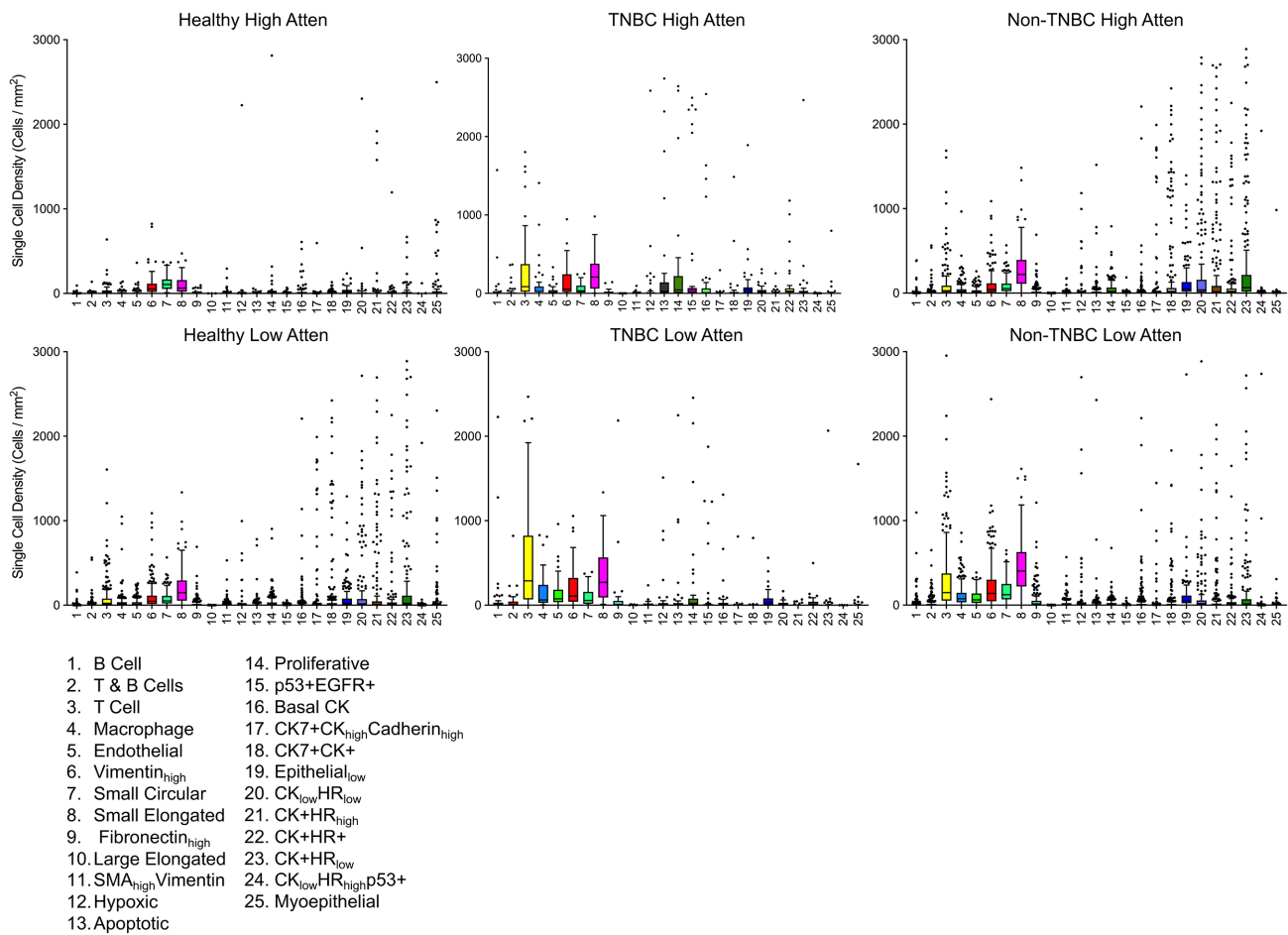
