	0.163±0.011	0.076±0.012	0.086±0.009	0.067±0.014	0.100±0.001
	RMSE ↓	2.937±0.185	2.306±0.088	3.056±0.134	3.846±0.295	3.700±0.639	**2.213±0.368**	3.312±0.235
HVG100	PCC ↑	**0.308±0.011**	0.276±0.003	0.263±0.014	0.159±0.022	0.133±0.016	0.115±0.012	0.122±0.002
	Spearman ↑	**0.232±0.019**	0.222±0.005	0.203±0.011	0.116±0.016	0.119±0.015	0.095±0.008	0.101±0.001
	RMSE ↓	2.148±0.070	2.064±0.051	2.248±0.074	2.451±0.094	2.595±0.091	**1.674±0.109**	2.350±0.079
SVG20	PCC ↑	**0.414±0.008**	0.343±0.023	0.381±0.010	0.405±0.026	0.236±0.018	0.240±0.014	0.127±0.021
	Spearman ↑	**0.415±0.012**	0.336±0.027	0.374±0.009	0.369±0.018	0.240±0.022	0.254±0.011	0.110±0.024
	RMSE ↓	3.938±0.042	3.524±0.021	3.728±0.053	**3.335±0.077**	3.902±0.020	3.685±0.038	4.244±0.066
SVG50	PCC ↑	0.402±0.004	0.333±0.014	**0.419±0.016**	0.377±0.004	0.288±0.004	0.238±0.004	0.128±0.010
	Spearman ↑	**0.394±0.004**	0.317±0.020	0.374±0.012	0.326±0.005	0.277±0.006	0.231±0.003	0.109±0.014
	RMSE ↓	3.327±0.044	2.990±0.027	3.090±0.069	**2.883±0.020**	3.452±0.035	3.052±0.052	3.585±0.038
SVG100	PCC ↑	0.370±0.004	0.305±0.009	**0.392±0.018**	0.310±0.008	0.245±0.006	0.209±0.009	0.123±0.004
	Spearman ↑	**0.358±0.004**	0.285±0.011	0.335±0.017	0.261±0.009	0.239±0.005	0.194±0.008	0.106±0.005
	RMSE ↓	2.947±0.006	2.660±0.016	2.711±0.040	**2.647±0.009**	3.161±0.018	2.667±0.028	3.131±0.019
HEG20	PCC ↑	0.357±0.002	0.255±0.021	0.374±0.008	**0.376±0.001**	0.258±0.004	0.232±0.005	0.127±0.015
	Spearman ↑	**0.401±0.001**	0.299±0.026	0.393±0.008	0.391±0.003	0.306±0.003	0.285±0.005	0.100±0.013
	RMSE ↓	4.264±0.007	4.034±0.020	**3.653±0.013**	3.659±0.006	4.300±0.021	4.078±0.023	4.264±0.028
HEG50	PCC ↑	0.368±0.004	0.271±0.013	**0.408±0.007**	0.332±0.006	0.223±0.007	0.226±0.015	0.135±0.006
	Spearman ↑	0.386±0.003	0.287±0.017	**0.386±0.008**	0.329±0.005	0.238±0.008	0.241±0.012	0.117±0.007
	RMSE ↓	3.716±0.010	3.449±0.012	**3.156±0.010**	3.232±0.021	3.861±0.008	3.438±0.051	3.736±0.018
HEG100	PCC ↑	0.347±0.002	0.263±0.009	**0.378±0.002**	0.274±0.003	0.210±0.001	0.190±0.002	0.113±0.004
	Spearman ↑	**0.356±0.002**	0.267±0.012	0.344±0.003	0.254±0.004	0.214±0.001	0.190±0.001	0.095±0.004
	RMSE ↓	3.221±0.002	2.947±0.008	**2.824±0.015**	2.866±0.007	3.434±0.008	2.936±0.032	3.261±0.023

Table S79: X5K-HCC — Liver — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.077±0.007	0.053±0.008	**0.123±0.003**	0.029±0.007	0.001±0.003	0.002±0.003	0.121±0.001
	Spearman ↑	0.069±0.007	0.050±0.009	**0.106±0.003**	0.029±0.001	0.001±0.003	0.001±0.003	0.103±0.001
	RMSE ↓	4.397±0.458	4.202±0.432	**3.884±0.513**	4.128±0.307	5.441±0.212	4.146±0.494	4.142±0.557
HVG50	PCC ↑	0.090±0.009	0.064±0.009	**0.128±0.006**	0.030±0.007	-0.000±0.004	0.002±0.004	0.120±0.001
	Spearman ↑	0.074±0.004	0.057±0.006	**0.109±0.003**	0.029±0.003	0.001±0.002	0.002±0.004	0.102±0.001
	RMSE ↓	3.625±0.371	3.537±0.250	3.281±0.270	**3.266±0.436**	4.843±0.137	3.447±0.355	3.472±0.351
HVG100	PCC ↑	0.093±0.011	0.064±0.004	**0.128±0.011**	0.027±0.005	0.001±0.002	0.002±0.003	0.122±0.001
	Spearman ↑	0.075±0.008	0.055±0.004	**0.108±0.005**	0.026±0.006	0.001±0.001	0.002±0.003	0.104±0.001
	RMSE ↓	2.956±0.147	2.889±0.069	2.762±0.121	**2.659±0.142**	4.345±0.036	2.856±0.169	2.859±0.173
SVG20	PCC ↑	0.083±0.015	0.040±0.007	**0.128±0.006**	0.040±0.016	0.005±0.002	0.001±0.001	0.120±0.002
	Spearman ↑	0.082±0.015	0.051±0.007	**0.115±0.007**	0.044±0.019	0.007±0.003	0.000±0.002	0.102±0.002
	RMSE ↓	4.883±0.198	4.819±0.108	**4.463±0.157**	4.831±0.222	5.118±0.129	4.893±0.212	4.639±0.228
SVG50	PCC ↑	0.088±0.013	0.043±0.012	**0.130±0.006**	0.031±0.008	0.005±0.002	0.002±0.007	0.121±0.001
	Spearman ↑	0.086±0.010	0.051±0.013	**0.116±0.005**	0.034±0.007	0.007±0.001	0.002±0.008	0.104±0.001
	RMSE ↓	4.075±0.067	3.973±0.118	**3.787±0.080**	3.929±0.151	4.469±0.037	4.078±0.078	3.877±0.061
SVG100	PCC ↑	0.091±0.014	0.045±0.011	**0.127±0.005**	0.030±0.007	0.003±0.001	0.002±0.007	0.121±0.001
	Spearman ↑	0.088±0.011	0.053±0.011	**0.113±0.004**	0.033±0.010	0.005±0.001	0.002±0.007	0.103±0.001
