BiomedCCPL: Causal Conditional Prompt Learning for Biomedical Vision-Language Models

Supplementary Material

7. Dataset Details

Tab. 6 provides a comprehensive overview of the 11 biomedical datasets employed in our study, encompassing 9 distinct imaging modalities and 10 different anatomical organs. As detailed in Tab. 6, each dataset is characterized by its imaging modality, target organ(s), class labels, and the exact splits for training, validation, and testing. These datasets represent diverse clinical applications, including detecting kidney cysts in CT scans, classifying skin lesions in dermatoscopy, and grading knee osteoarthritis severity from X-rays. This variety in diseases and imaging modalities provides a broad and realistic foundation for evaluating our model. To better reflect clinical situations where labeled data is limited, we use a few-shot learning approach instead of the entire training set. Moreover, examples from each class are proportionally distributed across the splits to ensure consistency with the dataset's overall distribution.

8. Effect of Prototype Number

As described in Sec. 3.2, the VGAP module compresses image patch tokens into a compact set of N adaptive visual prototypes. The hyperparameter N controls the granularity of the visual clues injected into the prompt learning process. To investigate its impact, we conducted an ablation study by varying $N \in \{7, 14, 28\}$. As shown in Tab. 3, $N = 14$ yields the most robust overall performance. When N is reduced to 7, we observe a performance drop (e.g., the 16-shot accuracy decreases from 82.25% to 80.28%), suggesting that a limited number of prototypes is insufficient to preserve fine-grained diagnostic details. Conversely, increasing N to 28 also degrades performance (e.g., the Novel accuracy drops from 79.20% to 77.69%), indicating excessive prototypes tend to capture irrelevant background noise. Consequently, we adopt $N = 14$ (i.e., $N = \sqrt{M} = \sqrt{196}$) as the default setting in BiomedCCPL, where M denotes the number of patch tokens.

9. Effect of VGAP Application Depth

To identify a suitable interaction strategy, we examined how BiomedCCPL performs when VGAP is applied at different encoder depths. We focus on three representative layers (i.e., $\{3, 7, 11\}$), corresponding to the Shallow, Middle, and Deep depths. As shown in Tab. 4, applying VGAP at the Deep depth yields the highest Base accuracy (82.00%), benefiting from high-level semantics on seen classes. However, single-depth configurations show limited generalization to Novel classes. Combining multiple depths consistently boosts Novel accuracy, with the three-depth integration achieving the best Harmonic Mean (79.98%). This confirms that fusing multi-scale features is essential for generalizing to unseen classes.

Table 3. Ablation study on the number of adaptive visual prototypes (N) in the VGAP module.

Prototype	Base-to-Novel			Few-shot				
Number	Base	Novel	HM	1	2	4	8	16
7	80.23	78.25	79.23	59.82	64.47	70.98	76.75	80.28
14	**80.78**	**79.20**	**79.98**	**62.17**	64.86	71.49	**77.22**	**82.25**
28	80.64	77.69	79.14	60.93	**65.04**	**72.14**	76.29	81.43

Table 4. Ablation study on the VGAP application depth.

Depth			Base-to-Novel			Few-shot				
Shallow	Middle	Deep	Base	Novel	HM	1	2	4	8	16
✓	✗	✗	80.38	76.21	78.24	56.28	59.92	65.57	72.41	77.17
✗	✓	✗	80.77	76.10	78.36	57.22	59.49	68.06	71.70	77.67
✗	✗	✓	**82.00**	76.19	78.99	58.81	**65.00**	70.09	76.19	81.10
✓	✓	✗	80.07	77.19	78.60	58.40	61.14	67.86	73.38	76.79
✓	✗	✓	80.37	77.58	78.95	59.07	64.33	70.49	75.19	81.53
✗	✓	✓	81.13	76.23	78.60	60.59	62.85	69.39	75.62	81.11
✓	✓	✓	80.78	**79.20**	**79.98**	**62.17**	64.86	**71.49**	**77.22**	**82.25**

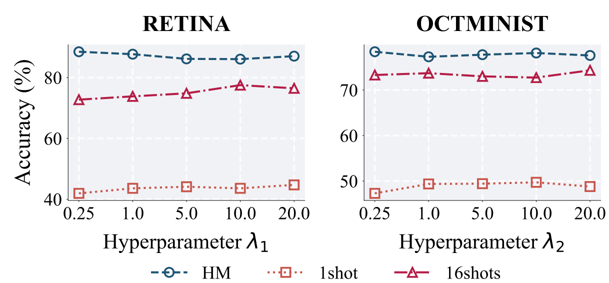

Figure 7. Sensitivity analysis of λ_1 on the RETINA dataset (left) and λ_2 on the OCTMNIST dataset (right). The accuracy is reported on the validation set.