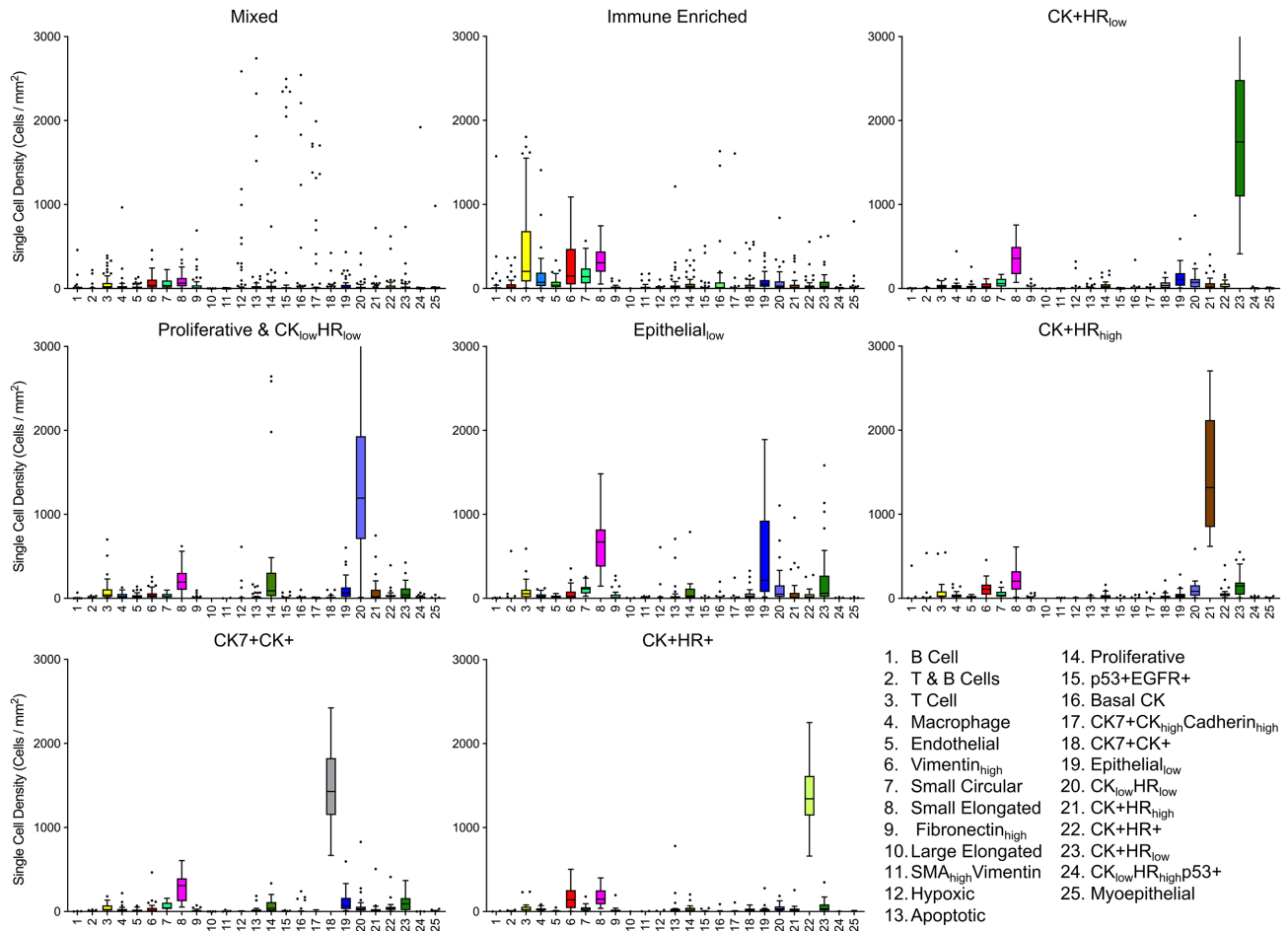


