FAST: A Dual-tier Few-Shot Learning Paradigm for Whole Slide Image Classification

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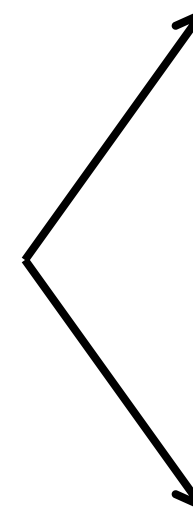
Whole Slide Image

≈100,000 X 100,000 pix

Huge size

fine-grained annotation
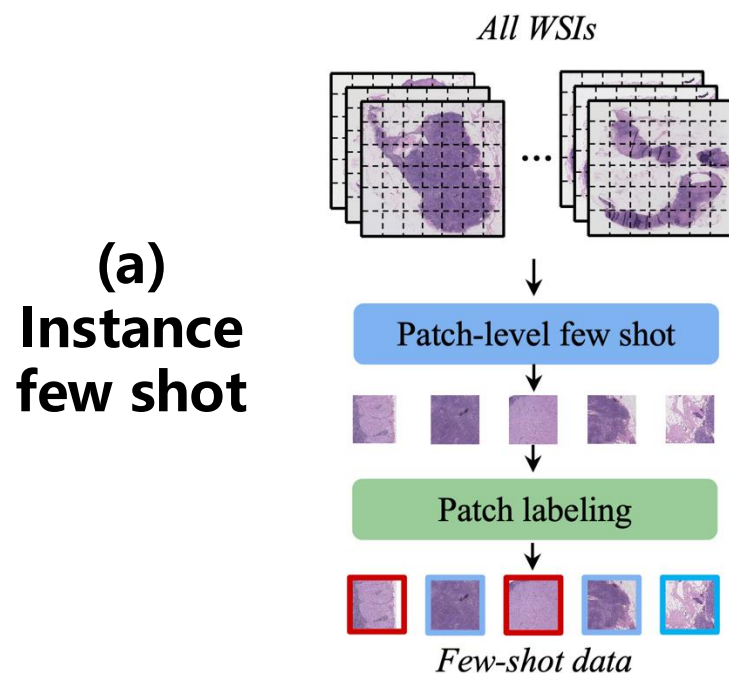is expensive

Fully supervised
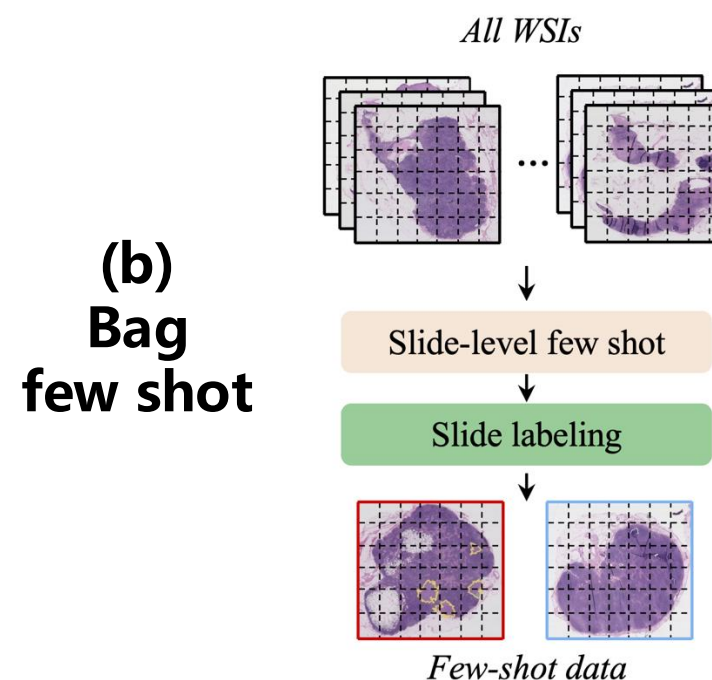methods

Multi-Instance
Learning methods

wide staining variations, multiple cancer types, and rare diseases

limited number of WSIs