10. Additional Hyperparameters

In this section, we provide additional details regarding the hyperparameter settings used in our experiments. To verify the robustness of our method, we evaluated BiomedCCPL under different parameter values. Figs. 7 and 8 illustrate the impact of varying λ_1, λ_2, and α on the validation accuracy for several representative datasets. The results indicate that the model maintains stable performance within a reasonable

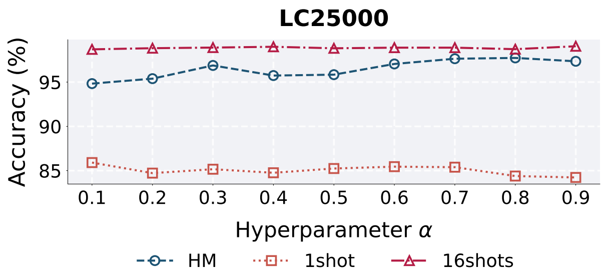

Figure 8. Sensitivity analysis of α on the LC25000 dataset. The accuracy is reported on the validation set.

Table 5. Hyperparameter settings for the Few-shot and Base-to-Novel tasks across all datasets.

Dataset	Task	λ_1	λ_2	α
BTMRI	Few-shot	20.0	1.00	0.30
	Base-to-Novel	1.00	5.00	0.80
BUSI	Few-shot	10.0	0.25	0.10
	Base-to-Novel	-	-	-
CHMNIST	Few-shot	0.25	10.0	0.80
	Base-to-Novel	1.00	5.00	0.90
COVID-QU-Ex	Few-shot	0.25	1.00	0.20
	Base-to-Novel	20.0	0.25	0.20
CTKIDNEY	Few-shot	20.0	1.00	0.30
	Base-to-Novel	10.0	0.25	0.20
DermaMNIST	Few-shot	20.0	20.0	0.20
	Base-to-Novel	10.0	10.0	0.70
KneeXray	Few-shot	1.00	20.0	0.10
	Base-to-Novel	5.00	0.25	0.10
Kvasir	Few-shot	10.0	0.25	0.50
	Base-to-Novel	10.0	0.25	0.40
LC25000	Few-shot	10.0	0.25	0.40
	Base-to-Novel	0.25	1.00	0.80
OCTMNIST	Few-shot	0.25	20.0	0.50
	Base-to-Novel	10.0	0.25	0.10
RETINA	Few-shot	10.0	0.25	0.30
	Base-to-Novel	0.25	1.00	0.90

range. Considering the diverse modalities and distinct characteristics of each dataset, we adopted specific hyperparameter settings to ensure optimal adaptation. Tab. 5 provides the detailed hyperparameter settings used for the Few-shot and Base-to-Novel tasks across all datasets.

11. Visual Interpretability

To qualitatively assess how different adaptation strategies influence model focus, we employed ScoreCAM [35] to generate saliency maps. Our analysis focuses on two dimensions: cross-modality consistency across Breast Ultrasound, Lung X-ray, and Dermatoscopy (Fig. 9), as well as class-wise discriminability among multiple categories within the COVID-QU-Ex dataset (Fig. 10). Specifically, column (a) shows the input images with ground truth annotations. CoCoOp (c) and BiomedCoOp (e) accurately localize diagnostic regions in Breast Ultrasound, while CoOp (b), MMA (d), and MMRL (f) produce more diffuse maps. However, CoCoOp and BiomedCoOp struggle on Lung X-ray and Dermatoscopy images. In contrast, our model BiomedCCPL's causal pathway (which our model solely relies on during inference) consistently aligns well with ground truth. Additionally, we visualize BiomedCCPL's non-causal pathway outputs (h) for comparison, although only the causal outputs are used at inference.

Fig. 11 provides more visualization results to contrast the localization of decoupled causal and non-causal pathways. The **non-causal pathway** (second row) tends to capture spurious correlations and background noise, such as healthy tissue textures in breast ultrasound, peripheral anatomical boundaries in lung X-rays, and hair artifacts in dermatoscopy images. In contrast, the **causal pathway** (third row), which is the sole pathway used for inference, accurately targets lesions and aligns consistently with ground truth annotations across all modalities. These supplementary results further illustrate the effectiveness of the causal prompt and decoupling mechanism. This precise localization of clinically relevant areas is crucial for enhancing model interpretability and fostering clinical acceptance.

12. Detailed Few-shot Results

Tabs. 7 and 8 present the detailed quantitative results for all 11 datasets. We report the mean accuracy and standard deviation over three independent runs for shot settings $K \in \{1, 2, 4, 8, 16\}$. Specifically, Tab. 7 summarizes the average performance across all datasets, alongside the results for individual datasets (BTMRI, BUSI, CHMNIST, COVID-QU-Ex, and CTKIDNEY). Results for the remaining datasets (DermaMNIST, KneeXray, Kvasir, LC25000, OCTMNIST, and RETINA) are listed in Tab. 8.