	RMSE ↓	3.477±0.099	3.402±0.090	**3.276±0.100**	3.369±0.127	3.945±0.051	3.493±0.102	3.307±0.099
HEG20	PCC ↑	0.088±0.004	0.033±0.015	**0.122±0.002**	0.027±0.012	0.001±0.003	0.001±0.007	0.120±0.002
	Spearman ↑	**0.184±0.004**	0.092±0.030	0.128±0.002	0.081±0.007	-0.002±0.001	0.004±0.011	0.104±0.002
	RMSE ↓	2.625±0.019	2.798±0.030	2.594±0.021	2.644±0.021	2.656±0.019	2.634±0.019	**2.502±0.019**
HEG50	PCC ↑	0.095±0.002	0.036±0.012	**0.126±0.001**	0.024±0.006	-0.001±0.001	0.001±0.006	0.120±0.000
	Spearman ↑	**0.164±0.003**	0.086±0.023	0.127±0.002	0.064±0.004	-0.003±0.001	0.004±0.008	0.103±0.001
	RMSE ↓	2.523±0.017	2.610±0.011	2.451±0.018	2.538±0.015	2.614±0.018	2.536±0.016	**2.408±0.017**
HEG100	PCC ↑	0.103±0.002	0.040±0.009	**0.126±0.001**	0.034±0.011	0.003±0.001	0.001±0.007	0.121±0.001
	Spearman ↑	**0.146±0.002**	0.079±0.018	0.121±0.001	0.052±0.003	0.003±0.001	0.004±0.008	0.104±0.001
	RMSE ↓	2.414±0.011	2.481±0.010	2.330±0.010	2.438±0.012	2.560±0.011	2.437±0.016	**2.303±0.011**
CancerCore89	PCC ↑	0.078±0.000	0.054±0.003	0.117±0.001	0.020±0.002	-0.002±0.000	0.001±0.002	**0.121±0.000**
	Spearman ↑	0.073±0.000	0.055±0.003	**0.105±0.001**	0.025±0.001	-0.003±0.001	0.001±0.002	0.103±0.000
	RMSE ↓	3.492±0.007	3.476±0.019	3.271±0.005	**3.245±0.036**	4.333±0.003	3.477±0.011	3.311±0.007

Table S80: TENX120 — Liver — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.215±0.004	**0.258±0.027**	0.150±0.004	0.075±0.002	0.043±0.008	0.026±0.010	0.124±0.002
	Spearman ↑	0.193±0.008	**0.202±0.026**	0.133±0.003	0.056±0.003	0.043±0.007	0.025±0.008	0.104±0.001
	RMSE ↓	4.241±0.223	**3.117±0.209**	4.350±0.164	4.995±0.019	4.635±0.060	3.680±0.065	4.444±0.098
HVG50	PCC ↑	**0.309±0.015**	0.295±0.010	0.246±0.018	0.185±0.025	0.159±0.024	0.152±0.014	0.141±0.004
	Spearman ↑	**0.282±0.016**	0.253±0.014	0.206±0.016	0.146±0.019	0.154±0.022	0.144±0.013	0.122±0.005
	RMSE ↓	3.014±0.087	2.559±0.035	3.066±0.129	3.207±0.226	3.037±0.263	**2.302±0.056**	3.352±0.047
HVG100	PCC ↑	**0.345±0.008**	0.310±0.013	0.296±0.009	0.229±0.013	0.201±0.012	0.194±0.009	0.143±0.005
	Spearman ↑	**0.313±0.011**	0.276±0.009	0.247±0.010	0.187±0.014	0.191±0.014	0.180±0.012	0.125±0.006
	RMSE ↓	2.381±0.044	2.063±0.034	2.343±0.054	2.386±0.072	2.499±0.074	**1.989±0.064**	2.721±0.054
SVG20	PCC ↑	0.553±0.006	0.509±0.008	0.503±0.007	**0.560±0.005**	0.550±0.005	0.507±0.005	0.201±0.034
	Spearman ↑	**0.579±0.006**	0.505±0.013	0.502±0.010	0.534±0.005	0.520±0.004	0.483±0.005	0.190±0.035
	RMSE ↓	3.461±0.052	3.166±0.048	3.393±0.013	**3.110±0.024**	3.283±0.022	3.193±0.010	4.000±0.053
SVG50	PCC ↑	0.507±0.002	0.440±0.012	**0.518±0.004**	0.489±0.003	0.479±0.003	0.437±0.003	0.240±0.010
	Spearman ↑	**0.522±0.003**	0.435±0.009	0.495±0.003	0.469±0.004	0.459±0.004	0.420±0.003	0.232±0.010
	RMSE ↓	3.087±0.019	**2.799±0.049**	2.851±0.026	2.807±0.013	3.080±0.019	2.905±0.011	3.552±0.027
SVG100	PCC ↑	0.449±0.001	0.376±0.011	**0.466±0.005**	0.405±0.000	0.404±0.001	0.375±0.001	0.191±0.012
	Spearman ↑	**0.459±0.001**	0.376±0.008	0.436±0.006	0.387±0.001	0.388±0.001	0.358±0.001	0.180±0.014
	RMSE ↓	2.745±0.022	**2.525±0.034**	2.541±0.010	2.554±0.017	2.837±0.022	2.592±0.021	3.134±0.026
HEG20	PCC ↑	**0.315±0.002**	0.266±0.016	0.278±0.007	0.255±0.002	0.170±0.001	0.174±0.003	0.144±0.003
	Spearman ↑	**0.443±0.004**	0.354±0.026	0.331±0.014	0.382±0.003	0.278±0.002	0.288±0.002	0.129±0.005
	RMSE ↓	2.749±0.005	2.719±0.032	**2.654±0.018**	2.675±0.007	2.788±0.010	2.756±0.012	2.775±0.006
HEG50	PCC ↑	**0.300±0.001**	0.260±0.016	0.264±0.008	0.223±0.001	0.171±0.002	0.154±0.007	0.140±0.003
	Spearman ↑	**0.375±0.001**	0.312±0.021	0.290±0.007	0.296±0.002	0.230±0.003	0.218±0.006	0.127±0.004
	RMSE ↓	2.826±0.005	2.787±0.027	**2.712±0.008**	2.786±0.003	2.872±0.002	2.836±0.009	2.846±0.005
HEG100	PCC ↑	**0.358±0.001**	0.294±0.012	0.330±0.007	0.270±0.001	0.254±0.001	0.227±0.002	0.154±0.007
	Spearman ↑	**0.394±0.001**	0.318±0.013	0.336±0.007	0.305±0.001	0.267±0.002	0.251±0.001	0.139±0.007
	RMSE ↓	2.700±0.003	2.629±0.017	**2.526±0.007**	2.642±0.002	2.774±0.003	2.682±0.007	2.820±0.004
