

Supplemental Material

Supplementary Table 1. Performance comparison for brain tumor classification on different tasks.

	Task	ACC	AUC	F1	Sensitivity	Specificity
Validation	Seven-classification	93.29 _{1.17}	99.23 _{0.15}	93.19 _{1.17}	93.29 _{1.17}	98.88 _{0.20}
Dataset	Five- classification	94.64 _{1.09}	99.33 _{0.15}	94.61 _{1.09}	94.64 _{1.09}	98.66 _{0.27}
Test	Seven- classification	85.60 _{0.42}	97.33 _{0.43}	85.59 _{0.44}	85.60 _{0.42}	97.60 _{0.07}
Dataset	Five- classification	91.00 _{0.35}	98.38 _{0.14}	91.16 _{0.40}	91.00 _{0.35}	97.75 _{0.09}

Supplementary Table 2. Performance comparison on the public dataset.

Category		Internal dataset			External dataset		
		ACC	AUC	F1	ACC	AUC	F1
ABMIL	5×	89.25 _{1.15}	97.46 _{0.66}	87.55 _{1.38}	86.67 _{1.64}	97.66 _{0.34}	84.85 _{1.64}
	20×	94.11 _{1.25}	99.51 _{0.16}	93.52 _{1.55}	90.61 _{1.12}	99.16 _{0.60}	89.70 _{3.17}
CLAM-SB	5×	90.96 _{1.48}	98.27 _{0.56}	89.80 _{1.98}	88.70 _{1.02}	98.31 _{0.37}	87.28 _{1.37}
	20×	95.61 _{3.19}	99.70 _{0.35}	95.10 _{3.87}	91.27 _{2.47}	98.49 _{0.67}	90.59 _{3.09}
CLAM-MB	5×	90.70 _{1.13}	98.40 _{0.47}	90.15 _{1.09}	88.44 _{2.47}	98.33 _{0.39}	87.59 _{3.31}
	20×	96.81 _{2.89}	99.81 _{0.27}	96.40 _{3.59}	91.99 _{1.25}	98.82 _{0.25}	91.47 _{2.14}
TRANS-MIL	5×	88.20 _{2.01}	95.10 _{1.41}	82.58 _{8.40}	87.39 _{1.37}	95.99 _{0.50}	86.32 _{1.44}
	20×	90.17 _{1.08}	96.91 _{1.11}	89.47 _{1.30}	90.28 _{1.40}	99.02 _{1.50}	89.45 _{2.15}
DTFD	5×	90.30 _{1.22}	98.28 _{0.26}	88.72 _{1.35}	88.31 _{0.77}	98.24 _{0.27}	86.60 _{0.76}
	20×	91.09 _{0.90}	98.38 _{0.33}	90.42 _{1.29}	90.28 _{2.26}	96.49 _{0.54}	89.41 _{3.06}
BCL	5×	93.87 _{1.54}	98.95 _{0.15}	93.54 _{1.50}	92.68 _{0.86}	99.03 _{0.48}	92.46 _{1.22}
	20×	-	-	-	-	-	-
MS-ABMIL	5×+20×	91.87 _{1.37}	98.75 _{0.25}	90.96 _{1.11}	91.26 _{0.88}	98.90 _{0.36}	90.36 _{1.24}
HOMIL	5×	95.84 _{0.62}	99.22 _{0.39}	95.52 _{0.74}	92.89 _{0.56}	99.16 _{0.33}	92.56 _{0.83}
	5×+20×	97.38_{0.53}	99.57_{0.16}	97.30_{0.49}	96.17_{1.11}	99.66_{0.19}	96.01_{1.29}

Supplementary Table 3. Performance comparison on the task of determining the origin of brain metastatic adenocarcinoma.