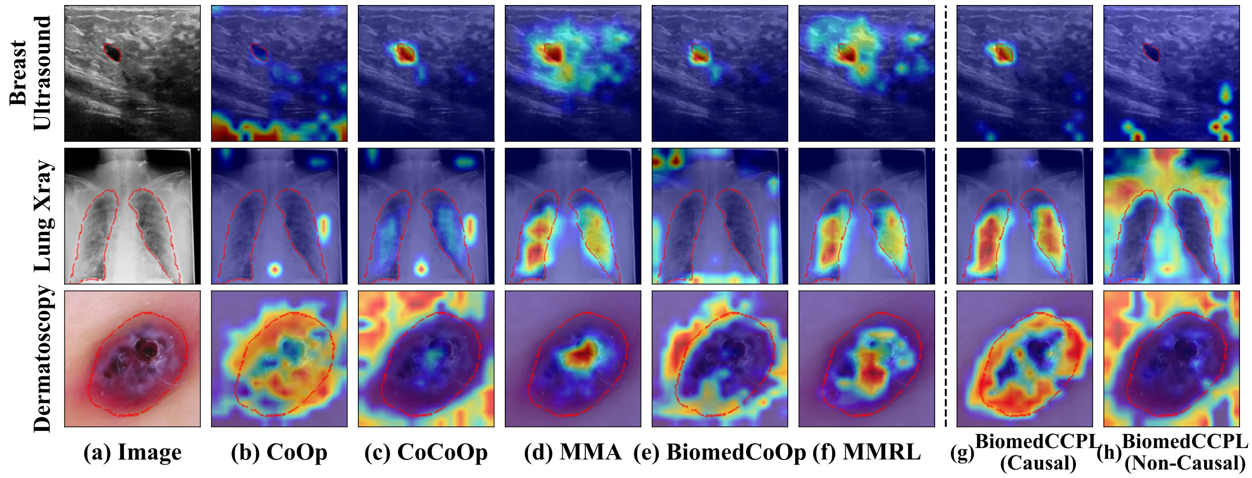

Figure 9. Saliency maps comparing different adaptation strategies across three medical imaging modalities.

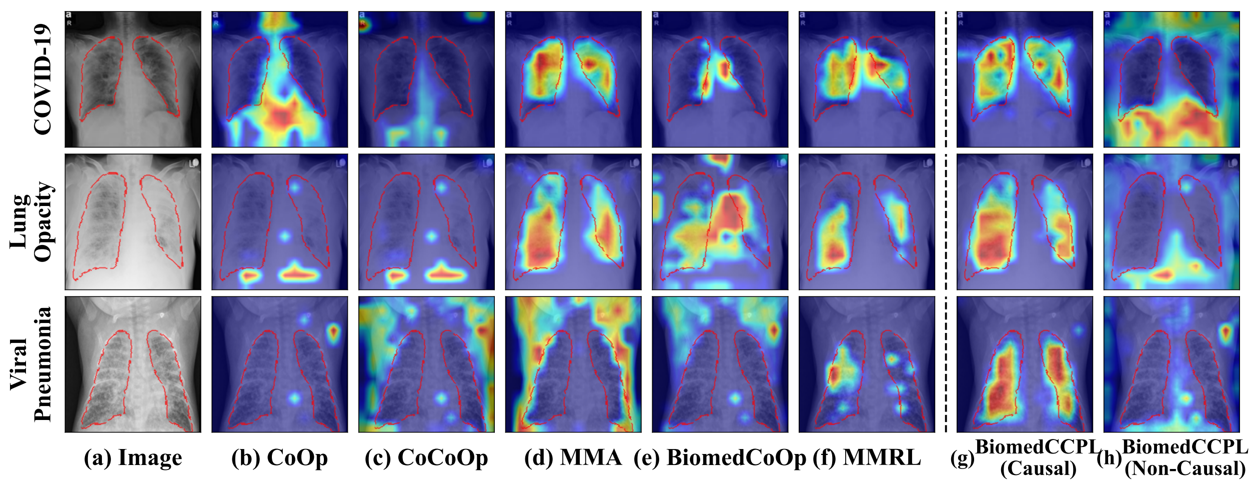

Figure 10. Class-specific saliency maps comparing different adaptation strategies on the COVID-QU-Ex dataset.

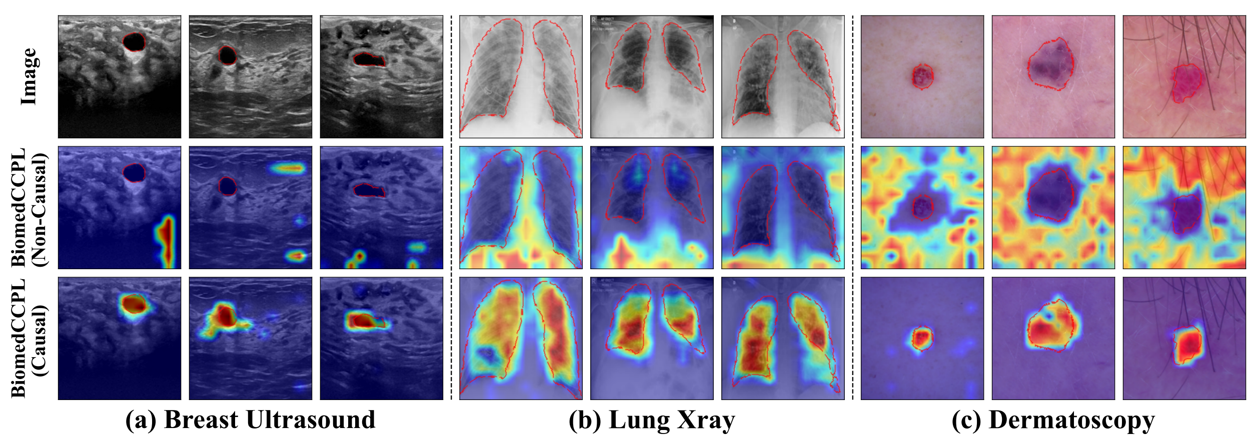

Figure 11. Saliency maps contrasting the localization behavior of the decoupled causal and non-causal pathways.