how to avoid expensive fine-grained annotations while fully utilizing limited WSIs
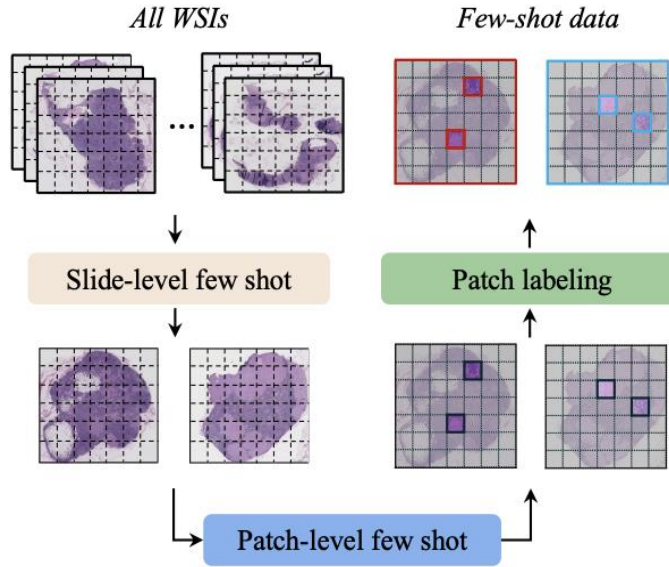
Few-shot Learning for WSI Classification

(a) Instance few shot

Strong supervision but discard a large number of unlabeled patches.
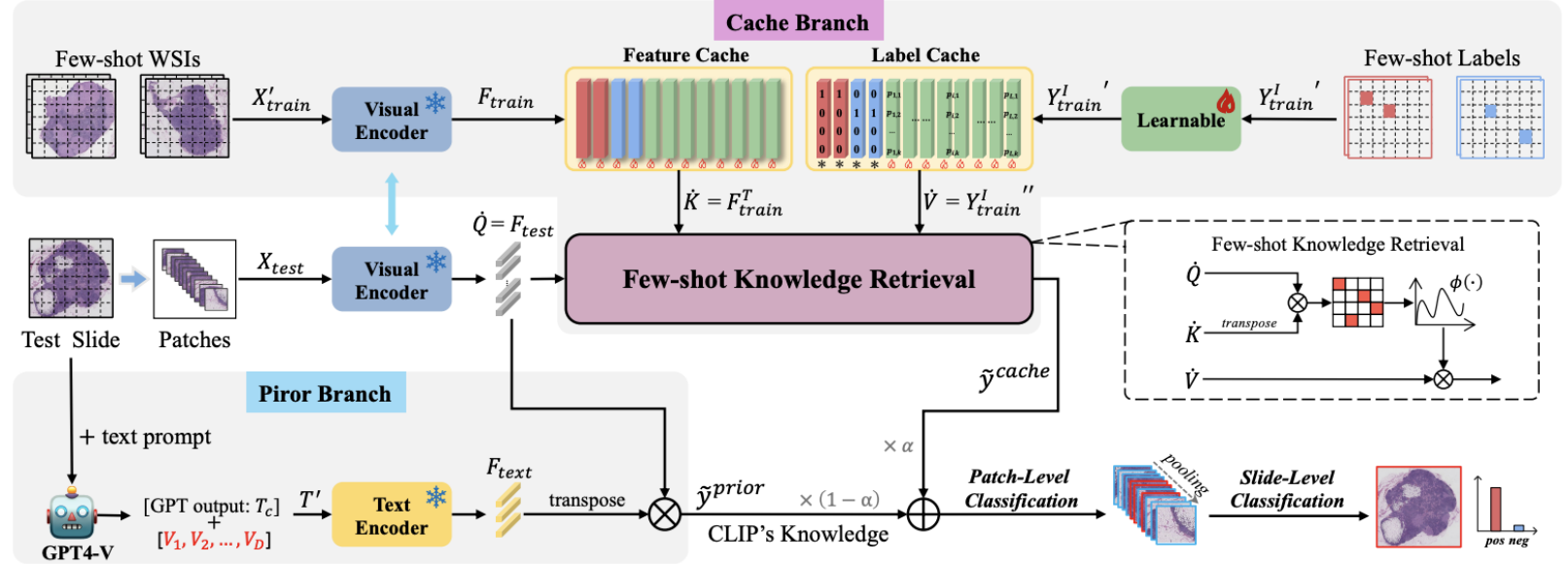
(b) Bag few shot

Lacks strong supervisory signals, resulting in low accuracy

cannot simultaneously utilize strong supervision from patch labels and the remaining unlabeled patches, lacking sufficient mining of available WSIs.

