

Benchmarking Out-of-Distribution Detection for Plankton Recognition: A Systematic Evaluation of Advanced Methods in Marine Ecological Monitoring

Supplementary Material

1. Dataset Detailed Categories

This section provides detailed classification information for the plankton dataset we constructed to evaluate Out-of-Distribution (OoD) detection methods. To simulate various distribution shift scenarios encountered in real-world marine ecological monitoring, we meticulously divided the ninety-two original classes from the DYB-PlanktonNet dataset into three subsets: In-Distribution (ID), Near-OoD, and Far-OoD. This hierarchical classification approach is designed to accurately evaluate anomalous data with varying semantic and morphological similarities, thus more comprehensively reflecting the model's performance in practical deployment. Tables 5 to 7 provide a detailed list of all categories in each subset, along with their specific meanings and roles in our benchmark.

2. Common OoD post hoc methods

Table 8 outlines the basic principles of the OoD detection methods employed in our study.

3. Experiment Details

3.1. Dataset Preprocessing

The ID dataset was split into training, validation, and testing subsets in a ratio of 8:1:1. All backbone networks were trained on the training split, while hyperparameter tuning was performed on the validation split. The classification accuracy (ACC) for ID classes was evaluated on the test split. All images underwent normalization as a preprocessing step. During training, we applied random cropping and random horizontal flipping for data augmentation to enhance model generalization. In the validation and testing phases, images were first resized and then subjected to center cropping. Consistent with the OpenOoD benchmark [66], our training protocol uses only standard data augmentation, without any advanced strategies. All cropped images were resized to a fixed resolution of 224×224 pixels before being fed into the network.

3.2. Hyperparameter Search

Given the high sensitivity of Out-of-Distribution (OoD) detection methods to hyperparameter choices, we adopted the OpenOoD-v1.5 Guidelines [66] for a fair and reproducible evaluation. Specifically, we used a validation set to tune the hyperparameters for each method and backbone model. For all methods requiring tuning, we conducted an extensive hy-

perparameter search to determine their optimal settings. To account for randomness, this search was performed for each of the three separate training runs (with different random seeds). The specific hyperparameter values that yielded the best performance for each combination are detailed in Tab. 9.

3.3. Ablation Study

To investigate the influence of different network architectures on OoD detection performance, we designed and conducted an ablation study where we only replaced the network backbone models. Each network was trained three times using different random seeds, and we report the mean and standard deviation of their AUROC values on the Near-OoD, Far-OoD (Bubbles & Particles), and Far-OoD (General) datasets. For methods requiring hyperparameter tuning, we performed an extensive search for each backbone to ensure the best performance is reported. The experimental results are shown in Figs. 2 to 4. We observed that some methods, such as GradNorm, ReAct, ASH, and SHE, exhibit strong dependence on the underlying network, while others, including KNN, fDBD, Relation, and ViM, are less sensitive. This highlights the importance of considering the chosen network architecture when evaluating OoD detection results.

3.4. A Good Closed-set Classifier Is All You Need?

To investigate the relationship between OoD detection performance and classifier accuracy, we selected five representative methods: MSP, ViM, Energy, KNN, and Mahalanobis. We evaluated them across four common network architectures—ResNet-18, ResNet-50, DenseNet-121, and ViT—on our Near-OoD, Far-OoD (Bubbles & Particles), and Far-OoD (General) benchmarks, strictly following the OpenOoD guidelines [66].

Figure 5 reveals a significant positive correlation between closed-set classification accuracy (ACC) and OoD detection performance (AUROC) for OoD data with semantic shifts. Specifically, for Near-OoD, the Spearman's ρ correlation coefficient was 0.667 ($p < 0.001$); for Far-OoD (Bubbles & Particles), it was 0.609 ($p < 0.005$), both of which are statistically significant. This suggests that for data with moderate semantic shifts, a stronger classifier generally learns more discriminative feature representations, which in turn improves OoD detection [54]. However, for the semantically disjoint Far-OoD (General) data, we observed no significant correlation between ACC and