CancerCore89	PCC ↑	**0.231±0.004**	0.228±0.002	0.176±0.004	0.110±0.004	0.110±0.001	0.110±0.009	0.143±0.009
	Spearman ↑	**0.254±0.001**	0.235±0.003	0.173±0.005	0.105±0.005	0.102±0.002	0.115±0.006	0.129±0.007
	RMSE ↓	5.824±0.069	**4.952±0.022**	5.385±0.088	5.769±0.023	5.276±0.012	5.012±0.085	5.740±0.037

Table S81: TENX121 — Liver — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.240±0.015	**0.307±0.006**	0.155±0.006	0.074±0.011	0.122±0.011	0.104±0.012	0.108±0.008
	Spearman ↑	0.187±0.020	**0.215±0.015**	0.135±0.007	0.068±0.008	0.092±0.011	0.082±0.007	0.089±0.009
	RMSE ↓	3.169±0.347	2.209±0.083	3.174±0.281	4.585±0.080	**1.916±0.253**	1.948±0.104	4.058±0.151
HVG50	PCC ↑	0.293±0.009	**0.299±0.003**	0.189±0.012	0.127±0.020	0.143±0.014	0.140±0.014	0.116±0.007
	Spearman ↑	0.224±0.011	**0.227±0.014**	0.150±0.008	0.081±0.009	0.103±0.008	0.097±0.010	0.093±0.010
	RMSE ↓	2.649±0.210	1.842±0.079	2.774±0.161	3.210±0.316	1.995±0.208	**1.624±0.143**	3.210±0.228
HVG100	PCC ↑	**0.329±0.006**	0.269±0.006	0.249±0.007	0.171±0.007	0.151±0.005	0.158±0.004	0.122±0.004
	Spearman ↑	**0.236±0.006**	0.217±0.003	0.186±0.006	0.108±0.006	0.111±0.004	0.107±0.005	0.100±0.004
	RMSE ↓	1.871±0.035	1.662±0.066	1.862±0.035	2.038±0.073	1.625±0.037	**1.353±0.043**	2.263±0.057
SVG20	PCC ↑	**0.393±0.023**	0.327±0.010	0.314±0.020	0.390±0.016	0.366±0.034	0.287±0.008	0.151±0.008
	Spearman ↑	**0.401±0.005**	0.308±0.002	0.280±0.010	0.300±0.006	0.293±0.015	0.206±0.006	0.126±0.003
	RMSE ↓	2.919±0.022	**2.721±0.016**	3.011±0.077	2.771±0.018	2.806±0.037	2.842±0.018	3.195±0.075
SVG50	PCC ↑	**0.384±0.003**	0.283±0.007	0.355±0.009	0.337±0.002	0.325±0.006	0.284±0.004	0.136±0.013
	Spearman ↑	**0.361±0.001**	0.266±0.003	0.283±0.006	0.250±0.002	0.233±0.004	0.216±0.005	0.110±0.009
	RMSE ↓	2.606±0.035	**2.382±0.029**	2.546±0.034	2.513±0.015	2.531±0.036	2.470±0.033	2.814±0.009
SVG100	PCC ↑	**0.370±0.001**	0.261±0.004	0.348±0.005	0.285±0.002	0.270±0.002	0.277±0.002	0.132±0.007
	Spearman ↑	**0.337±0.001**	0.251±0.003	0.270±0.004	0.209±0.002	0.207±0.002	0.213±0.001	0.107±0.007
	RMSE ↓	2.413±0.025	2.162±0.006	2.284±0.007	2.309±0.014	2.353±0.023	**2.160±0.026**	2.599±0.007
HEG20	PCC ↑	0.279±0.004	0.207±0.011	0.241±0.005	**0.282±0.007**	0.210±0.004	0.182±0.006	0.118±0.008
	Spearman ↑	**0.360±0.002**	0.242±0.011	0.241±0.006	0.260±0.002	0.217±0.004	0.175±0.004	0.103±0.011
	RMSE ↓	3.020±0.015	2.911±0.016	**2.857±0.020**	2.902±0.014	3.015±0.012	3.013±0.020	2.962±0.008
HEG50	PCC ↑	**0.331±0.001**	0.198±0.007	0.313±0.004	0.275±0.002	0.240±0.009	0.254±0.008	0.129±0.003
	Spearman ↑	**0.356±0.001**	0.235±0.006	0.286±0.002	0.259±0.003	0.219±0.003	0.243±0.006	0.110±0.005
	RMSE ↓	3.112±0.003	2.963±0.017	**2.798±0.007**	2.919±0.010	3.110±0.005	2.965±0.007	3.118±0.006
HEG100	PCC ↑	**0.344±0.003**	0.216±0.003	0.320±0.006	0.240±0.005	0.226±0.005	0.244±0.007	0.117±0.004
	Spearman ↑	**0.350±0.002**	0.247±0.003	0.282±0.004	0.211±0.005	0.202±0.005	0.217±0.007	0.097±0.005
	RMSE ↓	2.799±0.001	2.567±0.015	2.555±0.021	2.608±0.004	2.760±0.005	**2.508±0.009**	2.902±0.025

Table S82: TENX140 — Pancreas — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.218±0.006	**0.253±0.013**	0.163±0.013	0.124±0.009	0.130±0.018	0.115±0.005	0.125±0.012
	Spearman ↑	**0.196±0.004**	0.196±0.012	0.140±0.010	0.101±0.005	0.135±0.011	0.112±0.005	0.107±0.013
	RMSE ↓	3.817±0.268	3.234±0.106	3.628±0.387	4.579±0.157	4.350±0.759	**3.053±0.415**	3.926±0.209
HVG50	PCC ↑	0.251±0.011	**0.266±0.004**	0.195±0.009	0.138±0.011	0.158±0.020	0.134±0.021	0.126±0.002
	Spearman ↑	0.208±0.013	**0.208±0.009**	0.153±0.009	0.108±0.010	0.147±0.016	0.118±0.017	0.105±0.002
	RMSE ↓	2.964±0.111	2.737±0.095	3.003±0.220	3.617±0.085	3.152±0.201	**2.224±0.139**	3.155±0.156
HVG100	PCC ↑	0.269±0.009	**0.271±0.009**	0.221±0.003	0.144±0.010	0.156±0.004	0.139±0.004	0.132±0.005
	Spearman ↑	0.210±0.005	**0.212±0.012**	0.174±0.005	0.111±0.006	0.145±0.003	0.119±0.003	0.111±0.006
	RMSE ↓	2.357±0.166	2.252±0.075	2.443±0.105	2.803±0.231	2.621±0.207	**1.814±0.099**	2.605±0.183
