TailedCore: Few-Shot Sampling for Unsupervised Long-Tail Noisy Anomaly Detection

Supplementary Material

9. Supplementary to Method

We state the assumption and proposition from Sec. 5 here in a more rigorous, detailed manner:

Assumption. Let $p_{same}(s|e_i)$ denote the distribution of cosine similarity between e_i and (random vector) embedding e of a same class sample. On the other hand, let $p_{diff}(s|e_i)$ denote the distribution of cosine similarity between e_i and (random vector) embedding e of a different class sample. Then, a reflective symmetry holds between p_{same} and p_{diff} in terms of their angles:

$$p_{same}(\cos(a)|e_i) = p_{diff}(\cos(a_{\max} - a)|e_i). \tag{13}$$

where $a = \arccos(s)$ and $a_{\max} = \arccos(m_i)$. Recall that m_i is the minimum of the support of the inter-class similarity distribution $p_{diff}(\cdot|e_i)$.

Fig. 6 in Supp. 9 shows the feasibility of the above symmetric assumption. We prove Prop. **??** under a reasonable regularity condition, whose trend is evidenced by Fig. 6. Below, we denote by $supp$ the support of a distribution, and for notational brevity, we let $supp(p_{same}) := supp(p(\cdot|e_i))$ and similarly for p_{diff}.

Proposition 1. *For distributions $p_{same}(s|e_i)$ and $p_{diff}(s|e_i)$ that are weakly increasing and decreasing, respectively, let $supp(p_{same})$ be disjoint with $supp(p_{diff})$ and $\max supp(p_{same}) = 1$ Then the threshold given by $\tau_i = \cos(\arccos(m_i)/2)$ separates the supports by*

$$\max supp(p_{diff}) < \tau_i < \min supp(p_{same}), \tag{14}$$

and maximizes the distance between τ_i and $supp(p_{diff}) \cup supp(p_{same})$ under arccosine transformation.

Note that the radius satisfies $r_i = 1 - \tau_i$

Proof. Let $f(a) = p_{same}(\cos a)$ and $g(a) = p_{diff}(\cos a)$ for $0 \le a \le \pi$. Then, by the assumptions from the above, $f(a)$ is decreasing and $g(a)$ is increasing. Since $\max supp(p_{same}) = 1$, we have $\min supp f = 0$. Due to the reflective symmetry, we have

$$f(a) = g(a_{\max} - a), \tag{15}$$

or

$$f(a_{\max}/2 - a) = g(a_{\max}/2 + a). \tag{16}$$

Since $\cos$ is 1-to-1 for the given range of a, disjointness of supports for p_{same} and p_{diff} is preserved for the supports of f and g. Since f is decreasing and g is increasing,

$$a_{\max}/2 \notin supp(f) \cup supp(g), \tag{17}$$

showing that $a_{\max}/2$ separates the supports of f and g. Moreover,

$$a_{\max}/2 = \operatorname*{argmax}_a d(a, supp(f) \cup supp(g))) \tag{18}$$

where d is set distance. Observing that

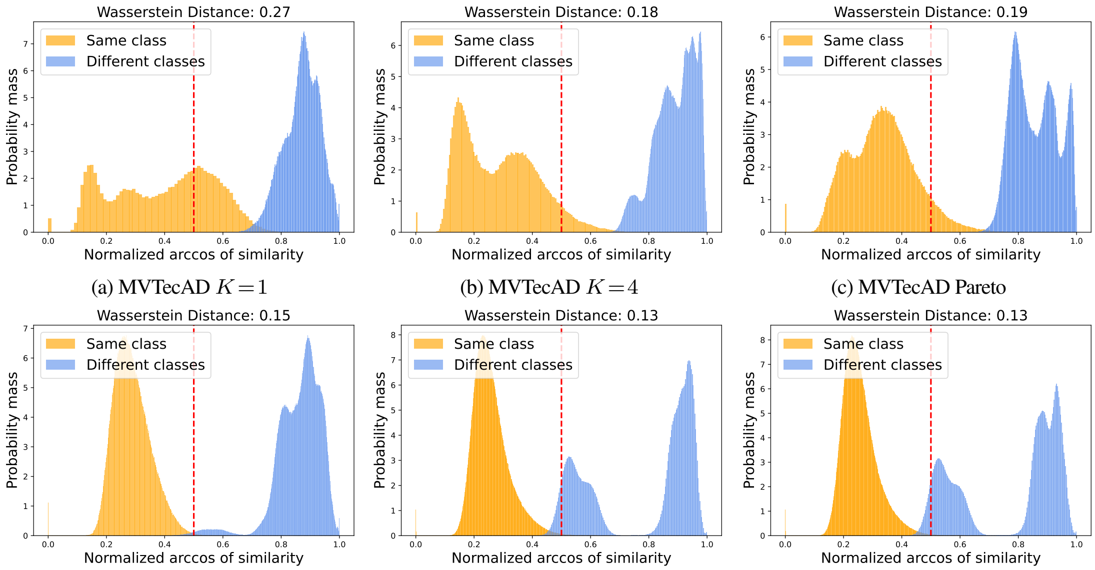
$$a_{\max}/2 = \arccos(m_i)/2 = \arccos(r_i) \tag{19}$$

completes the proof. □

10. Supplementary to Analysis

10.1. Qualitative analysis

Qualitative results of segmentation heatmap are given in Fig. 7, which shores the anomaly scores on the image pixel level. The result shows a trend that TailedCore resolves a performance trade-off between SoftPatch and PatchCore.



(a) MVTecAD $K=1$ (b) MVTecAD $K=4$ (c) MVTecAD Pareto

(d) VisA $K=1$ (e) VisA $K=4$ (f) VisA Pareto

Figure 6. Empirical validation of the assumption in Sec. 5, showing that the inter-class and intra-class similarity distributions approximately exhibit reflective symmetry discussed in the assumption in Sec. 5 and 9

Table 7. Experiments on TailedCore with mix perturbed data in the tail class denoted as TailPert where p is the perturbed ratio, SoftPatch + DBSCAN/K-Means, using transformer's classification token for TailSampler, and noise in tail classes denoted as NoisyTail.

tail type	Pareto			step ($K=4$)			step ($K=1$)		
class type	C_t	C_h	all	C_t	C_h	all	C_t	C_h	all
TailPert $p=0.1$	96.4 / 96.2	95.2 / 94.1	95.9 / 95.2	96.1 / 96.1	95.9 / 93.5	96 / 95.1	93.7 / 93.8	95.4 / 92	94.4 / 93.1
TailPert $p=0.3$	96.2 / 96	95.1 / 94.1	95.8 / 95.1	96.1 / 96.1	95.9 / 93.5	96 / 95.1	93.5 / 93.7	95.7 / 91.9	94.4 / 93
TailPert $p=0.5$	96 / 96	94.5 / 94.9	95.8 / 95.1	95.9 / 96.1	95.6 / 93	95.8 / 94.9	92.5 / 93.3	95.5 / 92	93.7 / 92.8
DBSCAN [13]-SoftPatch [20]	87 / 93.5	93.3 / 95.3	90.6 / 94.4	71.8 / 84.2	97.6 / 96.3	82.2 / 89.1	63.5 / 71.3	97.8 / 96.5	77.2 / 81.4
Kmeans [2]-SoftPatch [20]	86.7 / 92.8	92.5 / 95.1	90.5 / 94.1	71.8 / 83.4	97.6 / 96.4	82.2 / 88.7	63.5 / 71	97.8 / 96.8	77.2 / 81.3
ViT-L [12] ClsToken	96.6 / 96.5	95.3 / 95.3	96.1 / 95.7	96 / 95.5	95.9 / 94.4	96 / 95.2	93.4 / 94.2	96.1 / 95.1	94.5 / 94.6
Noisy Tail	-	-	-	92.3 / 94	95.6 / 92.4	93.7 / 93.5	-	-	-
SoftPatch [20]	84.7 / 92.2	87.0 / 93.8	87.7 / 93.41	67.7 / 81	97.5 / 96.5	79.6 / 87.2	60.7 / 70.3	97.5 / 96.9	75.4 / 81
Ours	96.6 / 96.1	95.2 / 95	96.1 / 95.3	95.8 / 95.6	95.3 / 93.2	95.7 / 94.7	93.5 / 94.2	95.8 / 93.7	94.4 / 94

10.2. Additional experiments and analysis

We conduct additional experiments in order to verify the strengthness of TailedCore with results in Tab. 7. First of all, we perturb the tail class samples with $brightness=0.5, constrast=0.5, saturation=0.5, hue=0.1$ perturbation with the ratio $p \in \{0.1, 0.3, 0.5\}$. Besides the extreme case where $k=1$, the effect of perturbation is not remarkable showing the robustness of TailedCore.