ID-class	Specimen type	Phylum	Class	Order
Polychaeta.most with eggs	Plankton	Annelida	Polychaeta	/
Polychaeta.Type A	Plankton	Annelida	Polychaeta	/
Polychaeta.Type B	Plankton	Annelida	Polychaeta	/
Polychaeta.Type C	Plankton	Annelida	Polychaeta	/
Polychaeta.Type D	Plankton	Annelida	Polychaeta	/
Polychaeta.Type E	Plankton	Annelida	Polychaeta	/
Polychaeta.Type F	Plankton	Annelida	Polychaeta	/
Penilia avirostris	Plankton	Arthropoda	Branchiopoda	Ctenopoda
Evadne tergestina	Plankton	Arthropoda	Branchiopoda	Onychopoda
Acartia sp.A	Plankton	Arthropoda	Hexanauplia	Calanoida
Acartia sp.B	Plankton	Arthropoda	Hexanauplia	Calanoida
Acartia sp.C	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanopia sp.	Plankton	Arthropoda	Hexanauplia	Calanoida
Labidocera sp.	Plankton	Arthropoda	Hexanauplia	Calanoida
Tortanus gracilis	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanoid with egg	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanoid.Type A	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanoid.Type B	Plankton	Arthropoda	Hexanauplia	Calanoida
Oithona sp.B with egg	Plankton	Arthropoda	Hexanauplia	Cyclopoida
Cyclopoid.Type A-with egg	Plankton	Arthropoda	Hexanauplia	Cyclopoida
Harpacticoid-mating	Plankton	Arthropoda	Hexanauplia	Harpacticoida
Microsetella sp.	Plankton	Arthropoda	Hexanauplia	Harpacticoida
Caligus sp.	Plankton	Arthropoda	Hexanauplia	Siphonostomatoida
Copepod.Type A	Plankton	Arthropoda	Hexanauplia	/
Caprella sp.	Plankton	Arthropoda	Malacostraca	Amphipoda
Amphipoda.Type A	Plankton	Arthropoda	Malacostraca	Amphipoda
Amphipoda.Type B	Plankton	Arthropoda	Malacostraca	Amphipoda
Amphipoda.Type C	Plankton	Arthropoda	Malacostraca	Amphipoda
Gammarids.Type A	Plankton	Arthropoda	Malacostraca	Amphipoda
Gammarids.Type B	Plankton	Arthropoda	Malacostraca	Amphipoda
Gammarids.Type C	Plankton	Arthropoda	Malacostraca	Amphipoda
Cymodoce sp.	Plankton	Arthropoda	Malacostraca	Isopoda
Lucifer sp.	Plankton	Arthropoda	Malacostraca	Decapoda
Macrura larvae	Plankton	Arthropoda	Malacostraca	Decapoda
Megalopa larva.Phase 1.Type B	Plankton	Arthropoda	Malacostraca	Decapoda
Megalopa larva.Phase 1.Type C	Plankton	Arthropoda	Malacostraca	Decapoda
Megalopa larva.Phase 1.Type D	Plankton	Arthropoda	Malacostraca	Decapoda
Megalopa larva.Phase 2	Plankton	Arthropoda	Malacostraca	Decapoda
Porcellanidae larva	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like larva.Type A	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like larva.Type B	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like.Type A	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like.Type B	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like.Type D	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like.Type F	Plankton	Arthropoda	Malacostraca	Decapoda
Cumacea.Type A	Plankton	Arthropoda	/	/
Cumacea.Type B	Plankton	Arthropoda	/	/
Chaetognatha	Plankton	Chaetognatha	/	/
Oikopleura sp. parts	Plankton	Chordata	Appendicularia	Copelata
Tunicata.Type A	Plankton	Chordata	/	/
Jellyfish	Plankton	Cnidaria	/	/
Creseis acicula	Plankton	Mollusca	Gastropoda	Pteropoda
Noctiluca scintillans	Plankton	Myzozoa	Dinophyceae	Noctilucales
Phaeocystis globosa	Plankton	Haptophyta	/	/

Table 5. In-Distribution (ID) Class

AUROC (Spearman’s $\rho = 0.248$, $p = 0.291$). This indicates that when OoD samples are highly dissimilar to the ID distribution, simply improving the closed-set classifier’s performance is not a sufficient guarantee for better OoD detection.

4. Network Results

4.1. ResNet-18

Tables 10 and 11 show the comprehensive performance of the ResNet-18 network on the Far-OoD and Near-OoD benchmarks.