Category		Internal dataset			External dataset		
		ACC	AUC	F1	ACC	AUC	F1
ABMIL	5×	68.99 _{3.15}	70.06 _{3.36}	67.72 _{3.91}	65.72 _{1.25}	68.60 _{1.74}	65.63 _{1.40}
	20×	75.96 _{6.81}	81.27 _{5.81}	75.87 _{6.57}	72.43 _{2.60}	76.28 _{0.99}	73.00 _{2.11}
CLAM-SB	5×	73.59 _{6.18}	79.27 _{4.94}	73.65 _{6.13}	69.83 _{2.35}	75.68 _{2.82}	70.51 _{2.25}
	20×	78.71 _{5.12}	81.79 _{6.81}	78.61 _{5.07}	72.57 _{2.43}	78.10 _{2.75}	72.96 _{2.07}
CLAM-MB	5×	71.12 _{5.75}	72.81 _{6.61}	71.35 _{5.73}	67.27 _{6.38}	74.68 _{5.41}	68.21 _{6.041}
	20×	79.32 _{6.60}	82.81 _{5.42}	79.45 _{6.52}	68.45 _{2.76}	76.30 _{2.29}	69.50 _{2.51}
TRANS-MIL	5×	72.63 _{7.96}	80.68 _{6.54}	69.20 _{10.45}	72.79 _{2.88}	78.27 _{3.91}	68.01 _{3.79}
	20×	78.39 _{6.03}	84.84 _{5.41}	77.94 _{5.93}	73.04 _{2.86}	80.97 _{1.40}	70.61 _{2.49}
DTFD	5×	77.18 _{7.97}	80.69 _{6.07}	77.16 _{7.92}	71.72 _{2.78}	78.37 _{0.98}	72.23 _{2.37}
	20×	81.45 _{5.72}	86.20 _{4.02}	81.26 _{5.95}	74.80 _{2.33}	81.95 _{1.03}	75.19 _{1.93}
BCL	5×	81.82 _{5.67}	83.91 _{5.68}	81.29 _{5.96}	63.41 _{4.28}	66.27 _{1.72}	63.58 _{2.93}
	20×	-	-	-	-	-	-
MS-ABMIL	5×+20×	80.53 _{4.52}	82.90 _{5.46}	80.58 _{4.40}	73.94 _{0.92}	78.24 _{1.54}	74.33 _{1.05}
HOMIL	5×	75.76 _{1.24}	79.31 _{2.45}	75.14 _{1.78}	71.07 _{0.55}	72.24 _{1.54}	70.21 _{0.65}
	5×+20×	86.36 _{4.29}	90.71 _{1.68}	86.38 _{4.26}	79.28 _{1.04}	83.38 _{1.19}	79.58 _{1.12}

Supplementary Table 4. Performance comparison on the task of grading gliomas.

Category		Internal dataset			External dataset		
		ACC	AUC	F1	ACC	AUC	F1
ABMIL	5×	84.27 _{2.92}	91.89 _{3.65}	84.16 _{2.99}	93.01 _{2.28}	97.63 _{0.74}	92.95 _{2.37}
	20×	84.35 _{2.59}	91.65 _{2.96}	84.32 _{2.59}	93.54 _{0.50}	97.43 _{0.38}	93.53 _{0.50}
CLAM-SB	5×	85.60 _{3.17}	92.51 _{2.83}	85.39 _{3.24}	95.09 _{3.62}	98.07 _{1.19}	94.44 _{4.17}
	20×	82.18 _{2.99}	91.68 _{2.91}	82.06 _{2.97}	91.80 _{2.59}	97.64 _{1.16}	91.62 _{2.77}
CLAM-MB	5×	84.27 _{3.80}	92.04 _{3.69}	84.07 _{3.78}	92.27 _{2.28}	97.20 _{0.77}	91.32 _{2.51}
	20×	85.36 _{3.72}	92.37 _{2.44}	85.32 _{3.71}	93.54 _{2.24}	97.69 _{0.88}	93.52 _{2.22}
TRANS-MIL	5×	86.92 _{4.19}	92.64 _{3.67}	86.71 _{4.29}	93.13 _{2.67}	97.95 _{0.53}	92.20 _{3.13}
	20×	84.67 _{3.69}	93.66 _{2.31}	84.28 _{3.54}	92.54 _{2.64}	98.27 _{0.54}	91.48 _{3.03}
DTFD	5×	85.33 _{4.27}	92.30 _{3.92}	84.93 _{4.87}	94.48 _{1.29}	98.37 _{0.70}	94.49 _{1.29}
	20×	86.85 _{2.04}	93.82 _{2.02}	86.82 _{2.04}	94.16 _{1.99}	98.06 _{0.80}	94.16 _{1.98}
BCL	5×	88.74 _{3.33}	94.51 _{2.47}	88.72 _{3.31}	95.09 _{1.64}	98.47 _{1.19}	95.03 _{1.68}
	20×	-	-	-	-	-	-
MS-ABMIL	5×+20×	85.51 _{1.64}	92.68 _{1.87}	85.50 _{1.66}	93.91 _{1.20}	98.12 _{0.24}	93.91 _{1.16}
HOMIL	5×	89.40 _{2.25}	95.86 _{1.89}	89.37 _{2.20}	95.09 _{1.86}	98.44 _{0.94}	95.04 _{1.87}
	5×+20×	91.21 _{2.07}	96.09 _{1.62}	91.19 _{2.09}	96.93 _{1.86}	99.37 _{0.58}	96.92 _{1.87}