Method

Annotation Strategy

Classification Framework

Main contributions:

➢ propose a novel few-shot learning paradigm for WSI classification.

➢ propose an efficient dual-level WSI annotation strategy, which can provide patch-level supervisory information at a cost close to that of slide-level annotation.

➢ propose a learnable cache model based on the foundation model, which fully utilizes both annotated and unannotated patches.

Results on CAMELYON16 dataset

| Bag Shot	Instance Shot	Methods	Instance-level AUC	Bag-level AUC
0	0	Zero-shot CLIP	0.6711	0.5409
0	0	Zero-shot PLIP	0.6004	0.5434
0	0	Zero-shot CONCH	0.8929	0.7113
1	16	**FAST**	**0.8400±0.0335**	**0.6933±0.0846**
		Tip-Adapter-F	0.7162±0.0435	0.5653±0.0604
		Tip-Adapter	0.6275±0.0777	0.498±0.0187
2	16	**FAST**	**0.8584±0.0380**	**0.7595±0.0391**
		Tip-Adapter-F	0.7200±0.0595	0.5748±0.0537
		Tip-Adapter	0.6198±0.0823	0.5141±0.0156
4	16	**FAST**	**0.8864±0.0563**	**0.7359±0.0853**
		Tip-Adapter-F	0.6990±0.0890	0.5731±0.0401
		Tip-Adapter	0.5601±0.0772	0.5321±0.0152
8	16	**FAST**	**0.9060±0.0074**	**0.7742±0.0249**
		Tip-Adapter-F	0.7392±0.0180	0.6045±0.0044
		Tip-Adapter	0.6782±0.0166	0.4880±0.0097
16	16	**FAST**	**0.9151±0.0200**	**0.8197±0.0474**
		Tip-Adapter-F	0.7227±0.0098	0.5965±0.0243
		Tip-Adapter	0.6835±0.0135	0.4913±0.0164
All	All	Fully Supervised	0.9532	0.8555