Secondly, we verify the robustness of TailSampler by substituting it with other unsupervised clustering methods which are DBSCAN [13] and K-Means [2] clustering. For this experiment, we have set the threshold of tail classes to less than 20 samples and normalized with L2 normalization. For hyperparameters, we used $eps=0.5$, $min\_samples=2$ for DBSCAN and $k=20$ for KMeans. DBSCAN-SoftPatch sometimes successfully generated 15 clusters+noise class resulting in 16 clusters in total, but often fails and generates more or less clusters. For Kmeans-SoftPatch, we have tried $k=15$, which is the number of classes of MVTec-AD, but this failed detecting any long-tailed clusters. Therefore, we attempted $k=20$ and acquired results as shown in Tab. 7.

Additionally, we substitute CNN with ViT-L [12], specifically the global average pooling feature of CNN with classification token for TailSampler which increased the results slightly as shown in Tab. 7 denoted as "ViT-L ClsToken".

We also test our method when tail classes are contaminated with noise denoted as Noisy Tail. Without the information of classes in an anomalous few-shot scenario, anomalies can't be statistically classified as abnormal from a statistical perspective. Our method tends to specifically address only those instances that are statistically confirmed to be anomalous. Such scenario is tested by including

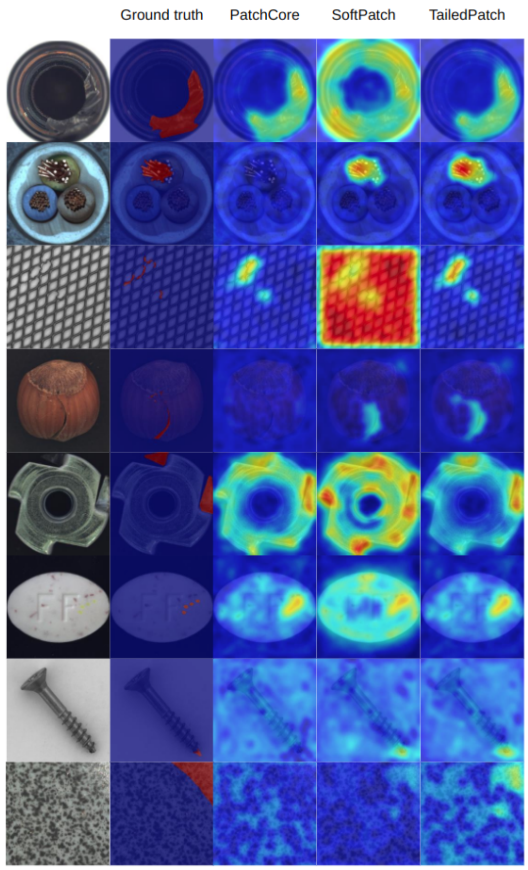


Figure 7. Qualitative analysis of PatchCore, SoftPatch, and TailedCore (**ours**).

Table 8. MVTec-LOCO image AUROC (%) with (all / structural / logical) format.

tail type	Pareto			step ($K=4$)		
class type	C_t	C_h	all	C_t	C_h	all
Patchcore	60.7 / 62.8 / 59.1	59.4 / 76.5 / 45.4	60.2 / 68.3 / 53.6	61.7 / 71.1 / 55.2	63.8 / 70.9 / 59.4	62.5 / 71 / 56.9
SoftPatch	52.3 / 57.8 / 52.9	66.5 / 67.8 / 74.5	58 / 61.8 / 61.6	62.7 / 60.3 / 68	61.7 / 68.4 / 64.3	62.3 / 63.5 / 66.5
Ours	63 / 68 / 59.4	66 / 74.8 / 59.3	64.2 / 70.7 / 59.4	65.9 / 71.7 / 61.7	67.1 / 68.8 / 66.6	66.4 / 70.6 / 63.6

one noisy samples in each of the tail classes with $K=4$ setup (1 noisy sample and 3 normal samples for each tail classes) and the results are shown in Tab. 7. The results show a minor decrease in performance in tail classes, however, the mechanism of our method is fundamentally unable to address such scenarios well.

Finally, we have done experiments on MVTec-Loco [4] dataset to test logical anomaly on PatchCore and our method where results are in Tab. 8. Due to the noisy head class and few-shot tail classes both of the methods do not work well, however, our method still shows better performance comparing with PatchCore.

11. Supplementary to Dataset

Number of total and anomaly samples We provide the detailed number of total and anomaly samples used for our experiments in Tabs. 9, 10, 11, 12, 13, and 14. The names of unsupervised long-tail noisy anomaly detection datasets are summarized as follows:

- ***MVTecAD-Pareto***: MVTecAD dataset where its class distribution follows Pareto distribution and 10% of train samples are noises in the head classes
- ***MVTecAD-step-K4***: MVTecAD dataset where its class distribution is imbalanced such that 9 out of 15 classes have only 4 samples for each class and 10% of train samples are noises in the head classes
- ***MVTecAD-step-K1***: MVTecAD dataset where its class distribution is imbalanced such that 9 out of 15 classes have only 1 samples

Table 9. The metadata of MVTecAD-Pareto dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		bottle	cable	capsule	carpet	grid	hazelnut	leather	metal nut	pill	screw	tile	toothbrush	transistor	wood	zipper
101	total	5	5	5	180	297	5	31	22	46	10	69	14	110	5	7
	anomaly	0	0	0	20	33	0	2	2	3	0	4	0	10	0	0
102	total	6	5	5	145	11	5	8	24	59	16	5	40	239	5	86
	anomaly	0	0	0	16	0	0	0	1	7	0	0	5	26	0	5
103	total	231	11	8	5	145	5	24	40	84	6	16	5	5	5	58
	anomaly	22	0	0	0	18	0	1	6	5	0	0	0	0	0	7
104	total	12	38	5	7	5	58	9	5	139	355	86	17	26	5	212
	anomaly	0	3	0	0	0	6	0	0	17	35	8	0	2	0	18
105	total	15	47	5	308	8	22	5	11	5	190	5	6	32	79	122
	anomaly	0	2	0	28	0	1	0	0	0	20	0	0	1	10	16

Table 10. The metadata of MVTecAD-step-K4 dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		bottle	cable	capsule	carpet	grid	hazelnut	leather	metal nut	pill	screw	tile	toothbrush	transistor	wood	zipper
101	total	4	246	241	4	4	430	4	4	4	352	253	66	4	4	4
	anomaly	0	22	22	0	0	39	0	0	0	32	23	6	0	0	0
102	total	4	4	4	4	4	4	4	242	294	352	4	66	4	272	264
	anomaly	0	0	0	0	0	0	0	22	27	32	0	6	0	25	24
103	total	4	4	241	4	290	4	269	4	294	4	4	4	4	272	264
	anomaly	0	0	22	0	26	0	24	0	27	0	0	0	0	25	24
104	total	4	4	4	308	4	430	269	4	4	352	253	4	4	4	264
	anomaly	0	0	0	28	0	39	24	0	0	32	23	0	0	0	24
105	total	230	246	4	4	4	430	269	4	4	352	4	4	234	4	4
	anomaly	21	22	0	0	0	39	24	0	0	32	0	0	21	0	0

for each class and 10% of train samples are noises in the head classes

- ***VisA-Pareto***: VisA dataset where its class distribution follows Pareto distribution and 10% of train samples are noises in the head classes
- ***VisA-step-K4***: VisA dataset where its class distribution is imbalanced such that 7 out of 12 classes have only 4 samples for each class and 10% of train samples are noises in the head classes
- ***VisA-step-K1***: VisA dataset where its class distribution is imbalanced such that 7 out of 12 classes have only 1 samples for each class and 10% of train samples are noises in the head classes

12. Full Experiment Results

The full experiment results for the baseline comparison are given in Tabs. 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, and 26. We note that both WinCLIP and AnomalyCLIP are zero-shot models, hence they do not have performance variance dependant on the train sets (indicated without standard deviation in the tables).

Table 11. The metadata of MVTecAD-step-K1 dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		bottle	cable	capsule	carpet	grid	hazelnut	leather	metal nut	pill	screw	tile	toothbrush	transistor	wood	zipper
101	total	1	1	1	308	1	430	269	1	1	352	253	1	1	1	264
	anomaly	0	0	0	28	0	39	24	0	0	32	23	0	0	0	24
102	total	1	1	241	1	290	1	269	1	294	1	1	1	1	272	264
	anomaly	0	0	22	0	26	0	24	0	27	0	0	0	0	25	24
103	total	1	1	241	1	1	1	269	1	1	352	1	66	234	272	1
	anomaly	0	0	22	0	0	0	24	0	0	32	0	6	21	25	0
104	total	1	1	1	1	290	1	269	242	1	352	1	66	1	1	264
	anomaly	0	0	0	0	26	0	24	22	0	32	0	6	0	0	24
105	total	1	246	241	1	290	430	1	1	294	352	1	1	1	1	1
	anomaly	0	22	22	0	26	39	0	0	27	32	0	0	0	0	0

Table 12. The metadata of VisA-Pareto dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		candle	capsules	cashew	chewinggum	fryum	macaroni1	macaroni2	pcb1	pcb2	pcb3	pcb4	pipe fryum
101	total	290	13	476	9	19	943	29	105	173	68	43	7
	anomaly	14	0	26	0	0	43	1	5	10	4	1	0
102	total	92	5	10	475	53	33	7	256	14	146	21	5
	anomaly	10	0	0	22	2	1	0	11	0	7	0	0
103	total	5	9	86	21	479	253	5	145	7	33	14	52
	anomaly	0	0	4	0	29	10	0	7	0	1	0	2
104	total	170	9	108	65	476	19	30	13	43	954	289	7
	anomaly	6	0	7	1	26	0	2	0	1	49	12	0
105	total	29	101	43	19	177	297	942	13	9	7	67	471
	anomaly	1	1	1	0	14	21	42	0	0	0	3	21