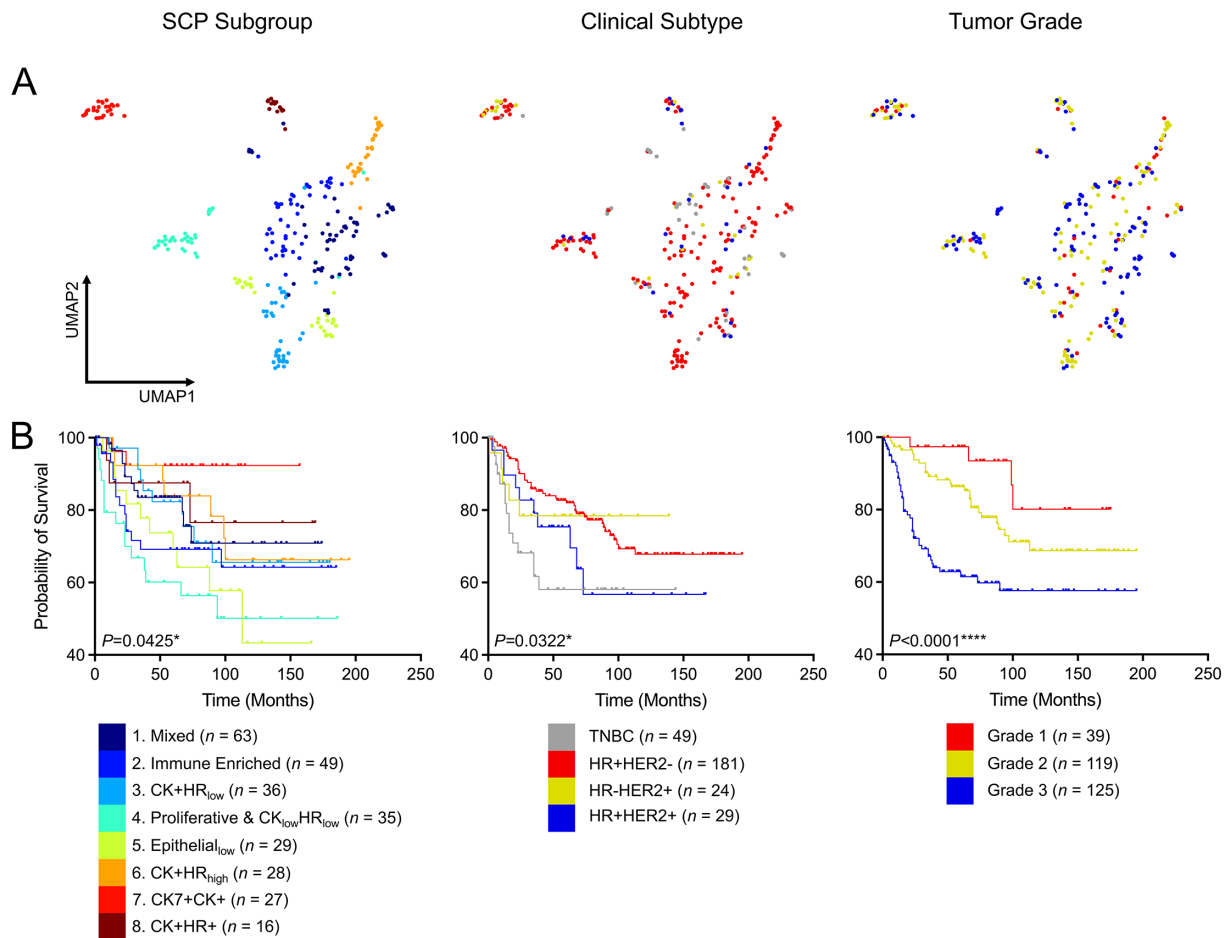
## Supplementary Figures



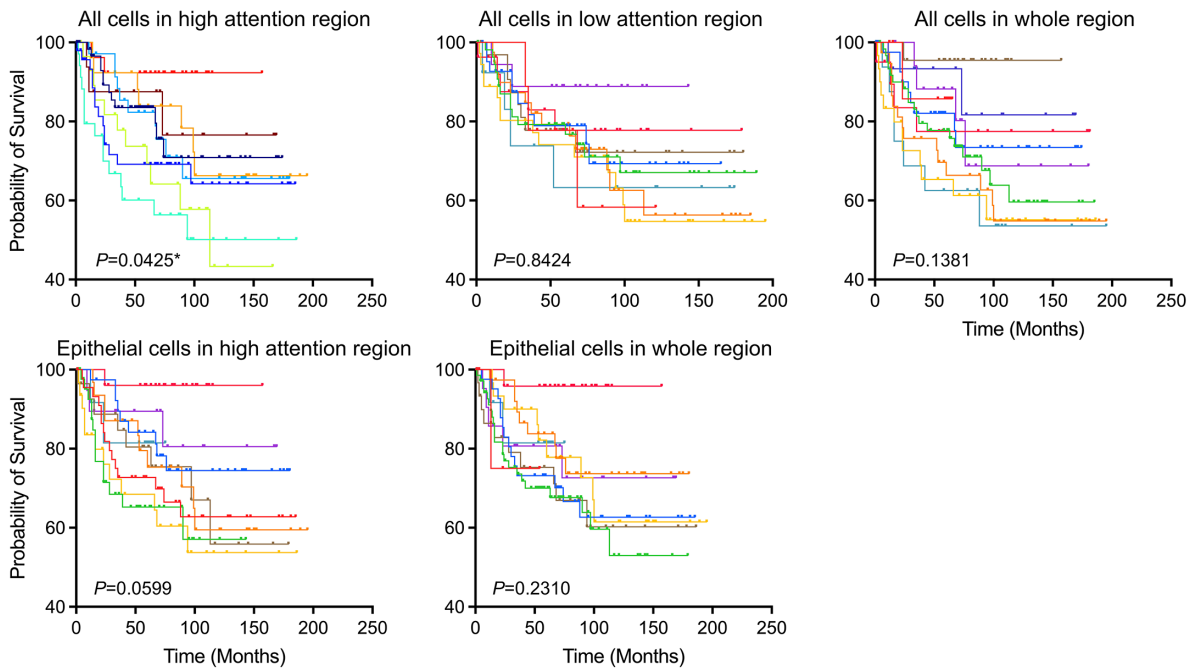
**Supplementary Figure 1.** Box plots of cell density per phenotype in high- and low-attention regions from