Table 6. An overview of the 11 datasets used spanning 9 biomedical imaging modalities and 10 different organs.

Name	Modality	Organ(s)	Classes	Train	Val	Test
BTMRI [23]	Magnetic Resonance Imaging	Brain	Glioma Tumor, Meningioma Tumor, Normal Brain, Pituitary Tumor	2854	1141	1717
BUSI [1]	Ultrasound	Breast	Benign Tumors, Malignant Tumors, Normal Scans	389	155	236
CHMNIST [15]	Histopathology	Colorectal	Adipose Tissue, Complex Stroma, Debris, Empty Background, Immune Cells, Normal Mucosal Glands, Simple Stroma, Tumor Epithelium	2496	1000	1504
COVID-QU-Ex [32]	X-Ray	Chest	COVID-19, Lung Opacity, Normal Lungs, Viral Pneumonia	10582	4232	6351
CTKIDNEY [14]	Computerized Tomography	Kidney	Kidney Cyst, Kidney Stone, Kidney Tumor, Normal Kidney	6221	2487	3738
DermaMNIST [7, 34]	Dermatoscopy	Skin	Actinic Keratosis, Basal Cell Carcinoma, Benign Keratosis, Dermatofibroma, Melanocytic nevus, Melanoma, Vascular Lesion	7007	1003	2005
KneeXray [6]	X-Ray	Knee	No, Doubtful, Minimal, Moderate, and Severe Osteoarthritis	5778	826	1656
Kvasir [27]	Endoscopy	Colon	Dyed Lifted Polyps, Normal Cecum, Esophagitis, Dyed Resection Margins, Normal Pylorus, Normal Z Line, Polyps, Ulcerative Colitis	2000	800	1200
LC25000 [4]	Histopathology	Lung, Colon	Colon Adenocarcinoma, Colon Benign Tissue, Lung Adenocarcinoma, Lung Benign Tissue, Lung Squamous Cell Carcinoma	12500	5000	7500
OCTMNIST [16]	Optical Coherence Tomography	Retina	Choroidal Neovascularization, Drusen, Diabetic Macular Edema, Normal	97477	10832	1000
RETINA [19, 28]	Fundus Photography	Retina	Cataract, Diabetic Retinopathy, Glaucoma, Normal Retina	2108	841	1268

Table 7. Detailed comparison of few-shot performance (Part I). We report the results (mean ± standard deviation) for the average performance across 11 datasets, alongside the results for individual datasets (BTMRI, BUSI, CHMNIST, COVID-QU-Ex, and CTKIDNEY).