Table 13. The metadata of VisA-step-K4 dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		candle	capsules	cashew	chewinggum	fryum	macaroni1	macaroni2	pcb1	pcb2	pcb3	pcb4	pipe fryum
101	total	4	4	4	4	4	945	4	4	946	950	949	472
	anomaly	0	0	0	0	0	45	0	0	45	45	45	22
102	total	4	4	472	4	4	945	945	4	946	4	4	472
	anomaly	0	0	22	0	0	45	45	0	45	0	0	22
103	total	4	4	4	4	4	4	4	949	946	950	949	472
	anomaly	0	0	0	0	0	0	0	45	45	45	45	22
104	total	945	4	472	476	472	4	4	949	4	4	4	4
	anomaly	45	0	22	23	22	0	0	45	0	0	0	0
105	total	945	4	472	476	4	945	4	949	4	4	4	4
	anomaly	45	0	22	23	0	45	0	45	0	0	0	0

Table 14. The metadata of VisA-step-K1 dataset, indicating the number of total samples in each class and the number of defect samples in each class in the train set.

seed		candle	capsules	cashew	chewinggum	fryum	macaroni1	macaroni2	pcb1	pcb2	pcb3	pcb4	pipe fryum
101	total	1	1	1	1	1	945	1	1	946	950	949	472
	anomaly	0	0	0	0	0	45	0	0	45	45	45	22
102	total	945	1	1	1	1	945	1	1	946	1	949	472
	anomaly	45	0	0	0	0	45	0	0	45	0	45	22
103	total	1	569	472	1	472	945	1	1	946	1	1	1
	anomaly	0	27	22	0	22	45	0	0	45	0	0	0
104	total	1	1	1	1	1	1	1	949	946	950	949	472
	anomaly	0	0	0	0	0	0	0	45	45	45	45	22
105	total	1	569	472	1	472	1	1	949	1	950	1	1
	anomaly	0	27	22	0	22	0	0	45	0	45	0	0

Table 15. Anomaly detection on MVTecAD-Pareto with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	96.95 ± 2.89	79.89 ± 15.76	97.35 ± 3.28	92.65 ± 9.56	99.30 ± 1.04	98.60	89.30	92.19 ± 13.68	97.95 ± 4.14	**99.76** ± 0.53
cable	66.76 ± 4.43	65.19 ± 9.65	70.05 ± 17.25	70.28 ± 10.73	73.73 ± 12.36	85.00	69.80	**94.81** ± 1.14	78.89 ± 19.04	94.54 ± 2.12
capsule	67.33 ± 7.69	70.59 ± 7.45	69.23 ± 6.25	59.89 ± 2.36	64.25 ± 5.15	68.70	89.90	89.84 ± 3.78	58.78 ± 23.22	**92.19** ± 1.67
carpet	97.51 ± 4.93	78.74 ± 12.14	89.24 ± 10.07	98.48 ± 0.80	98.48 ± 2.41	99.30	**100.00**	86.43 ± 12.97	99.11 ± 0.61	99.26 ± 0.29
grid	64.31 ± 11.57	52.45 ± 2.66	77.61 ± 10.34	78.91 ± 7.71	87.54 ± 9.00	**99.20**	97.00	64.04 ± 17.93	87.10 ± 9.44	91.33 ± 4.74
hazelnut	77.87 ± 21.57	72.94 ± 10.23	95.14 ± 2.48	94.83 ± 3.12	93.66 ± 4.30	92.30	97.20	84.54 ± 25.95	94.26 ± 7.47	**99.28** ± 0.83
leather	99.91 ± 0.14	65.63 ± 15.84	90.34 ± 10.90	99.99 ± 0.02	**100.00** ± 0.00	**100.00**	99.80	99.35 ± 0.97	99.93 ± 0.15	**100.00** ± 0.00
metal nut	71.23 ± 13.34	66.30 ± 13.35	84.15 ± 11.45	87.74 ± 7.61	89.77 ± 15.40	96.20	93.60	96.30 ± 2.50	73.00 ± 20.42	**97.90** ± 1.27
pill	68.33 ± 9.03	72.58 ± 8.61	88.88 ± 7.98	85.07 ± 10.02	81.09 ± 7.31	81.50	81.80	90.25 ± 3.89	90.90 ± 6.37	**93.70** ± 0.93
screw	61.20 ± 2.95	54.47 ± 8.87	71.08 ± 10.29	64.68 ± 14.12	71.07 ± 16.01	71.70	81.10	73.33 ± 8.14	72.04 ± 20.13	**87.24** ± 5.34
tile	94.51 ± 1.22	83.64 ± 15.49	88.59 ± 5.11	94.94 ± 2.07	97.78 ± 1.22	99.90	**100.00**	95.69 ± 3.79	99.02 ± 0.79	97.55 ± 3.25
toothbrush	96.22 ± 1.57	74.11 ± 16.33	94.28 ± 5.92	92.89 ± 4.03	92.44 ± 2.13	85.30	84.70	**99.83** ± 0.37	97.39 ± 3.02	99.50 ± 0.69
transistor	83.27 ± 4.02	64.91 ± 9.85	87.78 ± 8.90	72.44 ± 40.83	90.43 ± 6.33	89.10	92.80	91.62 ± 9.84	86.50 ± 19.44	**96.24** ± 2.23
wood	97.75 ± 1.57	82.05 ± 11.65	**98.61** ± 1.57	78.75 ± 43.50	97.25 ± 0.97	97.60	96.80	94.47 ± 7.58	98.60 ± 0.76	96.47 ± 4.51
zipper	87.99 ± 1.03	78.71 ± 8.46	89.71 ± 5.25	73.44 ± 40.58	90.84 ± 0.24	91.20	98.50	94.58 ± 2.50	82.26 ± 33.79	**96.96** ± 0.62
tail class	82.46 ± 16.66	69.25 ± 12.72	84.30 ± 13.61	83.46 ± 16.17	85.74 ± 14.96	89.36 ± 10.99	90.93 ± 8.42	<u>93.34</u> ± 9.12	84.69 ± 18.52	**96.55** ± 3.94
head class	80.95 ± 16.24	72.11 ± 13.95	88.73 ± 8.71	80.24 ± 16.46	89.33 ± 7.74	90.11 ± 8.65	<u>90.99</u> ± 8.61	87.59 ± 15.33	86.96 ± 12.48	**95.24** ± 4.17
all	82.08 ± 16.0	70.81 ± 13.1	86.14 ± 12.0	83.00 ± 18.7	88.51 ± 12.8	90.37 ± 10.1	<u>91.49</u> ± 8.81	89.82 ± 13.0	87.72 ± 18.0	**96.13** ± 4.28