Near-OoD-class	Specimen type	Phylum	Class	Order
Polychaeta larva	Plankton	Annelida	Polychaeta	/
Calanoid Nauplii	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanoid_Type C	Plankton	Arthropoda	Hexanauplia	Calanoida
Calanoid_Type D	Plankton	Arthropoda	Hexanauplia	Calanoida
Oithona sp.A with egg	Plankton	Arthropoda	Hexanauplia	Cyclopoida
Cyclopoid_Type A	Plankton	Arthropoda	Hexanauplia	Cyclopoida
Harpacticoid	Plankton	Arthropoda	Hexanauplia	Harpacticoida
Monstrilla sp.A	Plankton	Arthropoda	Hexanauplia	Monstrilloida
Monstrilla sp.B	Plankton	Arthropoda	Hexanauplia	Monstrilloida
Megalopa larva_Phase 1_Type A	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like_Type C	Plankton	Arthropoda	Malacostraca	Decapoda
Shrimp-like_Type E	Plankton	Arthropoda	Malacostraca	Decapoda
Ostracoda	Plankton	Arthropoda	Ostracoda	/
Oikopleura sp.	Plankton	Chordata	Appendicularia	Copelata
Actiniaria larva	Plankton	Cnidaria	Anthozoa	/
Hydroid	Plankton	Cnidaria	/	/
Jelly-like	Plankton	Cnidaria	/	/
Bryozoan larva	Plankton	Ectoprocta/bryozoan	/	/
Gelatinous Zooplankton	Plankton	/	/	/
Unknown_Type A	Plankton	/	/	/
Unknown_Type B	Plankton	/	/	/
Unknown_Type C	Plankton	/	/	/
Unknown_Type D	Plankton	/	/	/
Balanomorpha exuviate	Carcass	Arthropoda	Hexanauplia	Sessilia
Monstrilloid	Plankton	Arthropoda	Hexanauplia	Monstrilloida
Fish Larvae	Chordata	Vertebrata	Actinopterygii	/

Table 6. Near-OoD Class

Far-OoD-class	Specimen type	Phylum	Class
Crustacean limb_Type A	Carcass	Arthropoda	/
Crustacean limb_Type B	Carcass	Arthropoda	/
Fish egg	Chordata	Vertebrata	Actinopterygii
Particle_filamentous_Type A	Unknown	/	/
Particle_filamentous_Type B	Non-Living	/	/
Particle_bluish	Non-Living	/	/
Particle_molts	Non-Living	/	/
Particle_translucent flocs	Non-Living	/	/
Particle_yellowish flocs	Non-Living	/	/
Particle_yellowish rods	Non-Living	/	/
Bubbles	Non-Living	/	/
Fish tail	Non-Living	/	/

Table 7. Far-OoD (Bubbles & Particles) Class

4.2. ResNet-50

Tables 12 and 13 show the comprehensive performance of the ResNet-50 network on the Far-OoD and Near-OoD benchmarks.

4.3. ResNet-101

Tables 14 and 15 show the comprehensive performance of the ResNet-101 network on the Far-OoD and Near-OoD benchmarks.

4.4. ResNet-152

Tables 16 and 17 show the comprehensive performance of the ResNet-152 network on the Far-OoD and Near-OoD benchmarks.

4.5. DenseNet-121

Tables 18 and 19 show the comprehensive performance of the DenseNet-121 network on the Far-OoD and Near-OoD benchmarks.

