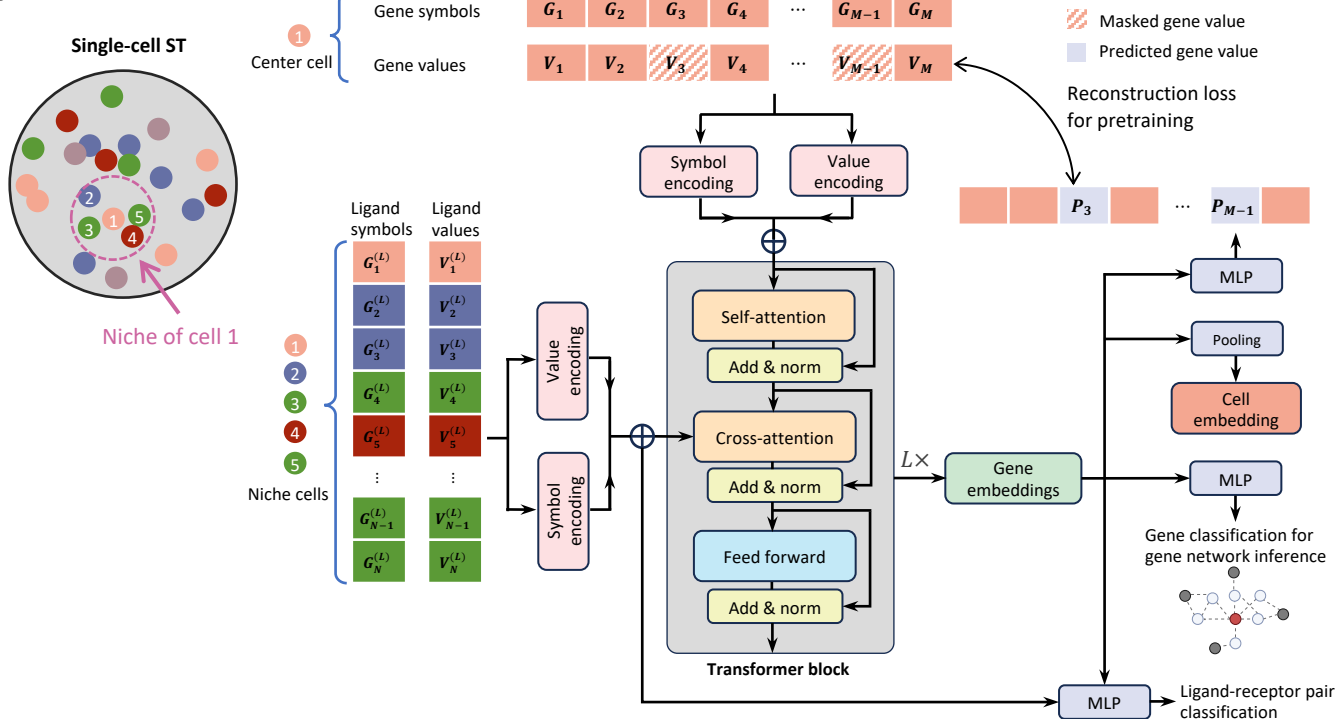


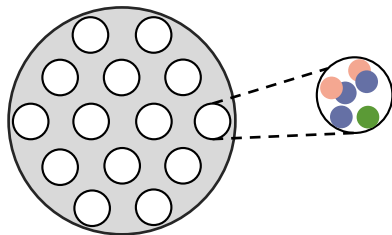
a

Single-cell ST



b

Spot-based ST



Deconvolution result

Cell type	Proportion
	p_1
	p_2
	p_3

Cross-attention with biases of logarithmic cell-type proportions

	Niche ligands				Attention bias		
Center genes				+			
	$\frac{q_1 \cdot k_1}{\sqrt{d_k}}$	$\frac{q_1 \cdot k_2}{\sqrt{d_k}}$	$\frac{q_1 \cdot k_3}{\sqrt{d_k}}$		$\log(p_1)$	$\log(p_2)$	$\log(p_3)$
	$\frac{q_2 \cdot k_1}{\sqrt{d_k}}$	$\frac{q_2 \cdot k_2}{\sqrt{d_k}}$	$\frac{q_2 \cdot k_3}{\sqrt{d_k}}$		$\log(p_1)$	$\log(p_2)$	$\log(p_3)$
	$\frac{q_3 \cdot k_1}{\sqrt{d_k}}$	$\frac{q_3 \cdot k_2}{\sqrt{d_k}}$	$\frac{q_3 \cdot k_3}{\sqrt{d_k}}$		$\log(p_1)$	$\log(p_2)$	$\log(p_3)$