Table 16. Anomaly detection on MVTecAD-step-K4 with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	94.30 ± 5.03	74.36 ± 18.09	90.45 ± 10.43	76.78 ± 7.92	96.98 ± 3.02	98.60	89.30	95.49 ± 9.50	65.92 ± 27.24	**99.75** ± 0.26
cable	63.05 ± 5.20	57.45 ± 7.96	75.18 ± 12.58	67.10 ± 21.09	71.47 ± 19.40	85.00	69.80	85.35 ± 9.56	72.85 ± 24.09	**96.18** ± 2.87
capsule	67.41 ± 16.32	62.25 ± 14.52	67.40 ± 27.08	82.37 ± 17.80	69.63 ± 16.31	68.70	89.90	89.18 ± 3.35	64.54 ± 28.56	**93.59** ± 2.67
carpet	99.62 ± 0.39	74.38 ± 8.92	89.07 ± 7.38	98.17 ± 0.83	99.63 ± 0.47	99.30	**100.00**	92.32 ± 13.43	96.90 ± 1.84	99.24 ± 0.48
grid	71.70 ± 3.08	53.85 ± 14.11	66.57 ± 20.92	84.85 ± 3.63	89.49 ± 4.82	**99.20**	97.00	68.60 ± 8.93	74.34 ± 14.00	93.38 ± 3.63
hazelnut	78.01 ± 19.31	71.68 ± 5.07	92.24 ± 7.56	84.18 ± 8.84	92.84 ± 7.23	92.30	**97.20**	63.86 ± 27.00	92.86 ± 9.85	96.67 ± 4.03
leather	99.71 ± 0.65	55.22 ± 16.24	93.43 ± 10.23	98.30 ± 3.75	100.00 ± 0.00	100.00	99.80	85.99 ± 13.06	97.00 ± 6.70	**100.00** ± 0.00
metal nut	64.24 ± 16.45	61.80 ± 14.05	66.98 ± 19.20	74.29 ± 22.95	69.74 ± 17.50	96.20	93.60	88.86 ± 7.32	61.57 ± 22.16	**98.68** ± 0.76
pill	62.20 ± 12.87	62.09 ± 4.64	80.20 ± 14.38	75.99 ± 18.01	73.40 ± 14.43	81.50	81.80	84.16 ± 6.27	72.57 ± 21.56	**93.01** ± 3.00
screw	60.02 ± 1.28	56.22 ± 8.90	80.62 ± 9.46	80.51 ± 11.82	77.02 ± 15.31	71.70	81.10	69.62 ± 8.56	85.28 ± 14.02	**90.14** ± 3.81
tile	86.30 ± 8.87	86.88 ± 5.82	88.89 ± 16.63	89.88 ± 4.80	97.16 ± 0.97	99.90	**100.00**	88.65 ± 14.75	98.69 ± 0.47	94.67 ± 6.50
toothbrush	86.00 ± 7.04	65.39 ± 5.43	81.94 ± 15.66	90.41 ± 8.34	**92.94** ± 1.40	85.30	84.70	85.28 ± 4.96	85.50 ± 13.65	92.44 ± 6.95
transistor	71.84 ± 7.14	60.33 ± 4.80	63.79 ± 17.06	76.06 ± 17.36	76.35 ± 16.41	89.10	92.80	87.47 ± 22.09	59.44 ± 23.09	**95.90** ± 1.56
wood	98.33 ± 0.53	87.98 ± 6.30	98.21 ± 1.18	96.81 ± 2.85	97.37 ± 0.42	97.60	96.80	82.23 ± 22.74	**98.61** ± 0.46	94.53 ± 5.48
zipper	85.25 ± 6.65	73.11 ± 22.83	87.27 ± 11.88	77.78 ± 16.38	91.31 ± 3.99	91.20	**98.50**	91.16 ± 5.59	68.62 ± 39.98	97.62 ± 0.75
tail class	77.47 ± 16.37	65.35 ± 16.11	72.70 ± 14.46	82.01 ± 15.62	81.86 ± 14.30	91.61 ± 9.98	91.82 ± 7.55	<u>92.20</u> ± 9.62	67.65 ± 19.45	**95.82** ± 3.64
head class	81.29 ± 14.08	69.78 ± 15.08	94.46 ± 4.81	85.51 ± 12.24	92.95 ± 6.18	88.22 ± 11.08	90.84 ± 8.88	71.19 ± 13.95	**97.54** ± 2.98	<u>95.34</u> ± 4.31
all	79.20 ± 16.79	66.87 ± 14.97	81.48 ± 17.24	83.57 ± 14.74	86.36 ± 14.92	90.37 ± 10.19	<u>91.49</u> ± 8.81	83.88 ± 15.49	79.65 ± 23.19	**95.72** ± 4.30

Table 17. Anomaly detection on MVTecAD-step-K1 with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	72.68 ± 15.75	60.40 ± 18.58	57.32 ± 17.54	73.71 ± 13.23	90.74 ± 3.63	98.60	89.30	**99.65** ± 0.12	36.13 ± 3.18	99.25 ± 0.52
cable	57.79 ± 9.61	55.09 ± 10.91	55.21 ± 19.54	58.63 ± 12.98	71.25 ± 18.42	85.00	69.80	76.14 ± 7.38	61.97 ± 20.97	**89.89** ± 4.87
capsule	78.92 ± 17.70	66.29 ± 13.88	65.17 ± 24.08	72.48 ± 19.26	76.86 ± 13.02	68.70	89.90	82.24 ± 4.85	72.55 ± 32.06	**90.39** ± 7.63
carpet	98.53 ± 0.78	57.46 ± 16.18	55.02 ± 17.19	97.88 ± 1.02	99.84 ± 0.10	99.30	**100.00**	92.01 ± 13.37	92.58 ± 6.85	99.13 ± 0.29
grid	67.84 ± 5.25	53.55 ± 12.45	73.28 ± 24.70	83.01 ± 5.46	94.02 ± 4.83	**99.20**	97.00	59.62 ± 7.35	88.69 ± 11.25	91.66 ± 4.84
hazelnut	77.88 ± 18.88	63.34 ± 6.59	69.95 ± 20.92	87.35 ± 7.10	90.43 ± 6.63	92.30	**97.20**	61.91 ± 16.15	84.68 ± 15.04	94.81 ± 4.08
leather	99.14 ± 1.78	54.68 ± 9.26	73.16 ± 23.74	99.99 ± 0.03	99.99 ± 0.02	**100.00**	99.80	79.23 ± 11.61	89.29 ± 23.94	**100.00** ± 0.00
metal_nut	56.36 ± 22.39	59.84 ± 14.35	63.00 ± 19.53	62.08 ± 21.15	63.41 ± 19.72	96.20	93.60	69.07 ± 5.61	55.25 ± 25.76	**96.71** ± 1.97
pill	62.14 ± 12.23	63.15 ± 12.93	73.60 ± 10.82	80.43 ± 17.80	67.64 ± 20.93	81.50	81.80	79.84 ± 2.43	71.72 ± 22.03	**90.51** ± 4.51
screw	61.24 ± 4.09	53.67 ± 10.12	76.44 ± 10.90	79.28 ± 12.84	78.53 ± 15.21	71.70	81.10	67.51 ± 10.18	85.03 ± 15.49	**89.72** ± 7.13
tile	84.31 ± 7.12	76.59 ± 19.53	74.61 ± 21.92	90.08 ± 4.88	97.24 ± 0.77	99.90	**100.00**	93.88 ± 12.51	80.19 ± 11.16	97.66 ± 3.40
toothbrush	84.28 ± 11.86	64.39 ± 8.57	71.78 ± 25.84	87.89 ± 10.45	88.89 ± 4.26	85.30	84.70	83.44 ± 4.81	78.11 ± 20.35	**91.72** ± 7.74
transistor	66.19 ± 9.92	52.65 ± 5.94	57.84 ± 20.07	65.20 ± 15.85	65.44 ± 18.95	89.10	92.80	85.52 ± 22.13	69.04 ± 19.32	**94.08** ± 1.26
wood	98.07 ± 1.04	87.79 ± 3.87	83.37 ± 14.98	95.95 ± 2.94	97.04 ± 1.36	97.60	96.80	81.79 ± 22.33	**98.16** ± 0.73	94.21 ± 6.11
zipper	69.09 ± 20.52	61.23 ± 24.34	60.53 ± 17.06	74.36 ± 18.45	84.42 ± 7.22	91.20	**98.50**	88.32 ± 4.83	67.62 ± 41.47	96.81 ± 1.48
tail class	71.55 ± 19.68	62.35 ± 14.91	59.60 ± 14.40	74.15 ± 18.62	79.06 ± 19.34	<u>91.80</u> ± 8.38	91.21 ± 8.80	86.36 ± 13.56	60.67 ± 21.77	**93.54** ± 6.19
head class	81.76 ± 14.47	61.49 ± 15.61	78.99 ± 7.19	90.16 ± 8.08	92.37 ± 7.35	88.23 ± 11.75	91.90 ± 7.96	70.48 ± 13.65	**97.50** ± 2.81	<u>95.78</u> ± 3.57
all	75.63 ± 18.71	62.01 ± 14.95	67.35 ± 16.00	80.55 ± 17.21	84.38 ± 16.80	90.37 ± 10.19	<u>91.49</u> ± 8.81	80.01 ± 15.56	75.40 ± 24.98	**94.44** ± 5.44