SVG20	PCC ↑	**0.422±0.010**	0.388±0.009	0.332±0.004	0.402±0.009	0.403±0.001	0.358±0.006	0.109±0.013
	Spearman ↑	**0.434±0.005**	0.344±0.007	0.335±0.001	0.359±0.006	0.402±0.002	0.342±0.001	0.088±0.013
	RMSE ↓	3.967±0.061	**3.436±0.050**	4.221±0.060	3.653±0.050	3.970±0.017	3.577±0.077	4.496±0.046
SVG50	PCC ↑	**0.391±0.002**	0.335±0.004	0.338±0.007	0.343±0.003	0.350±0.003	0.303±0.007	0.136±0.002
	Spearman ↑	**0.367±0.002**	0.282±0.005	0.296±0.007	0.290±0.003	0.322±0.002	0.268±0.004	0.117±0.004
	RMSE ↓	3.179±0.029	**2.773±0.041**	3.402±0.029	3.075±0.014	3.263±0.026	2.914±0.077	3.647±0.041
SVG100	PCC ↑	**0.360±0.001**	0.309±0.001	0.338±0.007	0.292±0.001	0.297±0.001	0.264±0.000	0.146±0.006
	Spearman ↑	**0.325±0.001**	0.255±0.002	0.277±0.004	0.240±0.001	0.269±0.001	0.226±0.002	0.126±0.005
	RMSE ↓	2.716±0.014	**2.420±0.003**	2.846±0.045	2.667±0.006	2.913±0.008	2.468±0.038	3.034±0.034
HEG20	PCC ↑	**0.321±0.002**	0.236±0.002	0.299±0.002	0.281±0.000	0.232±0.002	0.147±0.006	0.108±0.010
	Spearman ↑	**0.356±0.002**	0.238±0.004	0.309±0.002	0.305±0.001	0.266±0.002	0.175±0.004	0.096±0.010
	RMSE ↓	4.314±0.014	4.118±0.011	**3.940±0.013**	3.993±0.006	4.333±0.019	4.218±0.026	4.330±0.015
HEG50	PCC ↑	**0.337±0.002**	0.272±0.001	0.329±0.006	0.275±0.004	0.258±0.003	0.185±0.005	0.131±0.009
	Spearman ↑	**0.352±0.003**	0.271±0.001	0.318±0.006	0.283±0.004	0.268±0.003	0.190±0.004	0.115±0.006
	RMSE ↓	3.791±0.006	3.570±0.009	**3.435±0.027**	3.548±0.013	3.884±0.005	3.637±0.043	3.841±0.014
HEG100	PCC ↑	0.315±0.003	0.268±0.002	**0.315±0.002**	0.243±0.003	0.229±0.004	0.168±0.005	0.121±0.008
	Spearman ↑	**0.323±0.003**	0.262±0.002	0.291±0.003	0.238±0.003	0.231±0.003	0.163±0.004	0.104±0.007
	RMSE ↓	3.384±0.007	3.191±0.006	**3.085±0.010**	3.170±0.009	3.515±0.009	3.241±0.014	3.398±0.020
CancerCore89	PCC ↑	**0.223±0.002**	0.215±0.001	0.190±0.003	0.144±0.001	0.118±0.001	0.084±0.001	0.123±0.004
	Spearman ↑	**0.227±0.003**	0.210±0.002	0.178±0.003	0.140±0.001	0.112±0.004	0.081±0.001	0.107±0.004
	RMSE ↓	4.766±0.013	4.348±0.006	**4.332±0.031**	4.693±0.006	4.574±0.024	4.403±0.001	4.695±0.028

Table S83: TENX116 — Pancreas — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.211±0.025**	0.152±0.012	0.150±0.021	0.118±0.033	0.118±0.026	0.066±0.020	0.122±0.001
	Spearman ↑	**0.187±0.020**	0.079±0.016	0.126±0.018	0.081±0.027	0.112±0.021	0.059±0.016	0.103±0.000
	RMSE ↓	3.897±0.342	**2.725±0.113**	4.123±0.180	4.462±0.571	4.602±0.875	3.223±0.703	4.097±0.288
HVG50	PCC ↑	**0.256±0.007**	0.186±0.008	0.198±0.003	0.148±0.009	0.142±0.010	0.101±0.007	0.128±0.001
	Spearman ↑	**0.203±0.005**	0.120±0.013	0.157±0.003	0.105±0.007	0.126±0.007	0.083±0.006	0.110±0.001
	RMSE ↓	2.637±0.102	2.285±0.081	2.974±0.061	2.977±0.091	3.257±0.255	**1.992±0.061**	2.967±0.181
HVG100	PCC ↑	**0.295±0.004**	0.192±0.008	0.268±0.008	0.187±0.004	0.152±0.007	0.131±0.003	0.134±0.003
	Spearman ↑	**0.238±0.007**	0.138±0.012	0.210±0.008	0.147±0.007	0.141±0.007	0.113±0.004	0.115±0.003
	RMSE ↓	2.103±0.059	1.925±0.045	2.095±0.036	2.040±0.028	2.763±0.035	**1.743±0.070**	2.335±0.061
SVG20	PCC ↑	0.414±0.009	0.277±0.016	0.328±0.014	**0.424±0.010**	0.334±0.019	0.232±0.016	0.131±0.011
	Spearman ↑	**0.451±0.008**	0.271±0.030	0.322±0.010	0.410±0.011	0.365±0.017	0.246±0.015	0.111±0.010
	RMSE ↓	3.782±0.091	3.360±0.094	3.679±0.082	**3.222±0.064**	3.839±0.109	3.544±0.052	4.250±0.103
SVG50	PCC ↑	**0.383±0.003**	0.249±0.005	0.363±0.010	0.364±0.005	0.306±0.004	0.223±0.006	0.135±0.009
	Spearman ↑	**0.387±0.006**	0.224±0.008	0.315±0.011	0.329±0.009	0.304±0.007	0.216±0.009	0.114±0.011
	RMSE ↓	3.158±0.038	2.844±0.022	2.996±0.048	**2.800±0.037**	3.279±0.044	2.967±0.033	3.514±0.043
SVG100	PCC ↑	0.366±0.004	0.231±0.007	**0.369±0.007**	0.321±0.004	0.286±0.009	0.209±0.008	0.129±0.003
	Spearman ↑	**0.363±0.003**	0.213±0.012	0.325±0.007	0.300±0.003	0.278±0.007	0.209±0.006	0.107±0.005
	RMSE ↓	2.699±0.064	2.510±0.061	2.495±0.046	**2.468±0.055**	2.951±0.073	2.608±0.059	2.919±0.074
HEG20	PCC ↑	**0.259±0.001**	0.188±0.011	0.204±0.003	0.182±0.003	0.078±0.010	0.126±0.018	0.131±0.004