Results on TCGA-RENAL dataset

Bag Shot	Instance Shot	Methods	Instance-level AUC			Bag-level AUC			mean
			ccRCC	pRCC	chRCC	ccRCC	pRCC	chRCC	
0	0	Zero-shot CLIP	0.5475	0.5521	0.3640	0.4959	0.5192	0.4811	0.4987
0	0	Zero-shot PLIP	0.5396	0.6006	0.4774	0.6036	0.6610	0.4905	0.5850
0	0	Zero-shot CONCH	0.8127	0.9122	0.9131	0.9039	0.8936	0.9449	0.9141
1	16	**FAST**	**0.5935±0.0488**	**0.6853±0.0443**	**0.6548±0.0760**	**0.6067±0.0833**	**0.6921±0.0416**	0.6488±0.0984	**0.6492**
		Tip-Adapter-F	0.5710±0.0387	0.6533±0.0566	0.6230±0.0967	0.5981±0.0393	0.6523±0.0684	**0.6948±0.1113**	0.6484
		Tip-Adapter	0.5874±0.0503	0.6308±0.0655	0.6017±0.0734	0.5951±0.0602	0.6515±0.0668	0.6624±0.1099	0.6363
2	16	**FAST**	**0.6245±0.0733**	**0.6998±0.0229**	**0.6987±0.0582**	**0.6745±0.0900**	0.7327±0.0279	0.7329±0.0483	**0.7133**
		Tip-Adapter-F	0.6084±0.0609	0.6820±0.0405	0.6985±0.0481	0.6359±0.1143	**0.7391±0.0331**	**0.7481±0.0794**	0.7077
		Tip-Adapter	0.6068±0.0524	0.6413±0.0554	0.6238±0.0522	0.6545±0.0931	0.6682±0.1034	0.7405±0.0763	0.6877
4	16	**FAST**	**0.7107±0.1056**	**0.7547±0.0544**	**0.7652±0.0645**	**0.7684±0.1681**	**0.8260±0.0816**	**0.8143±0.1080**	**0.8029**
		Tip-Adapter-F	0.6587±0.0858	0.7266±0.0756	0.7488±0.0555	0.7220±0.1091	0.7621±0.0985	0.7132±0.1631	0.7324
		Tip-Adapter	0.6361±0.0737	0.6797±0.0820	0.6835±0.0805	0.6671±0.1384	0.7274±0.0391	0.7856±0.0866	0.7267
8	16	**FAST**	**0.7940±0.0522**	**0.8228±0.0275**	**0.8398±0.0194**	**0.8955±0.0453**	**0.8978±0.0478**	**0.8964±0.0485**	**0.8966**
		Tip-Adapter-F	0.7249±0.0529	0.7832±0.0255	0.7918±0.0239	0.7854±0.1382	0.8239±0.0595	0.7879±0.0595	0.7991
		Tip-Adapter	0.6839±0.0567	0.7552±0.0275	0.7623±0.0380	0.7735±0.0793	0.7787±0.0526	0.7908±0.0735	0.7810
16	16	**FAST**	**0.8252±0.0428**	**0.8420±0.0126**	**0.8609±0.0165**	**0.9254±0.0206**	**0.9216±0.0233**	**0.9234±0.0184**	**0.9235**
		Tip-Adapter-F	0.7409±0.0736	0.8026±0.0151	0.8030±0.0268	0.8612±0.0726	0.8235±0.0547	0.8531±0.0591	0.8459
		Tip-Adapter	0.6911±0.0484	0.7886±0.0230	0.7851±0.0191	0.7624±0.0931	0.7593±0.0400	0.8877±0.0621	0.8031
All	All	Fully Supervised	0.8917	0.9055	0.8977	0.9472	0.9576	0.9267	0.9438