Table 18. Anomaly segmentation on MVTecAD-Pareto with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	95.65 ± 1.24	75.95 ± 11.28	95.66 ± 2.28	96.24 ± 2.71	**97.71** ± 0.40	85.70	90.40	91.32 ± 12.81	97.66 ± 1.52	97.31 ± 2.64
cable	82.43 ± 6.33	66.77 ± 7.52	87.41 ± 11.64	89.50 ± 3.77	**92.45** ± 2.08	61.30	78.90	90.68 ± 2.55	87.09 ± 9.27	91.43 ± 2.33
capsule	97.14 ± 0.58	82.35 ± 7.93	94.96 ± 2.95	97.02 ± 0.22	96.82 ± 0.74	87.00	95.80	**98.51** ± 0.10	94.72 ± 3.52	98.37 ± 0.09
carpet	96.40 ± 3.98	71.85 ± 16.78	88.95 ± 9.43	98.51 ± 0.39	98.43 ± 0.23	90.90	98.80	85.87 ± 13.89	98.89 ± 0.18	**98.48** ± 0.85
grid	67.11 ± 21.48	35.73 ± 17.39	74.45 ± 11.12	92.70 ± 4.10	92.33 ± 3.01	79.40	**97.30**	64.41 ± 15.35	74.97 ± 27.60	91.09 ± 4.28
hazelnut	94.78 ± 0.88	86.32 ± 5.06	**97.15** ± 0.98	96.36 ± 0.98	95.63 ± 1.26	95.70	97.10	83.29 ± 24.37	95.44 ± 1.56	96.37 ± 4.75
leather	99.08 ± 0.15	68.17 ± 34.40	96.07 ± 3.19	98.89 ± 0.13	99.10 ± 0.08	95.50	98.60	99.19 ± 0.15	99.27 ± 0.04	**99.29** ± 00.03
metal_nut	83.10 ± 3.29	76.23 ± 10.81	**96.20** ± 2.87	88.02 ± 2.80	87.81 ± 7.22	49.30	74.40	91.37 ± 7.93	91.34 ± 6.31	91.78 ± 6.62
pill	91.88 ± 4.09	85.69 ± 13.19	95.09 ± 3.37	93.86 ± 2.08	91.79 ± 2.11	72.70	92.00	94.83 ± 4.41	**96.27** ± 2.30	96.25 ± 1.68
screw	94.53 ± 2.41	82.01 ± 9.86	91.90 ± 3.44	94.26 ± 3.35	93.87 ± 4.09	91.10	**97.50**	85.45 ± 10.93	93.27 ± 2.40	96.88 ± 2.42
tile	87.98 ± 3.36	73.42 ± 19.01	83.39 ± 7.08	89.54 ± 1.30	90.52 ± 1.10	79.10	94.60	90.79 ± 5.63	**95.14** ± 0.29	92.31 ± 5.53
toothbrush	97.76 ± 0.94	88.60 ± 8.44	98.35 ± 0.56	98.06 ± 0.60	98.35 ± 0.10	86.20	91.90	98.60 ± 0.06	98.33 ± 0.46	**98.63** ± 0.09
transistor	93.53 ± 3.46	75.27 ± 8.59	87.79 ± 6.41	75.25 ± 41.63	**95.29** ± 3.76	83.70	71.00	93.10 ± 1.02	90.55 ± 7.66	91.45 ± 4.26
wood	93.02 ± 0.93	78.71 ± 6.40	90.31 ± 0.93	73.47 ± 40.56	93.25 ± 0.37	85.10	**96.50**	90.52 ± 8.61	93.62 ± 1.59	91.24 ± 7.74
zipper	97.06 ± 0.74	82.46 ± 9.96	84.90 ± 4.73	76.69 ± 42.35	95.46 ± 0.88	91.70	91.40	91.04 ± 7.48	94.67 ± 8.52	**98.57** ± 0.10
tail class	90.11 ± 10.96	75.12 ± 16.98	90.93 ± 9.36	93.63 ± 4.55	94.16 ± 4.41	82.04 ± 12.69	91.25 ± 8.33	93.57 ± 8.41	92.20 ± 10.33	**96.09** ± 4.12
head class	92.66 ± 5.94	76.25 ± 15.15	91.48 ± 5.75	86.85 ± 12.87	94.86 ± 3.19	84.07 ± 12.24	91.70 ± 8.88	87.99 ± 13.77	93.84 ± 3.83	**95.01** ± 4.55
all	91.43 ± 9.43	75.30 ± 16.4	90.84 ± 7.93	90.56 ± 10.9	94.59 ± 3.8	82.29 ± 12.8	91.08 ± 8.98	89.93 ± 12.0	93.42 ± 8.36	**95.30** ± 4.72

Table 19. Anomaly segmentation on MVTecAD-step-K4 with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	91.44 ± 5.59	70.98 ± 6.76	91.71 ± 4.77	91.42 ± 4.94	96.66 ± 1.00	85.70	90.40	93.79 ± 10.21	80.67 ± 16.93	**98.44** ± 0.06
cable	76.19 ± 11.95	69.18 ± 8.88	90.60 ± 8.38	83.80 ± 9.04	90.16 ± 5.65	61.30	78.90	83.20 ± 10.16	78.37 ± 17.42	**92.70** ± 3.49
capsule	96.29 ± 1.79	78.90 ± 13.70	90.40 ± 9.88	97.65 ± 2.17	96.55 ± 2.04	87.00	95.80	92.31 ± 8.51	93.48 ± 4.96	**98.66** ± 0.15
carpet	97.26 ± 1.57	63.79 ± 34.82	93.59 ± 1.19	96.59 ± 1.85	98.49 ± 0.16	90.90	98.80	93.03 ± 13.35	98.70 ± 0.35	**99.09** ± 0.11
grid	53.43 ± 26.71	24.65 ± 5.41	68.62 ± 18.87	94.05 ± 7.42	91.61 ± 3.53	79.40	**97.30**	68.15 ± 2.89	52.00 ± 28.50	90.66 ± 5.13
hazelnut	95.35 ± 1.51	81.11 ± 10.20	96.28 ± 0.83	93.45 ± 3.30	95.86 ± 2.80	95.70	**97.10**	66.24 ± 29.23	92.85 ± 2.00	85.22 ± 15.52
leather	99.03 ± 0.26	62.90 ± 31.26	95.48 ± 4.09	98.06 ± 2.32	99.04 ± 0.17	95.50	98.60	82.26 ± 17.30	98.41 ± 2.01	**99.30** ± 0.01
metal_nut	78.49 ± 9.04	62.68 ± 17.13	88.03 ± 8.67	82.39 ± 12.96	79.48 ± 7.81	49.30	74.40	90.06 ± 11.31	84.47 ± 8.36	**96.43** ± 0.62
pill	87.44 ± 8.55	73.37 ± 11.91	**96.26** ± 2.17	89.10 ± 6.17	89.02 ± 4.93	72.70	92.00	90.57 ± 7.83	86.67 ± 10.27	95.06 ± 1.74
screw	95.67 ± 2.53	78.80 ± 22.19	94.50 ± 3.76	96.44 ± 3.14	96.23 ± 3.61	91.10	**97.50**	79.08 ± 7.81	93.66 ± 3.04	95.27 ± 2.21
tile	80.17 ± 8.11	76.29 ± 13.48	83.37 ± 9.64	88.75 ± 5.92	90.37 ± 1.03	79.10	94.60	87.22 ± 11.46	**94.98** ± 0.28	92.69 ± 3.70
toothbrush	93.88 ± 2.92	85.92 ± 8.55	94.73 ± 5.03	95.79 ± 3.04	**97.97** ± 0.20	86.20	91.90	93.48 ± 5.36	93.59 ± 4.59	97.87 ± 0.88
transistor	82.59 ± 10.43	61.63 ± 11.46	83.68 ± 4.75	85.40 ± 9.07	86.19 ± 8.95	83.70	71.00	83.49 ± 20.63	73.59 ± 9.03	**88.52** ± 4.14
wood	92.22 ± 3.52	76.12 ± 7.46	90.53 ± 5.62	92.51 ± 3.66	93.35 ± 0.57	85.10	**96.50**	87.54 ± 9.74	94.34 ± 1.09	92.70 ± 2.93
zipper	95.71 ± 4.08	76.50 ± 5.22	92.30 ± 3.88	87.63 ± 13.74	94.74 ± 2.32	91.70	91.40	87.58 ± 9.68	92.86 ± 8.14	**98.65** ± 0.22
tail class	82.53 ± 14.03	66.28 ± 23.04	86.62 ± 9.31	90.73 ± 8.46	90.90 ± 6.21	80.60 ± 11.80	89.96 ± 8.10	93.55 ± 9.15	80.99 ± 15.18	**95.56** ± 3.85
head class	95.29 ± 3.30	74.68 ± 13.83	94.99 ± 3.94	92.58 ± 6.73	96.17 ± 2.72	84.64 ± 11.11	92.66 ± 6.52	72.09 ± 11.76	**96.49** ± 2.45	93.20 ± 7.56
all	87.68 ± 13.7	69.52 ± 19.6	90.01 ± 9.50	91.54 ± 7.91	93.05 ± 6.4	82.29 ± 12.8	91.08 ± 8.98	85.20 ± 14.4	87.24 ± 15.1	**94.75** ± 5.67