Method	Score Function	Note
<i>Distance-based Methods</i>		
Mahalanobis	$-(\mathbf{z} - \mu_c)^\top \Sigma^{-1}(\mathbf{z} - \mu_c)$	Negative Mahalanobis distance to class- c prototype (μ_c, Σ from training)
RMDS	$-\min_c [(\mathbf{z} - \mu_c)^\top \Sigma_c^{-1}(\mathbf{z} - \mu_c) - (\mathbf{z} - \mu_0)^\top \Sigma_0^{-1}(\mathbf{z} - \mu_0)]$	Uses μ_0, Σ_0 of entire training data as background
KNN	$-\ \mathbf{z} - \mathbf{z}_{(k)}\ _2$	$\mathbf{z}_{(k)}$ is the k th nearest inlier feature (features are normalized)
fDBD	$-\frac{1}{ C -1} \sum_{c \neq y} \frac{\tilde{D}_f(\mathbf{z}, c)}{\ \mathbf{z} - \mu_{\text{train}}\ _2}$	$\tilde{D}_f(\mathbf{z}, c) = \frac{ (\mathbf{w}_y - \mathbf{w}_c)^\top \mathbf{z} + (b_y - b_c) }{\ \mathbf{w}_y - \mathbf{w}_c\ _2}$, y is predicted class, $\mathbf{W} = [\mathbf{w}_1, \dots, \mathbf{w}_C]$ classifier weights, μ_{train} training-feature mean
<i>Classification-based Methods</i>		
ViM	$-\alpha \ \mathbf{z}^{P^\perp}\ _2 + \log \sum_c e^{f_c(\mathbf{z})}$	Combines residual with LSE of logits $f_c(\mathbf{z})$
Residual	$-\ \mathbf{z}^{P^\perp}\ _2$	$\mathbf{z}^{P^\perp}$ is projection residual outside principal subspace
ODIN	$\max_c \sigma_{\text{SM}}(f(\tilde{\mathbf{x}})/T)^{(c)}$	Perturb input $\tilde{\mathbf{x}} = \mathbf{x} + \varepsilon \text{sign}(\nabla_{\mathbf{x}} \log p_{\max}(\mathbf{x}))$, then apply temp T -scaled softmax (operates in input space)
OpenMax	$\max_c \hat{P}(y = c \mathbf{x})$	$\hat{P}(y = c \mathbf{x})$ is recalibrated probability; accept if $\arg \max_j \hat{P}(y=j \mathbf{x}) \neq \text{unknown}$ (operates in input space)
TempScale	$\max_c \sigma_{\text{SM}}(f(\mathbf{z})/T)^{(c)}$	σ_{SM} is softmax with temperature T
GEN	$G_\gamma(\mathbf{p}) = -\sum_{m=1}^C p_{i_m}^\gamma (1 - p_{i_m})^\gamma$	$p_{i_1} \geq \dots \geq p_{i_C}$ are sorted softmax probabilities, $\gamma \in (0, 1)$
MSP	$\max_c p_c(\mathbf{z})$	Maximum softmax probability
MCDropout	$-H(\frac{1}{T} \sum_{t=1}^T \hat{\mathbf{y}}^{(t)}(\mathbf{x}))$	$H(\cdot)$ is entropy of predictive mean over T dropout samples (operates in input space)
MLS	$S_1(\mathbf{z}) = \max_c f_c(\mathbf{z})$	MaxLogit
KL Matching	$-\min_c D_{\text{KL}}(\mathbf{p}(\mathbf{x}) \parallel \mathbf{d}_c)$	$\mathbf{d}_c$ is class-prototype distribution (operates in input space)
ReAct	$\max_c \sigma_{\text{SM}}(f(\min(\mathbf{z}, b)))^{(c)}$	Clamp activations at threshold b and apply MSP score
ASH	$\log \sum_{c=1}^C \exp(f_c^{\text{ASH}}(\mathbf{z}))$	$f^{\text{ASH}} = \mathbf{W}^\top \mathbf{h}'(\mathbf{z}) + \mathbf{b}$, $\mathbf{W}$ classifier weights, $\mathbf{h}'(\mathbf{z})$ is processed feature (pruning & normalization)
SHE	$\beta^{-1} \log \sum_{j=1}^M \exp(\beta \boldsymbol{\xi}^\top \mathbf{S}_j)$	β is hyper-parameter, $\boldsymbol{\xi}^\top \mathbf{S}_j$ is inner product between test pattern and stored pattern
RankFeat	$\max_c f_c(\mathbf{z} - s_1 \mathbf{u}_1 \mathbf{v}_1^\top)$	Remove first principal component and apply MaxLogit
GradNorm	$\ \mathbf{p} - \frac{1}{C} \mathbf{1}\ _1 \cdot \ \mathbf{z}\ _1$	L1 distance of $\mathbf{p}$ to uniform distribution ($\times$) feature norm
Relation	$\sum_{i \in S} k(\mathbf{z}, \mathbf{z}_i)$	$k(\cdot, \cdot)$ similarity kernel, S support set of stored inlier features
<i>Density-based Methods</i>		
Energy	$T \log \sum_{c=1}^C \exp(f_c(\mathbf{z})/T)$	$f_c(\mathbf{z})$ is logit value, T temperature
DICE	$\log \sum_{c=1}^C \exp(((\mathbf{M} \odot \mathbf{W})^\top \mathbf{z})_c + b_c)$	$\mathbf{W}$ classifier weights, $\mathbf{M}$ mask matrix for sparsification