Dataset	Method	$K=1$	$K=2$	$K=4$	$K=8$	$K=16$
AVERAGE	CoOp	$50.18_{\pm 5.69}$	$54.17_{\pm 3.80}$	$59.77_{\pm 3.25}$	$65.85_{\pm 2.87}$	$69.72_{\pm 2.22}$
	CoCoOp	$48.53_{\pm 3.91}$	$51.28_{\pm 4.02}$	$54.69_{\pm 4.05}$	$61.09_{\pm 2.84}$	$65.10_{\pm 2.28}$
	KgCoOp	$51.89_{\pm 4.50}$	$53.34_{\pm 4.25}$	$58.71_{\pm 3.64}$	$63.53_{\pm 2.08}$	$64.90_{\pm 1.65}$
	ProGrad	$52.37_{\pm 4.55}$	$54.39_{\pm 3.78}$	$60.03_{\pm 3.74}$	$65.64_{\pm 2.85}$	$66.96_{\pm 2.35}$
	MMA	$51.40_{\pm 3.25}$	$54.33_{\pm 4.35}$	$63.30_{\pm 3.98}$	$70.29_{\pm 2.07}$	$75.24_{\pm 1.21}$
	MMRL	$52.93_{\pm 4.70}$	$57.17_{\pm 4.16}$	$64.03_{\pm 3.41}$	$69.85_{\pm 2.43}$	$74.53_{\pm 1.56}$
	BiomedCoOp	$56.69_{\pm 2.55}$	$58.55_{\pm 2.79}$	$64.45_{\pm 2.67}$	$68.83_{\pm 2.03}$	$72.14_{\pm 1.49}$
	BiomedCCPL (Ours)	$\mathbf{62.17_{\pm 3.01}}$	$\mathbf{64.86_{\pm 4.33}}$	$\mathbf{71.49_{\pm 3.76}}$	$\mathbf{77.22_{\pm 2.96}}$	$\mathbf{82.25_{\pm 2.19}}$
BTMRI	CoOp	$63.82_{\pm 3.94}$	$68.80_{\pm 5.18}$	$74.68_{\pm 2.99}$	$79.27_{\pm 1.90}$	$82.35_{\pm 1.87}$
	CoCoOp	$59.47_{\pm 0.78}$	$64.12_{\pm 0.67}$	$67.83_{\pm 4.80}$	$71.71_{\pm 4.38}$	$78.45_{\pm 1.83}$
	KgCoOp	$63.33_{\pm 3.69}$	$70.14_{\pm 5.45}$	$75.40_{\pm 2.45}$	$79.81_{\pm 1.01}$	$81.09_{\pm 0.35}$
	ProGrad	$66.36_{\pm 2.84}$	$71.44_{\pm 3.22}$	$74.96_{\pm 4.96}$	$79.13_{\pm 1.65}$	$82.64_{\pm 1.20}$
	MMA	$59.84_{\pm 3.49}$	$63.02_{\pm 4.06}$	$73.60_{\pm 3.98}$	$80.89_{\pm 3.01}$	$85.73_{\pm 0.29}$
	MMRL	$61.93_{\pm 6.11}$	$67.02_{\pm 5.98}$	$72.88_{\pm 1.14}$	$77.09_{\pm 4.66}$	$82.10_{\pm 0.23}$
	BiomedCoOp	$65.07_{\pm 2.40}$	$70.18_{\pm 4.37}$	$76.14_{\pm 3.97}$	$79.03_{\pm 2.53}$	$82.96_{\pm 1.41}$
	BiomedCCPL (Ours)	$\mathbf{71.64_{\pm 6.27}}$	$\mathbf{77.64_{\pm 5.92}}$	$\mathbf{84.45_{\pm 1.67}}$	$\mathbf{93.90_{\pm 3.85}}$	$\mathbf{96.37_{\pm 0.29}}$
BUSI	CoOp	$48.87_{\pm 3.21}$	$53.39_{\pm 2.61}$	$60.31_{\pm 3.48}$	$64.69_{\pm 6.23}$	$69.49_{\pm 3.30}$
	CoCoOp	$52.26_{\pm 3.73}$	$49.15_{\pm 2.77}$	$59.75_{\pm 1.83}$	$65.82_{\pm 3.83}$	$70.20_{\pm 1.22}$
	KgCoOp	$53.39_{\pm 7.25}$	$55.51_{\pm 3.30}$	$62.15_{\pm 4.23}$	$67.37_{\pm 2.42}$	$70.62_{\pm 2.11}$
	ProGrad	$50.43_{\pm 2.99}$	$47.60_{\pm 6.54}$	$62.29_{\pm 4.99}$	$66.38_{\pm 6.44}$	$68.93_{\pm 3.33}$
	MMA	$\mathbf{60.31_{\pm 2.94}}$	$58.76_{\pm 3.83}$	$65.82_{\pm 4.17}$	$\mathbf{72.03_{\pm 1.04}}$	$73.87_{\pm 2.08}$
	MMRL	$53.39_{\pm 10.14}$	$\mathbf{60.03_{\pm 2.12}}$	$\mathbf{65.96_{\pm 5.90}}$	$70.34_{\pm 1.83}$	$74.86_{\pm 0.72}$
	BiomedCoOp	$49.15_{\pm 5.02}$	$52.12_{\pm 4.21}$	$64.13_{\pm 5.04}$	$64.97_{\pm 3.14}$	$69.07_{\pm 0.00}$
	BiomedCCPL (Ours)	$58.62_{\pm 1.63}$	$54.94_{\pm 10.03}$	$62.29_{\pm 11.90}$	$70.20_{\pm 3.10}$	$\mathbf{80.37_{\pm 4.38}}$