	Spearman ↑	**0.342±0.002**	0.242±0.012	0.241±0.004	0.288±0.004	0.111±0.013	0.175±0.010	0.114±0.005
	RMSE ↓	2.862±0.021	2.827±0.019	2.813±0.020	2.829±0.011	2.929±0.014	2.862±0.018	**2.776±0.012**
HEG50	PCC ↑	**0.267±0.002**	0.182±0.011	0.229±0.005	0.184±0.002	0.135±0.003	0.080±0.019	0.129±0.005
	Spearman ↑	**0.315±0.002**	0.218±0.015	0.243±0.004	0.252±0.003	0.150±0.002	0.146±0.011	0.106±0.007
	RMSE ↓	2.969±0.005	2.925±0.004	**2.786±0.012**	2.917±0.007	3.035±0.006	2.962±0.008	2.925±0.009
HEG100	PCC ↑	**0.309±0.001**	0.194±0.011	0.292±0.005	0.235±0.002	0.217±0.000	0.133±0.006	0.133±0.004
	Spearman ↑	**0.336±0.001**	0.212±0.016	0.289±0.006	0.276±0.002	0.221±0.001	0.168±0.004	0.112±0.004
	RMSE ↓	2.862±0.004	2.768±0.011	**2.604±0.006**	2.770±0.005	2.977±0.005	2.811±0.006	2.870±0.005
CancerCore89	PCC ↑	**0.184±0.004**	0.141±0.006	0.157±0.003	0.077±0.005	0.070±0.006	0.066±0.005	0.126±0.006
	Spearman ↑	**0.200±0.002**	0.137±0.008	0.145±0.004	0.074±0.005	0.069±0.008	0.076±0.011	0.109±0.007
	RMSE ↓	5.639±0.021	**4.536±0.046**	5.033±0.058	5.527±0.043	5.438±0.080	4.885±0.100	5.718±0.029

Table S84: TENX126 — Pancreas — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.185±0.011**	0.157±0.013	0.161±0.017	0.092±0.018	0.090±0.009	0.063±0.008	0.129±0.004
	Spearman ↑	**0.161±0.011**	0.083±0.010	0.132±0.010	0.063±0.012	0.092±0.005	0.059±0.005	0.112±0.004
	RMSE ↓	3.910±0.051	**2.477±0.049**	3.972±0.042	4.896±0.162	5.026±0.064	3.007±0.224	4.306±0.075
HVG50	PCC ↑	**0.214±0.015**	0.214±0.009	0.185±0.008	0.100±0.016	0.098±0.014	0.074±0.012	0.127±0.003
	Spearman ↑	**0.168±0.014**	0.132±0.008	0.143±0.006	0.065±0.010	0.093±0.012	0.064±0.009	0.108±0.004
	RMSE ↓	2.916±0.129	2.150±0.061	3.185±0.141	3.837±0.186	4.057±0.121	**2.108±0.093**	3.224±0.146
HVG100	PCC ↑	0.236±0.008	**0.243±0.006**	0.206±0.010	0.113±0.013	0.111±0.013	0.088±0.013	0.133±0.005
	Spearman ↑	**0.169±0.009**	0.161±0.005	0.156±0.008	0.078±0.012	0.100±0.011	0.073±0.011	0.114±0.006
	RMSE ↓	2.066±0.035	1.857±0.023	2.272±0.097	2.769±0.064	2.922±0.256	**1.504±0.051**	2.156±0.056
SVG20	PCC ↑	0.398±0.009	0.380±0.011	0.320±0.020	0.387±0.020	**0.412±0.011**	0.346±0.013	0.188±0.006
	Spearman ↑	**0.403±0.009**	0.324±0.013	0.290±0.025	0.335±0.017	0.399±0.009	0.321±0.010	0.171±0.009
	RMSE ↓	3.800±0.008	3.005±0.040	3.946±0.040	3.380±0.062	3.450±0.048	**2.998±0.063**	4.378±0.042
SVG50	PCC ↑	**0.389±0.004**	0.335±0.013	0.371±0.007	0.345±0.011	0.344±0.002	0.287±0.002	0.178±0.008
	Spearman ↑	**0.375±0.002**	0.285±0.012	0.314±0.005	0.291±0.008	0.332±0.001	0.261±0.002	0.165±0.008
	RMSE ↓	3.285±0.011	**2.772±0.041**	3.282±0.017	3.021±0.020	3.339±0.009	2.830±0.029	3.788±0.054
SVG100	PCC ↑	0.354±0.002	0.297±0.005	**0.370±0.002**	0.288±0.003	0.279±0.001	0.237±0.001	0.166±0.007
	Spearman ↑	**0.334±0.002**	0.252±0.005	0.302±0.002	0.236±0.003	0.267±0.000	0.210±0.001	0.150±0.007
	RMSE ↓	2.983±0.010	**2.558±0.030**	2.839±0.004	2.792±0.008	3.286±0.019	2.596±0.023	3.321±0.021
HEG20	PCC ↑	**0.320±0.001**	0.235±0.006	0.275±0.007	0.272±0.003	0.254±0.002	0.197±0.003	0.129±0.009
	Spearman ↑	**0.345±0.002**	0.242±0.011	0.273±0.006	0.278±0.003	0.256±0.002	0.212±0.003	0.111±0.011
	RMSE ↓	4.995±0.012	**4.239±0.033**	4.439±0.034	4.543±0.008	4.960±0.021	4.647±0.050	4.954±0.043
HEG50	PCC ↑	0.355±0.003	0.285±0.004	**0.365±0.009**	0.304±0.004	0.285±0.004	0.232±0.005	0.166±0.005
	Spearman ↑	**0.365±0.003**	0.284±0.005	0.335±0.007	0.301±0.002	0.283±0.003	0.230±0.005	0.153±0.007
	RMSE ↓	3.787±0.009	3.389±0.043	**3.328±0.009**	3.492±0.015	4.013±0.010	3.485±0.022	3.898±0.023
HEG100	PCC ↑	0.335±0.000	0.275±0.004	**0.352±0.000**	0.268±0.001	0.246±0.001	0.202±0.003	0.150±0.003
	Spearman ↑	**0.336±0.000**	0.261±0.006	0.310±0.002	0.248±0.001	0.240±0.001	0.190±0.002	0.135±0.004
	RMSE ↓	3.276±0.006	**2.889±0.024**	2.953±0.015	3.045±0.007	3.556±0.007	2.955±0.051	3.417±0.036
CancerCore89	PCC ↑	**0.190±0.006**	0.184±0.003	0.154±0.012	0.066±0.010	0.079±0.003	0.079±0.005	0.121±0.002
	Spearman ↑	**0.200±0.002**	0.159±0.005	0.147±0.012	0.071±0.010	0.096±0.004	0.085±0.005	0.102±0.005