Table 8. Method Introduction

Network		Hyperparameters									
Backbone	Seed	ASH percentile	fDBD distance.as_normalizer	GEN gamma	M	KNN K	ReAct percentile	Relation pow	ViM dim	ODIN*	
ResNet-18	s0	95	FALSE	0.01	50	50	99	8	64	1	0.0014
	s1	95	FALSE	0.5	100	50	99	8	256	1	0.0014
	s2	95	FALSE	0.1	50	50	99	8	256	1	0.0014
ResNet-50	s0	95	TRUE	0.01	10	50	99	8	256	1	0.0014
	s1	95	FALSE	0.1	50	50	99	8	256	1	0.0014
	s2	95	FALSE	0.01	10	50	99	8	256	1	0.0014
ResNet-101	s0	95	FALSE	0.1	50	50	99	8	256		
	s1	95	FALSE	0.5	50	50	99	8	256		
	s2	95	FALSE	0.01	10	50	99	8	256		
ResNet-152	s0	95	TRUE	0.01	10	50	99	8	256		
	s1	95	FALSE	0.5	50	50	99	8	256		
	s2	95	FALSE	0.1	50	50	99	8	256		
DenseNet-121	s0	95	FALSE	0.01	10	50	99	8	128		
	s1	95	FALSE	0.01	10	50	99	8	256		
	s2	95	FALSE	0.1	50	50	99	8	256		
DenseNet-169	s0	95	FALSE	0.01	50	50	99	8	256		
	s1	95	FALSE	0.1	50	50	99	8	256		
	s2	95	FALSE	0.01	10	50	99	8	256		
DenseNet-201	s0	95	FALSE	0.01	10	50	99	8	256		
	s1	95	FALSE	0.01	10	50	99	8	256		
	s2	95	FALSE	0.01	10	50	99	8	256		
Se-ResNeXt-50	s0	95	FALSE	0.01	10	50	99	8	256	1	0.0014
	s1	95	FALSE	0.01	10	50	99	8	256	1	0.0014
	s2	95	FALSE	0.01	10	50	99	8	256	1	0.0014
ViT	s0	95	TRUE	0.1	10	50	99	8	256		
	s1	65	TRUE	0.1	50	50	99	8	256		
	s2	80	TRUE	0.1	10	50	99	8	256		