healthy, TNBC and non-TNBC cancer tissues.



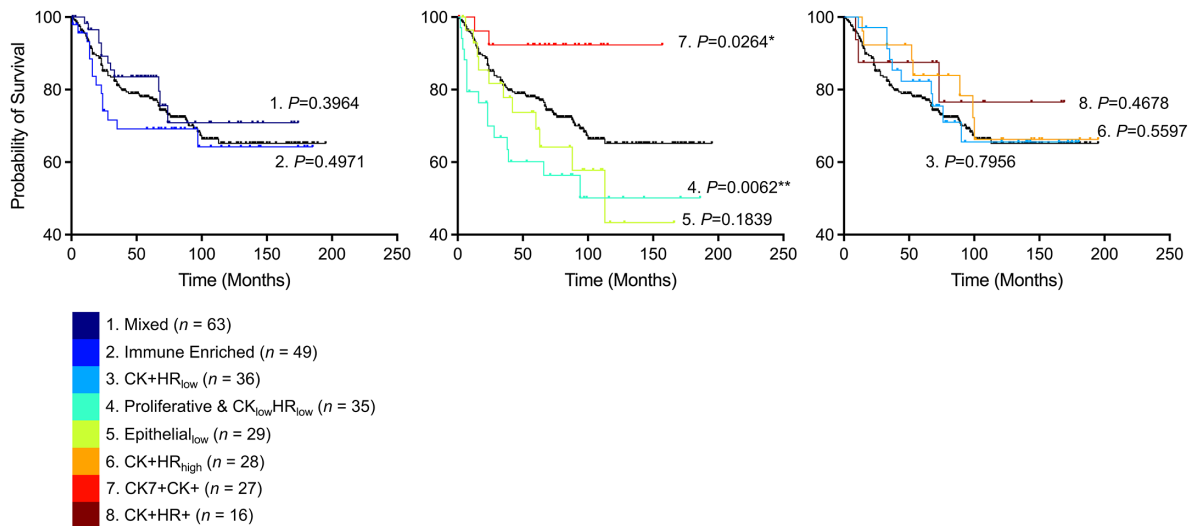
**Supplementary Figure 2.** Box plots of cell density per phenotype in high-attention regions from each single-cell patient subgroup.