	RMSE ↓	5.530±0.092	**4.347±0.006**	5.207±0.170	5.791±0.092	4.975±0.063	4.486±0.092	5.425±0.057

Table S85: TENX132 — Bone — Non-tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	**0.248±0.028**	0.189±0.008	0.150±0.006	0.030±0.015	0.120±0.007	0.046±0.009	0.121±0.003
	Spearman ↑	**0.210±0.014**	0.077±0.008	0.129±0.005	0.031±0.008	0.128±0.008	0.048±0.010	0.101±0.003
	RMSE ↓	4.513±0.352	**2.643±0.079**	4.659±0.165	5.851±0.104	5.282±0.230	5.198±0.268	5.310±0.136
HVG50	PCC ↑	**0.313±0.009**	0.257±0.014	0.163±0.007	0.023±0.002	0.102±0.003	0.049±0.007	0.119±0.002
	Spearman ↑	**0.222±0.006**	0.090±0.012	0.130±0.004	0.022±0.002	0.106±0.002	0.051±0.007	0.098±0.002
	RMSE ↓	3.741±0.073	**2.011±0.010**	3.860±0.100	4.917±0.082	4.403±0.055	4.130±0.088	4.361±0.052
HVG100	PCC ↑	**0.348±0.015**	0.308±0.004	0.185±0.001	0.034±0.004	0.112±0.005	0.062±0.005	0.125±0.002
	Spearman ↑	**0.234±0.007**	0.104±0.005	0.140±0.003	0.028±0.003	0.114±0.006	0.063±0.006	0.103±0.002
	RMSE ↓	2.806±0.153	**1.637±0.037**	3.028±0.027	4.174±0.065	3.156±0.041	2.882±0.044	3.416±0.078
SVG20	PCC ↑	**0.390±0.013**	0.277±0.011	0.203±0.009	0.116±0.005	0.229±0.008	0.115±0.008	0.140±0.007
	Spearman ↑	**0.382±0.018**	0.159±0.010	0.182±0.009	0.111±0.004	0.233±0.010	0.119±0.006	0.122±0.007
	RMSE ↓	4.001±0.161	**2.974±0.026**	4.314±0.181	5.187±0.020	4.197±0.135	4.369±0.128	4.663±0.151
SVG50	PCC ↑	**0.397±0.018**	0.307±0.009	0.220±0.003	0.096±0.006	0.208±0.002	0.106±0.005	0.129±0.004
	Spearman ↑	**0.370±0.008**	0.158±0.009	0.187±0.004	0.081±0.005	0.211±0.001	0.109±0.005	0.109±0.003
	RMSE ↓	3.550±0.161	**2.421±0.032**	3.666±0.083	4.533±0.018	3.809±0.049	3.915±0.025	4.138±0.027
SVG100	PCC ↑	**0.411±0.003**	0.311±0.011	0.218±0.005	0.069±0.005	0.181±0.002	0.095±0.004	0.128±0.006
	Spearman ↑	**0.348±0.004**	0.143±0.011	0.178±0.008	0.052±0.005	0.185±0.003	0.098±0.004	0.105±0.008
	RMSE ↓	2.951±0.033	**2.018±0.023**	3.210±0.058	4.036±0.015	3.429±0.048	3.435±0.038	3.591±0.084
HEG20	PCC ↑	**0.400±0.017**	0.319±0.006	0.206±0.006	0.128±0.004	0.231±0.001	0.112±0.010	0.138±0.002
	Spearman ↑	**0.424±0.012**	0.210±0.004	0.185±0.007	0.118±0.004	0.241±0.002	0.113±0.011	0.120±0.003
	RMSE ↓	4.526±0.087	**3.296±0.022**	4.494±0.080	5.117±0.039	4.736±0.024	4.966±0.052	4.757±0.044
HEG50	PCC ↑	**0.411±0.007**	0.331±0.005	0.214±0.004	0.096±0.001	0.201±0.003	0.097±0.003	0.126±0.003
	Spearman ↑	**0.402±0.003**	0.204±0.004	0.183±0.004	0.080±0.002	0.205±0.003	0.097±0.003	0.105±0.003
	RMSE ↓	3.737±0.056	**2.631±0.012**	3.830±0.042	4.545±0.010	4.105±0.043	4.231±0.044	4.268±0.022
HEG100	PCC ↑	**0.415±0.004**	0.321±0.007	0.216±0.002	0.068±0.004	0.180±0.004	0.092±0.006	0.124±0.003
	Spearman ↑	**0.378±0.002**	0.170±0.006	0.182±0.005	0.050±0.003	0.184±0.004	0.094±0.006	0.101±0.004
	RMSE ↓	3.141±0.035	**2.201±0.007**	3.326±0.013	4.062±0.004	3.700±0.028	3.691±0.023	3.696±0.076

Table S86: TENX138 — Brain — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.162±0.021	**0.200±0.006**	0.133±0.003	0.053±0.005	0.043±0.009	0.034±0.002	0.125±0.007
	Spearman ↑	0.134±0.005	**0.154±0.004**	0.112±0.002	0.041±0.005	0.037±0.008	0.025±0.002	0.108±0.006
	RMSE ↓	3.888±0.851	3.174±0.084	3.475±0.483	4.308±0.390	2.345±0.486	**2.112±0.185**	4.129±0.347
HVG50	PCC ↑	0.219±0.004	**0.221±0.005**	0.175±0.009	0.093±0.008	0.086±0.010	0.048±0.005	0.119±0.008
	Spearman ↑	0.190±0.002	**0.193±0.007**	0.148±0.006	0.083±0.007	0.077±0.010	0.045±0.003	0.101±0.010
	RMSE ↓	2.682±0.148	2.545±0.076	2.558±0.254	2.702±0.181	2.413±0.190	**2.106±0.134**	2.805±0.210
HVG100	PCC ↑	**0.245±0.003**	0.236±0.006	0.208±0.009	0.113±0.006	0.095±0.008	0.064±0.005	0.127±0.004
	Spearman ↑	0.200±0.008	**0.201±0.010**	0.166±0.008	0.097±0.006	0.081±0.007	0.055±0.005	0.107±0.005
	RMSE ↓	1.877±0.107	1.928±0.054	1.724±0.099	1.767±0.102	1.894±0.166	**1.599±0.102**	1.916±0.118
SVG20	PCC ↑	**0.333±0.007**	0.279±0.027	0.307±0.012	0.276±0.004	0.240±0.009	0.144±0.007	0.127±0.005
	Spearman ↑	**0.369±0.006**	0.315±0.036	0.308±0.010	0.305±0.008	0.234±0.007	0.154±0.004	0.115±0.006