Table 20. Anomaly segmentation on MVTecAD-step-K1 with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
bottle	76.52 ± 11.38	65.85 ± 16.14	60.97 ± 16.90	85.23 ± 14.39	94.31 ± 0.57	85.70	90.40	98.13 ± 0.08	50.48 ± 7.86	**98.36** ± 0.04
cable	71.28 ± 16.25	65.36 ± 12.90	75.16 ± 13.19	78.51 ± 7.99	**85.37** ± 7.80	61.30	78.90	76.87 ± 9.24	61.93 ± 19.83	83.29 ± 1.47
capsule	97.17 ± 2.50	83.48 ± 10.86	84.41 ± 15.09	97.14 ± 2.20	97.10 ± 1.86	87.00	95.80	87.59 ± 9.90	94.80 ± 5.59	**98.28** ± 0.77
carpet	95.21 ± 3.11	41.13 ± 37.80	68.31 ± 19.53	97.68 ± 0.59	98.43 ± 0.06	90.90	98.80	93.04 ± 13.33	91.00 ± 11.06	**99.04** ± 0.18
grid	71.65 ± 27.37	31.36 ± 16.26	75.59 ± 18.92	94.20 ± 5.63	92.20 ± 4.56	79.40	**97.30**	62.25 ± 6.55	68.87 ± 37.97	88.13 ± 9.06
hazelnut	94.05 ± 1.74	76.90 ± 4.35	88.40 ± 9.31	94.66 ± 1.97	94.69 ± 2.81	95.70	**97.10**	69.53 ± 32.77	90.52 ± 2.27	86.49 ± 15.74
leather	98.66 ± 1.03	60.45 ± 27.40	80.45 ± 20.05	99.12 ± 0.09	99.06 ± 0.18	95.50	98.60	78.87 ± 13.04	94.94 ± 9.75	**99.31** ± 0.01
metal_nut	73.03 ± 12.51	62.16 ± 6.20	89.41 ± 7.27	76.98 ± 10.03	70.76 ± 13.14	49.30	74.40	87.28 ± 5.31	75.83 ± 12.94	**96.01** ± 1.51
pill	85.75 ± 9.04	77.50 ± 9.98	88.57 ± 8.64	91.63 ± 5.53	86.62 ± 6.40	72.70	92.00	91.95 ± 6.94	86.06 ± 11.24	**95.91** ± 1.57
screw	95.53 ± 2.70	73.06 ± 21.56	83.27 ± 22.25	**96.86** ± 3.24	96.75 ± 3.36	91.10	97.50	77.17 ± 7.14	93.88 ± 3.08	95.49 ± 1.58
tile	74.32 ± 7.08	65.06 ± 32.44	67.70 ± 19.74	86.89 ± 2.37	89.83 ± 1.23	79.10	**94.60**	91.10 ± 9.87	69.74 ± 16.33	94.36 ± 1.84
toothbrush	92.99 ± 5.39	81.29 ± 11.74	88.81 ± 10.87	**97.22** ± 2.03	96.77 ± 2.17	86.20	91.90	89.01 ± 9.30	89.17 ± 8.67	96.59 ± 2.00
transistor	73.86 ± 16.73	64.74 ± 9.95	67.85 ± 11.88	79.97 ± 6.07	78.91 ± 7.96	83.70	71.00	83.26 ± 19.73	67.81 ± 15.07	**89.85** ± 0.76
wood	91.40 ± 4.42	73.93 ± 6.83	78.86 ± 12.15	90.74 ± 1.27	92.84 ± 0.64	85.10	**96.50**	82.93 ± 16.39	89.53 ± 4.79	90.38 ± 5.99
zipper	91.08 ± 7.68	56.81 ± 22.34	69.50 ± 13.27	81.71 ± 18.47	93.01 ± 3.31	91.70	91.40	87.41 ± 9.32	90.42 ± 11.43	**98.48** ± 0.42
tail class	78.80 ± 14.63	65.61 ± 16.44	75.37 ± 12.57	86.37 ± 10.24	87.85 ± 10.30	80.17 ± 13.51	89.34 ± 9.75	92.03 ± 8.45	70.34 ± 17.55	**94.19** ± 5.45
head class	95.55 ± 3.46	64.76 ± 19.08	81.48 ± 6.25	95.20 ± 5.33	96.00 ± 3.03	85.48 ± 9.71	93.69 ± 6.52	71.36 ± 13.13	**96.99** ± 2.13	93.71 ± 7.03
all	85.50 ± 14.2	65.27 ± 19.1	77.82 ± 12.7	89.90 ± 9.86	91.11 ± 9.05	82.29 ± 12.8	91.08 ± 8.98	83.76 ± 14.9	81.00 ± 19.0	**94.00** ± 6.50

Table 21. Anomaly detection on VisA-Pareto with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	86.88 ± 7.30	80.80 ± 7.81	90.25 ± 6.25	91.63 ± 3.55	80.41 ± 12.16	94.90	79.30	92.12 ± 3.46	84.04 ± 22.34	**95.95** ± 1.18
capsules	57.52 ± 2.04	68.07 ± 5.44	66.71 ± 6.85	63.95 ± 3.76	55.32 ± 1.55	79.40	81.50	66.08 ± 6.72	62.24 ± 5.23	**69.91** ± 5.36
cashew	85.60 ± 3.49	84.66 ± 5.94	91.66 ± 5.64	87.09 ± 7.38	84.99 ± 9.83	91.20	76.30	89.59 ± 9.87	95.95 ± 0.41	**96.18** ± 0.63
chewinggum	88.61 ± 5.90	91.05 ± 8.40	96.94 ± 3.87	95.58 ± 2.28	96.06 ± 1.04	95.50	97.40	94.27 ± 8.69	**98.61** ± 0.52	97.84 ± 1.04
fryum	80.02 ± 6.04	77.24 ± 6.10	89.89 ± 3.25	84.05 ± 2.88	76.49 ± 3.20	73.60	93.00	83.30 ± 8.74	93.31 ± 1.45	**93.96** ± 0.70
macaroni1	78.52 ± 7.18	77.59 ± 4.87	80.72 ± 9.84	65.83 ± 10.11	70.47 ± 7.12	79.00	87.20	81.91 ± 10.80	89.99 ± 7.90	**92.11** ± 4.16
macaroni2	61.87 ± 6.68	52.30 ± 3.42	60.27 ± 6.57	62.94 ± 8.93	58.14 ± 6.88	67.10	**73.40**	64.89 ± 11.32	56.65 ± 10.27	71.48 ± 2.94
pcb1	81.62 ± 6.95	84.91 ± 3.28	93.68 ± 6.21	83.09 ± 2.29	82.91 ± 1.75	72.10	85.40	90.63 ± 1.82	88.40 ± 8.58	**94.35** ± 1.42
pcb2	72.98 ± 9.37	78.32 ± 3.26	87.44 ± 8.82	76.72 ± 8.26	71.95 ± 6.15	47.00	62.20	88.41 ± 4.06	86.56 ± 4.46	**88.87** ± 4.39
pcb3	76.99 ± 11.80	80.35 ± 5.04	91.12 ± 7.12	72.12 ± 8.79	67.34 ± 8.99	63.90	62.70	83.19 ± 16.29	91.76 ± 3.70	**91.95** ± 3.29
pcb4	86.61 ± 7.03	92.90 ± 2.65	97.54 ± 1.85	94.83 ± 2.85	88.61 ± 8.15	74.20	93.90	97.24 ± 3.05	98.69 ± 1.09	**99.39** ± 0.35
pipe fryum	86.52 ± 6.52	79.18 ± 5.31	84.22 ± 13.52	83.08 ± 9.68	81.92 ± 5.73	67.80	92.40	95.50 ± 5.33	92.55 ± 13.18	**98.32** ± 0.72
tail class	70.71 ± 11.15	76.68 ± 11.91	78.50 ± 11.41	73.48 ± 12.57	69.51 ± 13.24	73.26 ± 14.34	81.97 ± 10.27	86.11 ± 13.42	78.05 ± 16.72	**87.55** ± 11.67
head class	83.35 ± 9.34	80.62 ± 10.10	90.60 ± 10.34	84.03 ± 11.84	80.41 ± 11.63	76.92 ± 13.25	82.48 ± 11.38	85.74 ± 11.63	92.17 ± 8.64	**93.06** ± 7.18
all	78.65 ± 11.8	78.95 ± 11.7	85.87 ± 13.1	68.25 ± 12.9	76.22 ± 13.3	75.48 ± 13.9	82.06 ± 11.7	85.59 ± 13.1	86.56 ± 15.2	**90.86** ± 10.18