Different annotation ratio
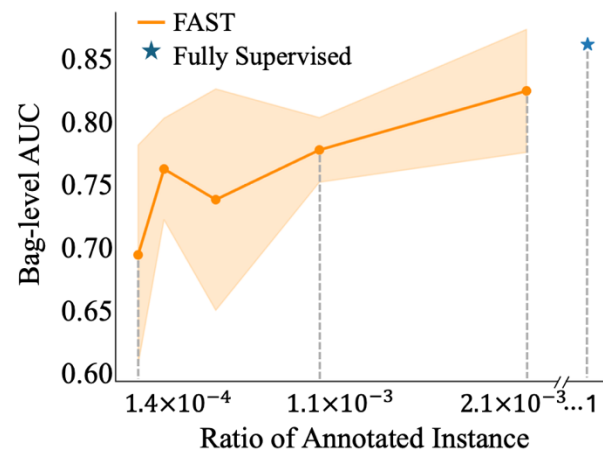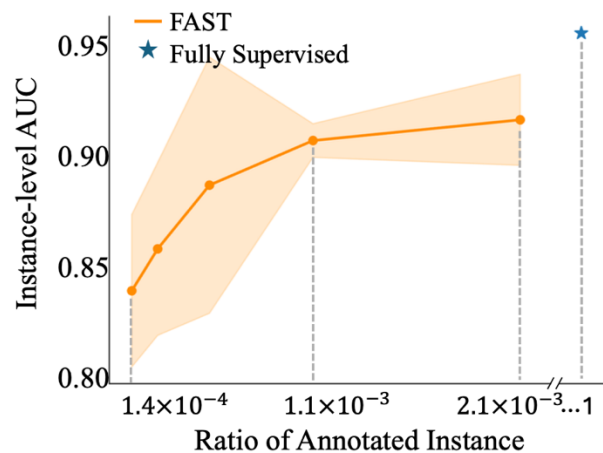
CAMELYON16
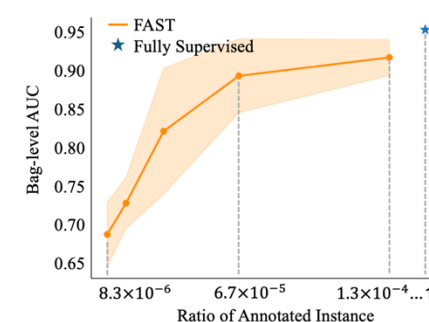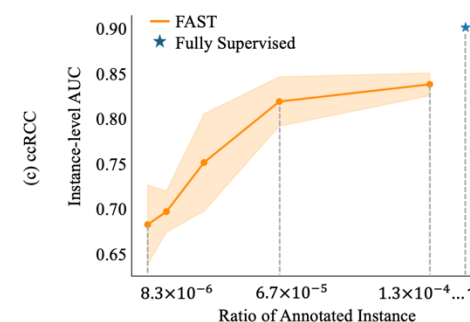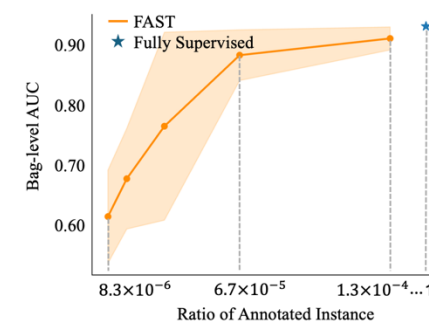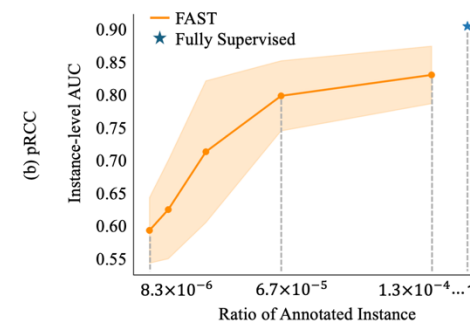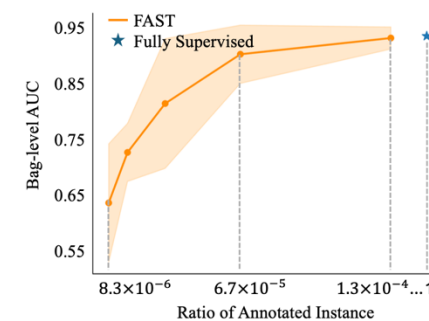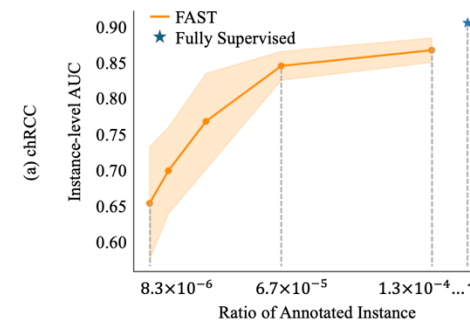
TCGA-RENAL