	RMSE ↓	2.917±0.124	2.753±0.106	**2.705±0.117**	2.836±0.108	2.960±0.111	2.970±0.129	2.934±0.149
SVG50	PCC ↑	**0.312±0.004**	0.260±0.024	0.296±0.006	0.240±0.003	0.237±0.004	0.144±0.004	0.131±0.002
	Spearman ↑	**0.333±0.003**	0.284±0.029	0.300±0.004	0.268±0.006	0.230±0.006	0.163±0.004	0.111±0.002
	RMSE ↓	2.637±0.008	2.607±0.030	**2.447±0.032**	2.571±0.015	2.684±0.007	2.669±0.009	2.616±0.016
SVG100	PCC ↑	**0.286±0.002**	0.242±0.019	0.264±0.005	0.196±0.002	0.197±0.002	0.115±0.003	0.124±0.001
	Spearman ↑	**0.298±0.001**	0.259±0.022	0.261±0.004	0.214±0.002	0.189±0.002	0.129±0.001	0.106±0.001
	RMSE ↓	2.547±0.027	2.509±0.027	**2.384±0.041**	2.509±0.032	2.633±0.020	2.554±0.019	2.517±0.019
HEG20	PCC ↑	0.303±0.001	0.233±0.037	**0.328±0.009**	0.279±0.002	0.221±0.002	0.191±0.003	0.132±0.001
	Spearman ↑	**0.361±0.001**	0.288±0.045	0.357±0.011	0.335±0.001	0.217±0.001	0.213±0.006	0.121±0.001
	RMSE ↓	2.165±0.002	2.161±0.012	**2.066±0.040**	2.127±0.002	2.195±0.003	2.177±0.004	2.135±0.005
HEG50	PCC ↑	**0.282±0.000**	0.229±0.026	0.274±0.002	0.218±0.000	0.199±0.003	0.140±0.003	0.127±0.004
	Spearman ↑	**0.318±0.001**	0.267±0.031	0.295±0.004	0.263±0.000	0.201±0.003	0.164±0.002	0.108±0.005
	RMSE ↓	2.499±0.001	2.490±0.006	**2.365±0.011**	2.479±0.002	2.541±0.002	2.507±0.002	2.457±0.003
HEG100	PCC ↑	**0.272±0.000**	0.227±0.019	0.254±0.004	0.184±0.002	0.186±0.002	0.115±0.004	0.120±0.003
	Spearman ↑	**0.289±0.000**	0.249±0.022	0.260±0.004	0.210±0.001	0.180±0.002	0.132±0.004	0.099±0.003
	RMSE ↓	2.577±0.001	2.559±0.004	**2.414±0.012**	2.563±0.003	2.640±0.002	2.577±0.006	2.522±0.010
CancerCore89	PCC ↑	**0.203±0.006**	0.191±0.006	0.177±0.005	0.102±0.001	0.067±0.004	0.062±0.003	0.135±0.003
	Spearman ↑	**0.217±0.002**	0.200±0.009	0.166±0.004	0.113±0.001	0.068±0.003	0.059±0.006	0.119±0.003
	RMSE ↓	3.177±0.064	3.075±0.004	**2.896±0.023**	3.116±0.006	3.030±0.009	2.996±0.023	3.011±0.019

Table S87: TENX188 — Cervix — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.147±0.016	**0.161±0.017**	0.126±0.007	0.055±0.027	0.051±0.015	0.051±0.015	0.120±0.003
	Spearman ↑	**0.130±0.009**	0.096±0.011	0.108±0.005	0.030±0.016	0.047±0.011	0.039±0.008	0.102±0.005
	RMSE ↓	4.871±0.137	**2.507±0.122**	4.082±0.261	4.115±1.680	5.759±0.093	4.458±0.165	5.288±0.087
HVG50	PCC ↑	0.170±0.005	**0.196±0.010**	0.136±0.005	0.064±0.006	0.067±0.010	0.060±0.003	0.122±0.001
	Spearman ↑	**0.129±0.007**	0.108±0.011	0.109±0.003	0.031±0.004	0.051±0.007	0.043±0.003	0.104±0.001
	RMSE ↓	3.696±0.111	**2.009±0.120**	3.497±0.095	4.496±0.071	4.857±0.020	3.192±0.135	4.220±0.112
HVG100	PCC ↑	0.177±0.008	**0.214±0.003**	0.146±0.003	0.066±0.006	0.074±0.007	0.061±0.005	0.122±0.003
	Spearman ↑	**0.127±0.010**	0.122±0.004	0.109±0.001	0.032±0.003	0.054±0.006	0.045±0.005	0.102±0.004
	RMSE ↓	2.893±0.120	**1.851±0.030**	2.957±0.149	3.748±0.113	4.084±0.090	2.313±0.201	3.363±0.151
SVG20	PCC ↑	0.336±0.002	**0.388±0.004**	0.301±0.003	0.276±0.005	0.355±0.003	0.339±0.004	0.161±0.014
	Spearman ↑	**0.354±0.003**	0.346±0.003	0.275±0.005	0.255±0.007	0.342±0.003	0.303±0.004	0.143±0.015
	RMSE ↓	4.283±0.057	3.470±0.014	4.588±0.014	4.454±0.018	3.973±0.050	**3.334±0.030**	4.700±0.163
SVG50	PCC ↑	0.354±0.025	**0.368±0.002**	0.333±0.039	0.315±0.067	0.351±0.020	0.334±0.020	0.166±0.009
	Spearman ↑	**0.346±0.020**	0.320±0.002	0.289±0.035	0.263±0.042	0.326±0.015	0.288±0.017	0.149±0.009
	RMSE ↓	3.181±0.407	2.949±0.025	3.320±0.561	3.216±0.649	3.071±0.387	**2.599±0.242**	3.706±0.522
SVG100	PCC ↑	**0.355±0.002**	0.341±0.005	0.339±0.006	0.324±0.004	0.329±0.003	0.315±0.003	0.166±0.004
	Spearman ↑	**0.326±0.003**	0.290±0.005	0.281±0.008	0.241±0.001	0.298±0.002	0.265±0.002	0.140±0.005
	RMSE ↓	2.439±0.018	2.528±0.045	2.481±0.039	2.337±0.025	2.486±0.023	**2.087±0.013**	2.929±0.060
HEG20	PCC ↑	**0.330±0.001**	0.293±0.002	0.317±0.012	0.296±0.001	0.288±0.001	0.255±0.002	0.119±0.005
	Spearman ↑	**0.382±0.001**	0.326±0.005	0.314±0.015	0.313±0.001	0.324±0.001	0.280±0.001	0.103±0.008
	RMSE ↓	3.921±0.004	4.555±0.010	**3.544±0.035**	3.573±0.003	3.794±0.017	3.741±0.031	3.872±0.036