Table 22. Anomaly detection on VisA-step-K4 with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	70.21 ± 21.15	72.35 ± 10.28	67.81 ± 26.77	86.47 ± 9.89	66.55 ± 18.77	**94.90**	79.30	86.94 ± 8.04	66.09 ± 30.70	94.30 ± 2.66
capsules	56.49 ± 1.12	68.11 ± 6.70	62.70 ± 6.64	59.55 ± 2.97	56.11 ± 2.86	**79.40**	81.50	59.88 ± 2.99	58.50 ± 4.02	70.06 ± 2.45
cashew	79.82 ± 15.68	77.46 ± 3.32	91.98 ± 6.17	82.54 ± 11.97	77.47 ± 20.14	91.20	76.30	83.38 ± 9.76	86.08 ± 15.53	**95.42** ± 1.66
chewinggum	75.35 ± 21.02	79.44 ± 3.80	85.94 ± 18.73	93.06 ± 4.91	89.45 ± 6.66	95.50	97.40	89.20 ± 11.90	93.92 ± 5.16	**98.62** ± 0.64
fryum	65.18 ± 12.47	75.26 ± 5.35	75.78 ± 12.23	72.47 ± 7.91	64.78 ± 9.52	**73.60**	93.00	86.46 ± 6.80	50.93 ± 24.47	92.35 ± 1.82
macaroni1	76.63 ± 10.17	69.72 ± 10.58	74.02 ± 24.22	70.72 ± 10.86	68.49 ± 10.40	79.00	87.20	70.15 ± 8.37	78.08 ± 24.37	**88.46** ± 9.69
macaroni2	59.73 ± 4.53	50.93 ± 5.62	63.14 ± 8.68	60.06 ± 7.47	55.81 ± 4.23	67.10	**73.40**	60.19 ± 10.80	53.01 ± 10.33	69.59 ± 3.02
pcb1	81.77 ± 14.82	66.43 ± 11.59	84.89 ± 20.74	80.88 ± 12.72	78.39 ± 12.74	72.10	85.40	67.71 ± 13.11	83.60 ± 18.70	**90.46** ± 9.04
pcb2	74.79 ± 16.86	69.33 ± 5.46	89.89 ± 10.52	79.90 ± 16.16	78.16 ± 5.67	47.00	62.20	67.39 ± 18.48	80.39 ± 19.73	**91.29** ± 4.94
pcb3	69.52 ± 16.09	64.65 ± 3.53	73.58 ± 20.21	72.29 ± 13.30	61.79 ± 14.12	63.90	62.70	74.98 ± 17.86	77.18 ± 18.43	**89.82** ± 6.03
pcb4	72.62 ± 21.77	81.42 ± 8.07	88.28 ± 11.79	80.94 ± 15.02	72.40 ± 21.78	74.20	93.90	88.00 ± 13.16	81.46 ± 16.86	**97.01** ± 2.39
pipe fryum	87.17 ± 10.82	74.24 ± 2.02	86.93 ± 14.47	85.41 ± 13.55	83.03 ± 11.05	67.80	92.40	88.01 ± 8.48	88.53 ± 14.75	**98.38** ± 1.05
tail class	60.65 ± 8.82	70.04 ± 11.19	66.91 ± 13.55	68.25 ± 9.89	61.02 ± 10.69	75.99 ± 12.06	82.29 ± 11.69	**83.53** ± 15.54	59.70 ± 15.73	85.17 ± 11.28
head class	88.94 ± 7.80	71.80 ± 8.51	95.31 ± 5.86	89.30 ± 7.59	85.06 ± 9.54	74.76 ± 12.32	81.74 ± 13.29	67.51 ± 13.09	**95.97** ± 6.17	95.92 ± 6.14
all	72.44 ± 16.62	70.78 ± 10.14	78.75 ± 18.28	77.02 ± 14.51	71.04 ± 15.99	75.48 ± 13.96	82.06 ± 11.77	76.86 ± 15.60	74.81 ± 22.27	**89.65** ± 10.76

Table 23. Anomaly detection on VisA-step-K1 with image-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	51.53 ± 24.34	66.92 ± 19.26	54.68 ± 28.57	71.00 ± 15.55	74.89 ± 6.83	**94.90**	79.30	87.41 ± 7.11	47.01 ± 28.30	92.33 ± 3.58
capsules	55.24 ± 2.23	58.46 ± 4.42	64.51 ± 14.93	60.77 ± 6.42	53.56 ± 0.83	79.40	**81.50**	54.37 ± 4.14	58.59 ± 5.55	64.33 ± 4.21
cashew	71.51 ± 17.61	69.40 ± 12.10	83.28 ± 13.51	71.55 ± 18.13	71.12 ± 18.80	91.20	76.30	88.78 ± 4.47	75.20 ± 19.42	**93.89** ± 3.03
chewinggum	56.00 ± 10.76	65.94 ± 9.60	55.56 ± 3.73	67.93 ± 7.83	62.56 ± 9.82	95.50	97.40	97.30 ± 0.91	75.18 ± 15.66	**97.97** ± 0.34
fryum	67.91 ± 16.31	72.33 ± 8.71	73.71 ± 20.03	71.31 ± 13.56	64.88 ± 12.91	73.60	**93.00**	82.99 ± 1.80	64.21 ± 28.02	91.84 ± 2.50
macaroni1	74.01 ± 12.30	63.53 ± 15.04	78.65 ± 17.86	66.28 ± 15.48	67.13 ± 12.11	79.00	**87.20**	64.53 ± 6.42	76.81 ± 25.38	84.55 ± 14.14
macaroni2	58.82 ± 5.20	57.12 ± 4.10	45.77 ± 10.89	54.65 ± 3.86	59.91 ± 7.73	67.10	**73.40**	58.12 ± 3.22	40.87 ± 5.62	66.36 ± 3.16
pcb1	69.87 ± 20.89	58.32 ± 19.89	75.86 ± 28.20	75.11 ± 14.25	75.65 ± 12.98	72.10	**85.40**	67.99 ± 21.50	71.23 ± 28.26	84.17 ± 12.48
pcb2	79.57 ± 16.79	66.91 ± 7.51	89.59 ± 16.40	76.68 ± 19.53	79.39 ± 5.20	47.00	62.20	60.50 ± 8.81	85.54 ± 21.53	**90.78** ± 9.14
pcb3	72.57 ± 19.16	60.24 ± 8.39	77.67 ± 25.26	66.13 ± 18.37	66.71 ± 12.91	63.90	62.70	68.29 ± 13.90	81.03 ± 21.23	**90.09** ± 8.63
pcb4	80.92 ± 21.97	78.70 ± 7.67	85.96 ± 21.77	77.61 ± 20.38	80.13 ± 22.19	74.20	93.90	81.99 ± 13.97	86.86 ± 17.42	**97.84** ± 2.35
pipe fryum	87.71 ± 9.87	69.71 ± 6.77	79.58 ± 26.83	74.09 ± 17.64	76.19 ± 19.91	67.80	92.40	85.86 ± 7.74	76.60 ± 31.00	**97.22** ± 2.68
tail class	55.98 ± 10.38	62.18 ± 13.25	56.09 ± 14.72	61.58 ± 7.34	60.31 ± 8.56	78.81 ± 12.99	**83.27** ± 10.94	79.33 ± 17.74	52.61 ± 15.29	82.97 ± 13.40
head class	86.76 ± 8.85	70.46 ± 6.12	**94.43** ± 5.11	80.41 ± 6.04	81.99 ± 10.66	70.81 ± 13.42	80.36 ± 13.54	68.56 ± 11.77	94.17 ± 6.81	94.11 ± 6.71
all	68.81 ± 18.82	65.63 ± 12.24	72.07 ± 22.90	69.43 ± 12.94	69.34 ± 14.59	75.48 ± 13.96	82.06 ± 11.77	74.84 ± 16.17	69.93 ± 24.89	**87.61** ± 12.99

Table 24. Anomaly segmentation on VisA-Pareto with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	97.49 ± 1.24	92.06 ± 3.38	95.98 ± 0.88	98.63 ± 0.47	97.77 ± 1.38	87.00	**98.80**	92.98 ± 6.06	93.92 ± 10.70	98.75 ± 0.63
capsules	78.32 ± 5.30	91.73 ± 2.28	95.63 ± 2.66	91.77 ± 2.96	83.58 ± 1.76	80.00	95.00	95.92 ± 1.03	88.76 ± 10.75	**97.68** ± 0.49
cashew	95.78 ± 1.37	95.69 ± 1.05	97.48 ± 1.38	**98.74** ± 0.38	98.50 ± 0.53	84.80	93.80	90.20 ± 11.64	98.02 ± 0.25	98.39 ± 0.22
chewinggum	96.86 ± 1.00	94.28 ± 2.57	98.64 ± 0.50	98.54 ± 0.33	98.75 ± 0.10	95.40	**99.30**	94.27 ± 7.88	98.05 ± 0.21	99.06 ± 0.52
fryum	92.73 ± 1.60	85.64 ± 1.58	92.84 ± 2.57	**97.16** ± 0.30	96.45 ± 1.01	87.70	94.60	82.65 ± 8.10	91.37 ± 0.56	91.61 ± 0.54
macaroni1	97.32 ± 1.49	94.19 ± 3.76	96.89 ± 1.66	97.19 ± 1.25	96.80 ± 0.91	50.30	98.30	83.38 ± 17.64	98.27 ± 0.50	**99.23** ± 0.56
macaroni2	90.94 ± 1.98	80.47 ± 6.45	89.86 ± 1.44	94.19 ± 2.04	90.25 ± 2.21	44.70	**97.60**	86.05 ± 16.68	87.28 ± 5.32	92.95 ± 5.85
pcb1	92.39 ± 7.08	96.22 ± 1.72	99.13 ± 0.97	97.97 ± 0.85	97.75 ± 1.52	38.70	94.10	96.14 ± 4.32	98.08 ± 1.58	**99.75** ± 0.04
pcb2	91.86 ± 3.13	90.36 ± 3.12	**97.96** ± 1.19	95.07 ± 1.97	94.24 ± 2.26	58.70	92.40	95.36 ± 3.61	96.87 ± 0.50	97.24 ± 1.61
pcb3	95.76 ± 3.15	95.15 ± 1.92	98.57 ± 0.99	96.41 ± 1.32	95.60 ± 1.86	76.00	88.40	89.19 ± 16.29	98.11 ± 0.25	**99.00** ± 0.26
pcb4	85.95 ± 3.26	90.16 ± 3.11	**98.27** ± 0.51	95.83 ± 1.10	94.66 ± 1.87	91.40	95.70	92.91 ± 6.69	96.35 ± 0.81	97.44 ± 0.71
pipe fryum	98.36 ± 0.74	97.12 ± 0.60	97.38 ± 1.54	**99.10** ± 0.31	98.92 ± 0.17	83.60	98.20	94.62 ± 9.11	98.19 ± 1.12	98.73 ± 0.08
tail class	89.02 ± 8.14	91.02 ± 5.59	96.42 ± 2.51	95.28 ± 3.24	93.01 ± 5.95	71.95 ± 18.13	95.61 ± 2.79	<u>96.84</u> ± 1.97	93.20 ± 5.59	**97.98** ± 1.35
head class	95.10 ± 3.88	92.58 ± 5.18	96.74 ± 2.94	**97.60** ± 1.41	96.69 ± 2.67	73.97 ± 19.94	95.46 ± 3.32	88.00 ± 12.00	96.74 ± 3.24	<u>97.26</u> ± 3.31
all	92.82 ± 6.4	91.92 ± 5.4	96.55 ± 3.0	<u>96.72</u> ± 2.4	95.27 ± 4.6	73.19 ± 19.6	95.52 ± 3.17	91.14 ± 10.4	95.27 ± 5.20	**97.49** ± 2.92