CHMNIST	CoOp	$57.38_{\pm 4.17}$	$59.68_{\pm 1.12}$	$68.68_{\pm 2.11}$	$75.04_{\pm 0.76}$	$79.65_{\pm 1.28}$
	CoCoOp	$49.09_{\pm 4.38}$	$50.84_{\pm 3.43}$	$58.58_{\pm 2.15}$	$66.58_{\pm 1.14}$	$72.19_{\pm 0.52}$
	KgCoOp	$59.02_{\pm 4.10}$	$60.09_{\pm 1.10}$	$68.75_{\pm 1.03}$	$69.52_{\pm 0.08}$	$73.58_{\pm 1.19}$
	ProGrad	$59.42_{\pm 5.18}$	$59.71_{\pm 1.68}$	$69.21_{\pm 1.36}$	$71.10_{\pm 0.35}$	$74.82_{\pm 0.65}$
	MMA	$54.72_{\pm 1.93}$	$60.70_{\pm 4.14}$	$74.05_{\pm 3.15}$	$82.29_{\pm 1.20}$	$86.12_{\pm 0.98}$
	MMRL	$59.62_{\pm 1.63}$	$66.44_{\pm 0.60}$	$74.49_{\pm 1.03}$	$80.19_{\pm 1.61}$	$84.98_{\pm 0.41}$
	BiomedCoOp	$59.55_{\pm 2.66}$	$59.53_{\pm 0.88}$	$71.45_{\pm 1.75}$	$75.29_{\pm 1.16}$	$79.12_{\pm 1.52}$
	BiomedCCPL (Ours)	$\mathbf{63.76_{\pm 4.78}}$	$\mathbf{69.10_{\pm 2.66}}$	$\mathbf{80.27_{\pm 3.38}}$	$\mathbf{87.55_{\pm 0.79}}$	$\mathbf{90.29_{\pm 0.71}}$
COVID-QU-Ex	CoOp	$58.81_{\pm 14.49}$	$58.35_{\pm 8.12}$	$67.02_{\pm 6.58}$	$74.65_{\pm 0.28}$	$76.36_{\pm 1.39}$
	CoCoOp	$69.77_{\pm 2.77}$	$68.80_{\pm 2.65}$	$63.78_{\pm 10.28}$	$69.36_{\pm 3.27}$	$74.52_{\pm 0.73}$
	KgCoOp	$61.69_{\pm 9.85}$	$54.69_{\pm 12.18}$	$65.91_{\pm 8.62}$	$74.85_{\pm 0.29}$	$75.65_{\pm 0.88}$
	ProGrad	$63.39_{\pm 7.99}$	$65.84_{\pm 5.16}$	$68.39_{\pm 4.93}$	$74.22_{\pm 1.02}$	$75.12_{\pm 0.82}$
	MMA	$58.89_{\pm 4.39}$	$55.19_{\pm 6.76}$	$66.66_{\pm 4.38}$	$72.55_{\pm 0.18}$	$77.45_{\pm 1.12}$
	MMRL	$61.04_{\pm 10.05}$	$57.95_{\pm 13.01}$	$61.85_{\pm 6.40}$	$72.79_{\pm 2.48}$	$77.23_{\pm 0.31}$
	BiomedCoOp	$72.22_{\pm 2.61}$	$\mathbf{72.83_{\pm 1.37}}$	$72.01_{\pm 3.44}$	$76.19_{\pm 0.84}$	$77.90_{\pm 0.30}$
	BiomedCCPL (Ours)	$\mathbf{72.77_{\pm 4.03}}$	$72.62_{\pm 8.39}$	$\mathbf{76.24_{\pm 2.95}}$	$\mathbf{86.44_{\pm 1.64}}$	$\mathbf{88.33_{\pm 2.71}}$
CTKIDNEY	CoOp	$54.51_{\pm 8.75}$	$60.54_{\pm 2.26}$	$68.13_{\pm 2.11}$	$77.40_{\pm 3.87}$	$83.50_{\pm 1.81}$
	CoCoOp	$47.88_{\pm 7.72}$	$52.71_{\pm 9.71}$	$61.06_{\pm 1.35}$	$73.93_{\pm 1.50}$	$77.70_{\pm 2.65}$
	KgCoOp	$58.92_{\pm 1.27}$	$62.82_{\pm 3.41}$	$68.67_{\pm 5.54}$	$77.45_{\pm 4.18}$	$77.68_{\pm 3.11}$
	ProGrad	$52.35_{\pm 6.89}$	$63.32_{\pm 5.32}$	$68.10_{\pm 2.89}$	$78.47_{\pm 5.28}$	$81.25_{\pm 2.26}$
	MMA	$57.08_{\pm 2.91}$	$57.81_{\pm 7.98}$	$68.89_{\pm 7.18}$	$\mathbf{85.96_{\pm 0.00}}$	$89.84_{\pm 0.10}$
	MMRL	$53.65_{\pm 0.94}$	$67.75_{\pm 7.07}$	$73.90_{\pm 3.30}$	$80.83_{\pm 5.40}$	$87.14_{\pm 2.73}$
	BiomedCoOp	$54.97_{\pm 4.44}$	$58.97_{\pm 6.76}$	$69.13_{\pm 4.28}$	$77.14_{\pm 4.99}$	$82.91_{\pm 1.91}$
	BiomedCCPL (Ours)	$\mathbf{61.98_{\pm 3.47}}$	$\mathbf{67.90_{\pm 2.64}}$	$\mathbf{76.29_{\pm 4.04}}$	$85.29_{\pm 4.20}$	$\mathbf{93.25_{\pm 1.77}}$