HEG50	PCC ↑	**0.314±0.001**	0.268±0.003	0.310±0.004	0.261±0.001	0.276±0.000	0.237±0.002	0.169±0.005
	Spearman ↑	**0.349±0.001**	0.289±0.005	0.298±0.004	0.262±0.000	0.288±0.001	0.249±0.003	0.155±0.005
	RMSE ↓	3.596±0.002	3.999±0.007	**3.215±0.029**	3.302±0.006	3.506±0.014	3.320±0.010	3.533±0.026
HEG100	PCC ↑	**0.288±0.001**	0.259±0.002	0.278±0.002	0.210±0.002	0.243±0.000	0.195±0.003	0.161±0.004
	Spearman ↑	**0.312±0.001**	0.266±0.003	0.260±0.003	0.198±0.001	0.245±0.000	0.198±0.003	0.147±0.006
	RMSE ↓	3.225±0.002	3.482±0.007	**2.932±0.016**	2.955±0.003	3.241±0.012	2.945±0.028	3.225±0.053
CancerCore89	PCC ↑	0.183±0.000	**0.215±0.000**	0.126±0.001	0.046±0.001	0.042±0.001	0.053±0.002	0.125±0.000
	Spearman ↑	0.166±0.000	**0.166±0.000**	0.100±0.001	0.033±0.001	0.036±0.001	0.043±0.009	0.107±0.001
	RMSE ↓	3.652±0.006	**2.753±0.006**	3.433±0.017	4.163±0.004	4.298±0.016	3.439±0.181	3.950±0.005

Table S88: TENX157 — Prostate — Tumor — Inside spots

Panel	Metric	FineST	PanoSpace	HISTEX	Hist2SR	DS2Cell	sCellST	STARS
HVG20	PCC ↑	0.163±0.013	**0.213±0.013**	0.129±0.006	0.031±0.011	0.025±0.017	0.029±0.010	0.119±0.002
	Spearman ↑	0.134±0.020	**0.139±0.025**	0.111±0.005	0.029±0.009	0.025±0.018	0.026±0.010	0.100±0.002
	RMSE ↓	4.155±0.289	**2.886±0.347**	4.205±0.230	5.264±0.078	4.642±0.396	3.504±0.344	4.665±0.173
HVG50	PCC ↑	0.171±0.011	**0.226±0.009**	0.134±0.006	0.023±0.007	0.021±0.008	0.027±0.013	0.119±0.001
	Spearman ↑	0.127±0.010	**0.142±0.013**	0.110±0.004	0.019±0.005	0.022±0.008	0.022±0.013	0.100±0.001
	RMSE ↓	3.439±0.079	**2.359±0.152**	3.257±0.121	4.347±0.045	3.925±0.158	2.644±0.043	3.756±0.218
HVG100	PCC ↑	0.178±0.007	**0.227±0.010**	0.141±0.011	0.015±0.005	0.025±0.008	0.033±0.012	0.117±0.002
	Spearman ↑	0.120±0.008	**0.136±0.009**	0.112±0.006	0.013±0.003	0.025±0.010	0.029±0.011	0.098±0.002
	RMSE ↓	2.785±0.094	2.003±0.128	2.553±0.156	3.794±0.315	3.149±0.310	**1.942±0.136**	2.919±0.125
SVG20	PCC ↑	0.297±0.006	**0.374±0.010**	0.224±0.023	0.288±0.005	0.353±0.024	0.357±0.021	0.118±0.006
	Spearman ↑	0.334±0.005	0.365±0.017	0.237±0.026	0.298±0.004	**0.385±0.019**	0.362±0.017	0.097±0.009
	RMSE ↓	4.696±0.008	3.880±0.051	4.443±0.037	4.445±0.023	4.253±0.042	**3.774±0.093**	4.785±0.020
SVG50	PCC ↑	0.279±0.004	**0.332±0.011**	0.206±0.012	0.203±0.004	0.296±0.006	0.307±0.010	0.130±0.013
	Spearman ↑	0.307±0.001	0.319±0.015	0.216±0.015	0.200±0.004	**0.326±0.005**	0.315±0.008	0.110±0.017
	RMSE ↓	3.785±0.044	3.168±0.008	3.616±0.033	3.770±0.020	3.503±0.053	**3.121±0.049**	3.872±0.032
SVG100	PCC ↑	0.280±0.002	**0.314±0.007**	0.237±0.012	0.176±0.004	0.246±0.007	0.243±0.010	0.112±0.019
	Spearman ↑	0.291±0.001	**0.296±0.009**	0.227±0.016	0.173±0.003	0.264±0.006	0.246±0.009	0.091±0.026
	RMSE ↓	3.277±0.019	2.852±0.014	3.110±0.027	3.304±0.013	3.196±0.020	**2.818±0.056**	3.366±0.031
HEG20	PCC ↑	0.261±0.001	0.252±0.008	**0.271±0.009**	0.207±0.003	0.153±0.004	0.181±0.010	0.128±0.016
	Spearman ↑	**0.289±0.001**	0.256±0.009	0.278±0.010	0.215±0.003	0.167±0.005	0.194±0.010	0.105±0.017
	RMSE ↓	4.496±0.009	4.293±0.032	**3.970±0.020**	4.255±0.007	4.455±0.016	4.278±0.043	4.341±0.022
HEG50	PCC ↑	**0.271±0.001**	0.261±0.004	0.271±0.008	0.206±0.002	0.172±0.001	0.171±0.021	0.124±0.011
	Spearman ↑	**0.292±0.001**	0.260±0.006	0.270±0.009	0.209±0.002	0.183±0.002	0.174±0.020	0.106±0.015
	RMSE ↓	4.005±0.004	3.803±0.015	**3.534±0.005**	3.795±0.009	3.989±0.007	3.803±0.030	3.944±0.020
HEG100	PCC ↑	0.268±0.001	0.266±0.004	**0.269±0.010**	0.181±0.003	0.165±0.003	0.157±0.007	0.128±0.004
	Spearman ↑	**0.283±0.001**	0.266±0.006	0.266±0.013	0.185±0.004	0.176±0.004	0.158±0.008	0.108±0.009
	RMSE ↓	3.578±0.005	3.398±0.012	**3.177±0.012**	3.437±0.003	3.624±0.008	3.420±0.027	3.513±0.023
CancerCore89	PCC ↑	0.213±0.000	**0.240±0.001**	0.150±0.001	0.046±0.001	0.029±0.001	0.040±0.005	0.117±0.001
	Spearman ↑	**0.198±0.001**	0.196±0.001	0.128±0.001	0.041±0.001	0.029±0.001	0.037±0.005	0.098±0.001
	RMSE ↓	3.612±0.010	**2.931±0.008**	3.267±0.038	4.082±0.007	3.859±0.037	3.011±0.039	3.751±0.018