Table 25. Anomaly segmentation on VisA-step-K4 with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	92.17 ± 6.03	85.13 ± 9.19	87.24 ± 7.67	97.78 ± 1.33	95.69 ± 2.65	87.00	**98.80**	82.17 ± 22.34	86.22 ± 15.30	98.56 ± 0.69
capsules	73.37 ± 0.66	83.64 ± 4.54	88.48 ± 2.57	88.94 ± 1.14	82.04 ± 0.41	80.00	95.00	94.47 ± 0.55	67.11 ± 3.69	**96.88** ± 0.39
cashew	93.70 ± 4.97	92.02 ± 2.19	96.45 ± 0.76	**98.07** ± 0.52	96.51 ± 3.14	84.80	93.80	78.26 ± 20.71	94.34 ± 4.59	97.74 ± 0.41
chewinggum	93.51 ± 4.69	81.63 ± 5.60	95.61 ± 3.98	**98.06** ± 0.36	97.88 ± 0.81	95.40	99.30	90.31 ± 10.28	97.50 ± 0.69	99.24 ± 0.20
fryum	85.41 ± 4.52	79.59 ± 5.77	92.88 ± 3.67	**95.65** ± 0.93	92.90 ± 2.43	87.70	94.60	86.15 ± 8.46	82.57 ± 3.28	89.69 ± 1.19
macaroni1	95.43 ± 4.08	88.33 ± 8.63	96.72 ± 2.59	97.34 ± 1.56	95.86 ± 2.37	50.30	98.30	73.56 ± 21.73	96.40 ± 3.07	**99.26** ± 0.53
macaroni2	90.05 ± 2.20	74.04 ± 9.95	91.71 ± 3.82	93.46 ± 2.06	89.73 ± 2.26	44.70	**97.60**	84.67 ± 15.24	85.76 ± 1.78	94.27 ± 4.41
pcb1	90.34 ± 11.11	90.72 ± 1.49	**98.26** ± 2.17	96.59 ± 3.74	94.50 ± 6.37	38.70	94.10	72.82 ± 22.46	90.77 ± 11.79	97.88 ± 1.35
pcb2	91.53 ± 7.91	90.22 ± 2.08	**97.49** ± 2.39	95.36 ± 2.89	94.11 ± 3.61	58.70	92.40	74.16 ± 20.63	93.25 ± 4.02	96.36 ± 1.39
pcb3	91.80 ± 5.56	90.10 ± 2.80	95.73 ± 3.21	95.62 ± 2.34	92.02 ± 4.66	76.00	88.40	78.54 ± 26.58	92.23 ± 6.09	**99.04** ± 0.21
pcb4	78.97 ± 12.27	83.57 ± 1.49	92.44 ± 5.82	93.28 ± 4.15	90.17 ± 6.77	91.40	95.70	78.97 ± 21.25	89.96 ± 5.68	**96.71** ± 0.68
pipe fryum	97.88 ± 1.89	96.29 ± 1.06	97.33 ± 0.84	**98.79** ± 0.61	98.44 ± 0.88	83.60	98.20	88.48 ± 11.11	97.14 ± 1.57	97.15 ± 2.68
tail class	83.90 ± 8.10	82.55 ± 6.66	91.46 ± 4.73	93.89 ± 3.30	90.02 ± 5.05	74.61 ± 19.30	<u>95.54</u> ± 3.00	95.39 ± 5.00	83.96 ± 9.92	**96.80** ± 2.69
head class	97.36 ± 3.71	91.49 ± 4.60	98.02 ± 1.80	**98.35** ± 1.32	<u>97.94</u> ± 1.97	71.21 ± 19.32	95.48 ± 3.34	62.96 ± 10.16	97.11 ± 4.18	97.03 ± 3.38
all	89.51 ± 9.18	86.27 ± 7.2	94.20 ± 4.9	<u>95.74</u> ± 3.3	93.32 ± 5.5	73.19 ± 19.6	95.52 ± 3.17	81.88 ± 18.3	89.44 ± 10.0	**96.90** ± 3.01

Table 26. Anomaly segmentation on VisA-step-K1 with pixel-level AUROC. We report the mean over 5 random seeds for each measurement. The best performance is indicated with bold and the second-best with underline.

	PaDiM	SimpleNet	EfficientAD	HVQ	UniAD	WinCLIP	AnomalyCLIP	PatchCore	SoftPatch	TailedCore (ours)
candle	84.28 ± 8.15	80.29 ± 8.82	76.45 ± 11.25	94.56 ± 3.44	88.46 ± 6.15	87.00	**98.80**	88.20 ± 21.36	76.50 ± 12.90	98.18 ± 0.71
capsules	79.63 ± 10.69	75.87 ± 16.78	87.88 ± 10.46	88.76 ± 9.25	83.30 ± 2.13	80.00	95.00	84.81 ± 10.74	75.43 ± 15.75	**95.28** ± 0.36
cashew	90.16 ± 6.83	85.16 ± 18.54	92.51 ± 5.09	93.86 ± 5.48	93.14 ± 5.38	84.80	93.80	96.75 ± 1.03	91.05 ± 6.64	**97.43** ± 1.13
chewinggum	88.79 ± 2.65	68.19 ± 19.17	83.31 ± 7.37	95.56 ± 1.64	94.26 ± 1.22	95.40	99.30	97.73 ± 0.12	94.14 ± 2.73	**99.31** ± 0.14
fryum	85.49 ± 7.54	75.45 ± 17.82	92.83 ± 0.69	**93.47** ± 3.85	92.28 ± 4.44	87.70	94.60	83.20 ± 6.50	84.26 ± 6.65	89.64 ± 2.28
macaroni1	94.04 ± 5.81	78.33 ± 18.65	94.70 ± 5.55	94.64 ± 3.66	95.82 ± 2.37	50.30	98.30	71.40 ± 21.31	90.90 ± 10.48	**98.64** ± 1.33
macaroni2	88.45 ± 0.73	67.73 ± 5.73	86.12 ± 4.12	90.06 ± 0.96	88.14 ± 2.33	44.70	**97.60**	87.97 ± 0.86	82.66 ± 1.09	93.94 ± 1.64
pcb1	84.27 ± 12.99	89.11 ± 3.28	95.83 ± 3.46	92.32 ± 6.40	90.93 ± 7.47	38.70	94.10	82.00 ± 17.26	84.35 ± 13.83	**99.06** ± 0.60
pcb2	93.85 ± 7.95	88.49 ± 3.79	97.46 ± 3.91	92.26 ± 7.46	95.27 ± 3.13	58.70	92.40	63.48 ± 18.14	92.89 ± 8.14	**96.32** ± 1.81
pcb3	92.12 ± 7.98	85.06 ± 6.99	93.42 ± 7.84	91.28 ± 6.56	92.90 ± 5.57	76.00	88.40	69.94 ± 25.21	92.09 ± 8.55	**98.93** ± 0.48
pcb4	81.85 ± 14.74	78.50 ± 2.33	92.59 ± 8.64	88.04 ± 9.46	91.47 ± 8.21	91.40	**95.70**	70.39 ± 19.28	88.89 ± 9.01	95.24 ± 2.23
pipe fryum	97.96 ± 1.82	93.84 ± 2.79	96.21 ± 2.95	96.87 ± 3.28	97.37 ± 2.42	83.60	**98.20**	89.44 ± 11.46	96.06 ± 3.28	97.86 ± 1.82
tail class	82.58 ± 7.84	74.21 ± 11.63	85.44 ± 7.41	90.59 ± 4.34	88.47 ± 4.44	73.81 ± 21.67	**96.17** ± 2.84	94.11 ± 4.19	80.73 ± 9.48	<u>96.13</u> ± 3.48
head class	96.57 ± 2.80	89.31 ± 5.31	**98.25** ± 1.46	95.51 ± 1.93	96.81 ± 2.83	72.32 ± 18.68	94.61 ± 3.09	65.30 ± 14.32	96.82 ± 2.44	<u>97.39</u> ± 2.24
all	88.41 ± 9.54	80.50 ± 12.1	90.78 ± 8.66	92.64 ± 4.8	91.95 ± 5.8	73.19 ± 19.6	<u>95.52</u> ± 3.17	82.11 ± 17.6	87.44 ± 10.9	**96.65** ± 3.10