Table 8. Detailed comparison of few-shot performance (Part II). We report the results (mean ± standard deviation) for individual datasets (DermaMNIST, KneeXray, Kvasir, LC25000, OCTMNIST, and RETINA).

Dataset	Method	$K=1$	$K=2$	$K=4$	$K=8$	$K=16$
DermaMNIST	CoOp	$25.93_{\pm 9.03}$	$38.93_{\pm 6.02}$	$43.69_{\pm 6.28}$	$46.83_{\pm 6.79}$	$51.12_{\pm 2.53}$
	CoCoOp	$24.51_{\pm 4.22}$	$24.96_{\pm 0.73}$	$25.29_{\pm 5.61}$	$40.42_{\pm 2.44}$	$40.97_{\pm 6.50}$
	KgCoOp	$27.06_{\pm 10.83}$	$30.29_{\pm 4.45}$	$35.35_{\pm 8.07}$	$38.75_{\pm 4.83}$	$36.59_{\pm 2.32}$
	ProGrad	$35.96_{\pm 10.83}$	$35.54_{\pm 6.48}$	$43.04_{\pm 10.16}$	$50.99_{\pm 2.52}$	$46.39_{\pm 4.51}$
	MMA	$32.19_{\pm 4.90}$	$27.71_{\pm 6.08}$	$47.35_{\pm 7.68}$	$49.97_{\pm 3.75}$	$55.26_{\pm 3.31}$
	MMRL	$29.87_{\pm 12.18}$	$34.24_{\pm 6.56}$	$50.72_{\pm 8.10}$	$54.47_{\pm 2.25}$	$56.99_{\pm 2.00}$
	BiomedCoOp	$57.87_{\pm 0.70}$	$57.13_{\pm 0.63}$	$61.28_{\pm 2.93}$	$61.28_{\pm 0.58}$	$61.60_{\pm 0.47}$
	BiomedCCPL (Ours)	$\mathbf{65.28_{\pm 2.11}}$	$\mathbf{60.03_{\pm 5.32}}$	$\mathbf{62.39_{\pm 4.48}}$	$\mathbf{66.78_{\pm 1.20}}$	$\mathbf{67.02_{\pm 1.37}}$
KneeXray	CoOp	$24.98_{\pm 9.41}$	$25.87_{\pm 5.04}$	$23.89_{\pm 4.21}$	$26.25_{\pm 4.04}$	$28.50_{\pm 1.89}$
	CoCoOp	$25.42_{\pm 6.38}$	$28.85_{\pm 8.24}$	$30.66_{\pm 4.49}$	$21.80_{\pm 8.21}$	$24.84_{\pm 4.15}$
	KgCoOp	$29.73_{\pm 2.54}$	$26.69_{\pm 5.31}$	$23.63_{\pm 3.58}$	$23.41_{\pm 2.54}$	$24.94_{\pm 0.61}$
	ProGrad	$29.11_{\pm 4.85}$	$24.66_{\pm 1.47}$	$24.12_{\pm 3.31}$	$23.83_{\pm 2.15}$	$26.17_{\pm 3.65}$
	MMA	$27.35_{\pm 4.72}$	$30.84_{\pm 6.14}$	$32.61_{\pm 6.88}$	$27.88_{\pm 5.57}$	$37.44_{\pm 1.21}$
	MMRL	$30.05_{\pm 1.45}$	$29.08_{\pm 4.82}$	$31.90_{\pm 4.92}$	$30.51_{\pm 3.33}$	$36.63_{\pm 4.74}$
	BiomedCoOp	$36.31_{\pm 2.40}$	$39.17_{\pm 0.62}$	$37.60_{\pm 1.44}$	$38.21_{\pm 1.27}$	$39.90_{\pm 1.23}$
	BiomedCCPL (Ours)	$\mathbf{38.75_{\pm 0.36}}$	$\mathbf{38.89_{\pm 0.56}}$	$\mathbf{39.23_{\pm 0.57}}$	$\mathbf{40.28_{\pm 1.06}}$	$\mathbf{42.53_{\pm 3.59}}$
Kvasir	CoOp	$58.14_{\pm 1.68}$	$64.92_{\pm 1.43}$	$70.78_{\pm 0.31}$	$77.14_{\pm 1.25}$	$78.92_{\pm 1.48}$
	CoCoOp	$59.45_{\pm 3.25}$	$65.50_{\pm 3.41}$	$68.94_{\pm 1.29}$	$72.94_{\pm 1.43}$	$75.22_{\pm 2.04}$
	KgCoOp	$61.67_{\pm 2.16}$	$65.67_{\pm 1.94}$	$68.31_{\pm 0.32}$	$72.05_{\pm 1.80}$	$72.94_{\pm 1.26}$
	ProGrad	$60.28_{\pm 0.59}$	$64.03_{\pm 0.81}$	$69.78_{\pm 0.27}$	$75.78_{\pm 1.91}$	$77.22_{\pm 0.82}$
	MMA	$61.83_{\pm 1.87}$	$66.47_{\pm 1.26}$	$71.75_{\pm 2.54}$	$77.97_{\pm 0.53}$	$81.92_{\pm 0.36}$
	MMRL	$60.44_{\pm 1.20}$	$68.78_{\pm 0.57}$	$71.44_{\pm 2.21}$	$77.56_{\pm 0.83}$	$79.22_{\pm 0.63}$
	BiomedCoOp	$63.14_{\pm 1.81}$	$65.53_{\pm 2.36}$	$72.58_{\pm 0.36}$	$77.80_{\pm 0.50}$	$79.17_{\pm 1.27}$