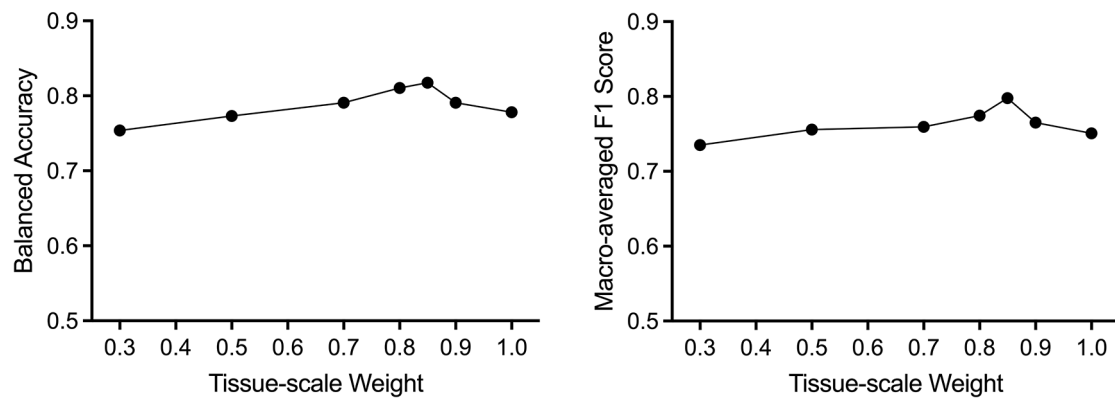
**Supplementary Figure 3.** Comparisons of the patient group classified by SCP subgroup, clinical subtype and tumor grade. (A) UMAP plots of the tissues labeled with their corresponding SCP indexes, clinical subtypes and tumor grades. (B) Kaplan-Meier curves of overall survival for each patient group on the basis of SCP subgroup, clinical subtype and tumor grade.



**Supplementary Figure 4.** Kaplan-Meier curves of overall survival from different clustering strategies and their corresponding  $P$  values of log-rank tests.



**Supplementary Figure 5.** Kaplan-Meier curves of overall survival of each subgroup on the basis of cell density per phenotype of high attention regions. The black curve represents the survival curve of all samples. Each  $P$  value represents the statistical significance of a single subgroup compared to all the other samples. All the  $P$  values were calculated through two-sided log-rank tests.



**Supplementary Figure 6.** The relationship between tissue-scale weight  $\eta$  and clinical type classification performance.

## Supplementary Tables

**Supplementary Table 1.** Cell markers used in training and downstream analysis.

Metal Tag	Target	Metal Tag	Target
141Pr	Cytokeratin5	159Tb	p53
142Nd	Fibronectin	160Gd	CD44
143Nd	Cytokeratin19	162Dy	CD45
144Nd	Cytokeratin8/18	163Dy	GATA3
145Nd	Twist	164Dy	CD20
146Nd	CD68	166Er	Carbonic Anhydrase IX
147Sm	Cytokeratin14	167Er	E/P-Cadherin
148Nd	SMA	168Er	Ki-67
149Sm	Vimentin	169Tm	EGFR
150Nd	c-Myc	170Er	S6
151Eu	c-erbB-2-Her2	172Yb	vWF
152Sm	CD3	173Yb	mTOR
155Gd	Slug	174Yb	Cytokeratin7
156Gd	Rabbit IgG H L	175Lu	panCytokeratin
158Gd	Progesterone Receptor A/B	176Yb	cleaved PARP

**Supplementary Table 2.** *P* values for overall survival analysis from different clustering strategies.

Cell Types	Region	<i>P</i> Value
All	High attention	0.0425*
All	Low attention	0.8424
All	Whole	0.1381
Epithelial cells	High attention	0.0599
Epithelial cells	Whole	0.2310