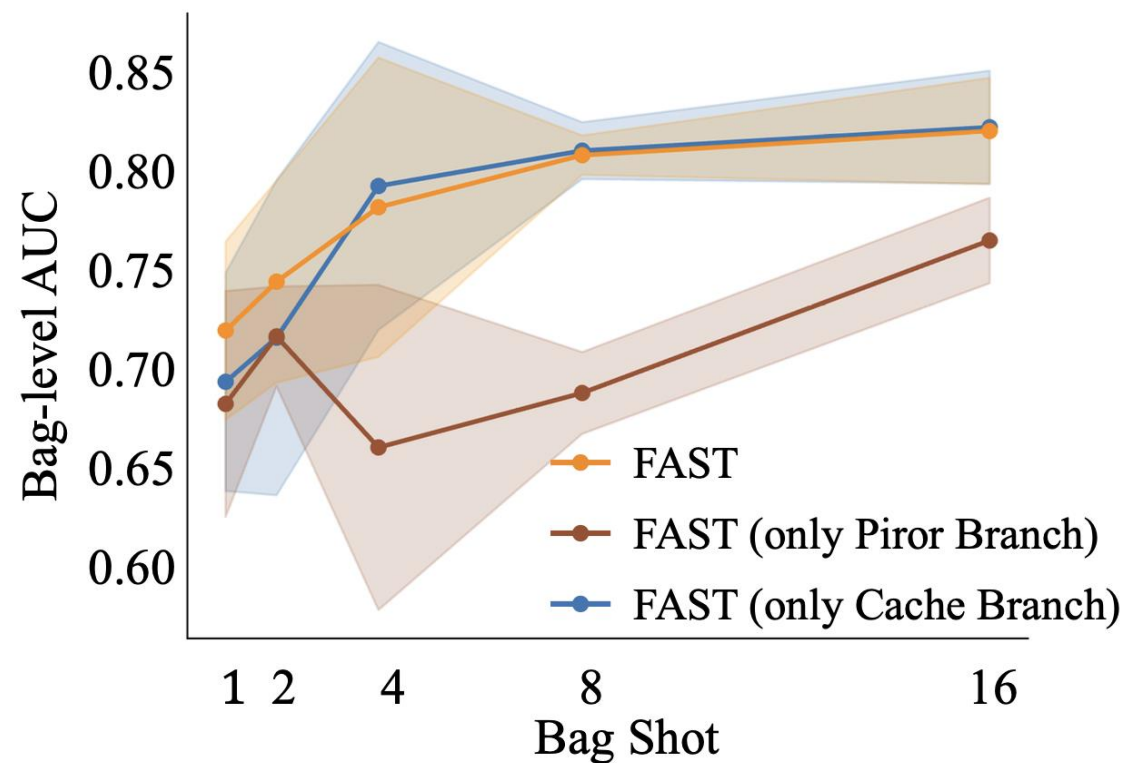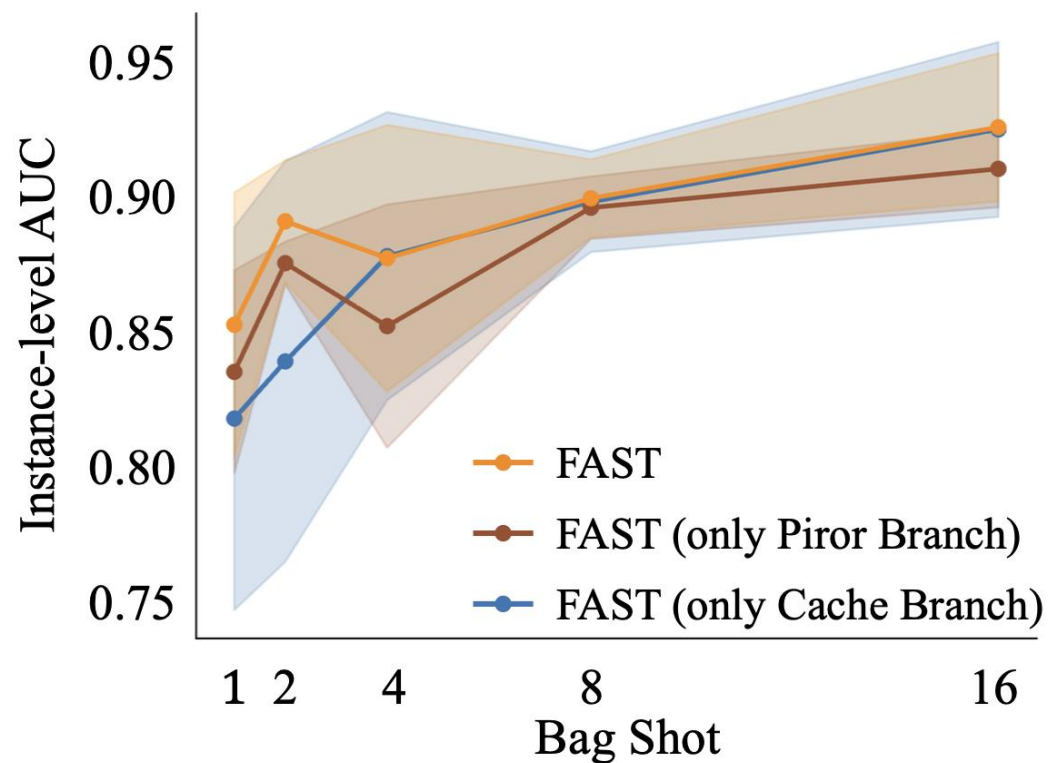## Comparison of cache branch and prior branch

Thanks