	BiomedCCPL (Ours)	$\mathbf{68.05_{\pm 1.19}}$	$\mathbf{74.97_{\pm 3.95}}$	$\mathbf{85.83_{\pm 2.02}}$	$\mathbf{91.75_{\pm 2.34}}$	$\mathbf{93.28_{\pm 0.32}}$
LC25000	CoOp	$71.90_{\pm 3.53}$	$76.55_{\pm 2.80}$	$84.66_{\pm 2.26}$	$87.49_{\pm 0.26}$	$92.20_{\pm 0.49}$
	CoCoOp	$63.67_{\pm 4.50}$	$71.76_{\pm 0.55}$	$77.42_{\pm 2.46}$	$85.56_{\pm 1.83}$	$87.37_{\pm 0.52}$
	KgCoOp	$71.78_{\pm 2.11}$	$75.18_{\pm 1.04}$	$82.11_{\pm 2.35}$	$84.63_{\pm 0.30}$	$86.80_{\pm 0.53}$
	ProGrad	$72.28_{\pm 1.79}$	$75.34_{\pm 2.39}$	$84.36_{\pm 2.94}$	$87.51_{\pm 1.00}$	$90.71_{\pm 0.36}$
	MMA	$70.15_{\pm 0.59}$	$74.30_{\pm 1.35}$	$85.04_{\pm 0.83}$	$90.14_{\pm 1.06}$	$94.62_{\pm 0.42}$
	MMRL	$75.36_{\pm 2.74}$	$76.93_{\pm 1.27}$	$86.40_{\pm 0.88}$	$89.94_{\pm 0.87}$	$93.38_{\pm 0.77}$
	BiomedCoOp	$78.08_{\pm 2.37}$	$77.70_{\pm 1.28}$	$86.47_{\pm 1.56}$	$89.24_{\pm 0.26}$	$92.64_{\pm 0.82}$
	BiomedCCPL (Ours)	$\mathbf{88.61_{\pm 1.34}}$	$\mathbf{89.74_{\pm 2.47}}$	$\mathbf{97.69_{\pm 0.68}}$	$\mathbf{99.14_{\pm 0.74}}$	$\mathbf{99.99_{\pm 0.00}}$
OCTMNIST	CoOp	$52.63_{\pm 2.95}$	$53.60_{\pm 3.89}$	$53.37_{\pm 2.35}$	$63.70_{\pm 4.42}$	$65.47_{\pm 7.47}$
	CoCoOp	$49.33_{\pm 4.58}$	$50.93_{\pm 8.01}$	$48.57_{\pm 6.25}$	$55.40_{\pm 1.88}$	$60.70_{\pm 3.37}$
	KgCoOp	$50.63_{\pm 3.18}$	$50.50_{\pm 5.44}$	$52.97_{\pm 1.58}$	$61.03_{\pm 3.78}$	$62.80_{\pm 3.85}$
	ProGrad	$52.70_{\pm 3.97}$	$55.00_{\pm 4.45}$	$52.77_{\pm 1.53}$	$62.70_{\pm 7.01}$	$63.60_{\pm 5.87}$
	MMA	$51.87_{\pm 1.39}$	$57.73_{\pm 3.91}$	$59.30_{\pm 0.36}$	$71.73_{\pm 3.92}$	$76.57_{\pm 1.04}$
	MMRL	$\mathbf{56.77_{\pm 0.93}}$	$57.07_{\pm 2.26}$	$\mathbf{64.63_{\pm 2.24}}$	$\mathbf{77.33_{\pm 2.34}}$	$\mathbf{81.17_{\pm 3.73}}$
	BiomedCoOp	$51.17_{\pm 1.25}$	$54.67_{\pm 5.81}$	$52.53_{\pm 2.46}$	$60.90_{\pm 5.07}$	$67.07_{\pm 4.88}$
	BiomedCCPL (Ours)	$49.73_{\pm 4.47}$	$\mathbf{59.37_{\pm 0.69}}$	$63.83_{\pm 1.94}$	$68.87_{\pm 3.17}$	$74.63_{\pm 6.49}$
RETINA	CoOp	$34.99_{\pm 1.42}$	$35.20_{\pm 3.32}$	$42.24_{\pm 3.11}$	$51.89_{\pm 1.80}$	$59.38_{\pm 0.87}$
	CoCoOp	$32.96_{\pm 0.73}$	$36.46_{\pm 4.09}$	$39.75_{\pm 3.99}$	$48.48_{\pm 1.35}$	$53.89_{\pm 1.55}$
	KgCoOp	$33.54_{\pm 2.48}$	$35.14_{\pm 3.13}$	$42.61_{\pm 2.24}$	$50.00_{\pm 1.68}$	$51.21_{\pm 1.95}$
	ProGrad	$33.83_{\pm 2.18}$	$35.78_{\pm 4.10}$	$43.30_{\pm 3.85}$	$51.97_{\pm 2.02}$	$49.74_{\pm 2.35}$
	MMA	$31.15_{\pm 6.64}$	$45.14_{\pm 2.31}$	$51.21_{\pm 2.59}$	$\mathbf{61.78_{\pm 2.49}}$	$68.87_{\pm 2.38}$
	MMRL	$40.14_{\pm 4.28}$	$43.56_{\pm 1.45}$	$50.21_{\pm 1.37}$	$57.25_{\pm 1.12}$	$66.17_{\pm 0.94}$
	BiomedCoOp	$36.07_{\pm 2.42}$	$36.20_{\pm 2.41}$	$45.58_{\pm 2.11}$	$57.13_{\pm 1.95}$	$61.25_{\pm 2.53}$
	BiomedCCPL (Ours)	$\mathbf{44.72_{\pm 3.45}}$	$\mathbf{48.21_{\pm 5.02}}$	$\mathbf{57.89_{\pm 7.75}}$	$59.17_{\pm 10.43}$	$\mathbf{78.71_{\pm 2.45}}$