Table 9. Optimal Hyperparameters for OoD Detection Methods. This table lists the best-performing hyperparameter configurations found for each backbone network and OoD detection method after an hyperparameter search. **ODIN*** was only evaluated on the ResNet-18, ResNet-50, and Se-ResNeXt-50 backbones due to its significant computational cost.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	58.06± 13.75	60.48 ± 4.63	76.16 ± 9.10	83.78 ± 2.39	85.23 ± 3.29	80.65 ± 6.34	88.07 ± 1.87	91.36 ± 2.56	89.47 ± 2.35	64.49 ± 2.54
DICE	33.79 ± 3.18	30.72 ± 3.19	64.11 ± 6.26	65.58 ± 3.35	93.05 ± 0.85	74.18 ± 3.78	85.83 ± 1.14	89.12 ± 4.23	87.60 ± 1.12	65.47 ± 1.90
MCDropout	42.77 ± 1.26	29.35 ± 0.36	75.45 ± 2.12	62.34 ± 2.16	92.16 ± 0.20	64.11 ± 3.35	76.76 ± 4.80	89.41 ± 1.73	89.66 ± 2.54	81.17 ± 1.01
Energy	37.64 ± 3.13	31.83 ± 2.44	72.61 ± 2.31	74.35 ± 3.35	92.22 ± 0.68	64.88 ± 3.86	84.83 ± 1.29	86.99 ± 2.98	88.29 ± 1.38	74.24 ± 0.66
fDBD	36.18 ± 1.68	30.42 ± 1.67	73.00 ± 4.39	58.96 ± 4.60	92.91 ± 0.37	40.78 ± 3.29	33.36 ± 4.00	75.89 ± 1.66	57.54 ± 6.60	91.89 ± 0.89
GEN	36.91 ± 2.72	28.50 ± 2.16	71.76 ± 2.23	69.69 ± 3.03	92.66 ± 0.54	63.70 ± 3.14	82.23 ± 3.84	87.07 ± 3.04	88.35 ± 1.30	77.14 ± 2.15
GradNorm	87.04 ± 8.99	92.30 ± 0.21	91.74 ± 7.72	97.41 ± 0.31	54.64 ± 4.32	94.57 ± 4.07	92.70 ± 3.07	96.73 ± 3.95	94.03 ± 2.67	31.41 ± 3.45
KL Matching	38.28 ± 0.92	77.71 ± 5.48	72.69 ± 3.82	94.95 ± 0.94	88.87 ± 0.86	55.22 ± 2.58	73.91 ± 5.84	78.97 ± 1.57	85.22 ± 3.04	80.39 ± 1.56
KNN	33.73 ± 1.27	22.21 ± 0.84	77.82 ± 2.36	44.88 ± 1.27	93.99 ± 0.28	31.66 ± 4.62	19.34 ± 2.16	73.21 ± 3.89	35.16 ± 3.92	94.56 ± 0.83
Mahalanobis	48.01 ± 5.11	28.80 ± 2.56	83.49 ± 4.63	43.96 ± 1.71	91.57 ± 1.15	2.46 ± 0.65	2.80 ± 0.69	14.46 ± 3.65	7.87 ± 0.89	99.40 ± 0.13
MLS	36.95 ± 2.91	31.15 ± 2.46	71.62 ± 2.08	74.24 ± 3.23	92.35 ± 0.62	63.89 ± 3.29	84.80 ± 1.28	87.73 ± 2.08	88.34 ± 1.35	74.70 ± 0.63
MSP	40.77 ± 1.15	25.80 ± 0.39	72.16 ± 2.06	54.80 ± 4.05	92.79 ± 0.26	62.66 ± 2.30	76.52 ± 4.03	87.70 ± 2.03	88.82 ± 1.44	81.99 ± 0.90
ODIN	33.24 ± 1.77	26.01 ± 0.49	68.26 ± 1.97	63.78 ± 3.79	93.63 ± 0.11	27.23 ± 1.48	49.84 ± 8.09	49.76 ± 3.01	79.33 ± 4.39	91.74 ± 0.88
OpenMax	90.99 ± 1.70	25.01 ± 0.76	98.96 ± 0.61	48.44 ± 0.67	85.00 ± 0.41	68.34 ± 1.48	30.94 ± 2.88	85.52 ± 1.48	61.44 ± 4.93	87.91 ± 0.87
RankFeat	79.80± 10.24	86.33 ± 2.59	92.52 ± 5.25	96.24 ± 0.67	68.55 ± 4.76	95.83 ± 3.84	93.55 ± 2.09	98.56 ± 1.70	96.58 ± 1.59	34.08 ± 5.08
ReAct	41.04 ± 2.94	39.04 ± 2.04	72.91 ± 2.34	66.64 ± 3.12	90.96 ± 0.36	62.29 ± 4.73	81.63 ± 1.35	85.35 ± 2.30	87.82 ± 1.37	77.57 ± 0.94
Relation	38.26 ± 1.30	46.33 ± 5.34	71.22 ± 0.81	65.61 ± 0.22	91.35 ± 0.54	58.50 ± 2.56	51.41 ± 2.60	86.78 ± 1.41	61.86 ± 0.33	85.82 ± 0.78
Residual	60.65 ± 6.61	43.89 ± 3.25	88.66 ± 2.61	58.19 ± 2.43	87.02 ± 1.99	3.76 ± 1.45	2.91 ± 0.65	15.62 ± 5.01	7.89 ± 1.02	99.28 ± 0.21
RMDS	44.78 ± 4.33	18.73 ± 0.99	90.50 ± 2.00	40.42 ± 2.90	93.36 ± 0.55	28.53 ± 3.28	12.91 ± 0.21	59.48 ± 3.90	18.59 ± 0.44	96.25 ± 0.33
SHE	83.12 ± 1.77	88.43 ± 0.98	88.55 ± 0.78	94.76 ± 0.68	57.37 ± 1.25	84.67 ± 1.47	92.76 ± 1.98	91.65 ± 1.36	95.39 ± 1.18	55.85 ± 3.32
TempScale	38.27 ± 1.39	25.92 ± 0.81	71.26 ± 2.35	57.08 ± 4.90	93.01 ± 0.32	61.83 ± 2.67	78.57 ± 3.06	87.54 ± 2.52	88.65 ± 1.36	81.25 ± 0.82
ViM	30.61 ± 3.37	19.46 ± 0.47	69.01 ± 5.53	35.31 ± 1.30	94.92 ± 0.37	0.82 ± 0.19	0.94 ± 0.29	5.04 ± 1.29	3.49 ± 0.73	99.75 ± 0.06

Table 10. Far-OoD on ResNet-18.

4.6. DenseNet-169

Tables 20 and 21 show the comprehensive performance of the DenseNet-169 network on the Far-OoD and Near-OoD benchmarks.

4.7. DenseNet-201

Tables 22 and 23 show the comprehensive performance of the DenseNet-201 network on the Far-OoD and Near-OoD benchmarks.

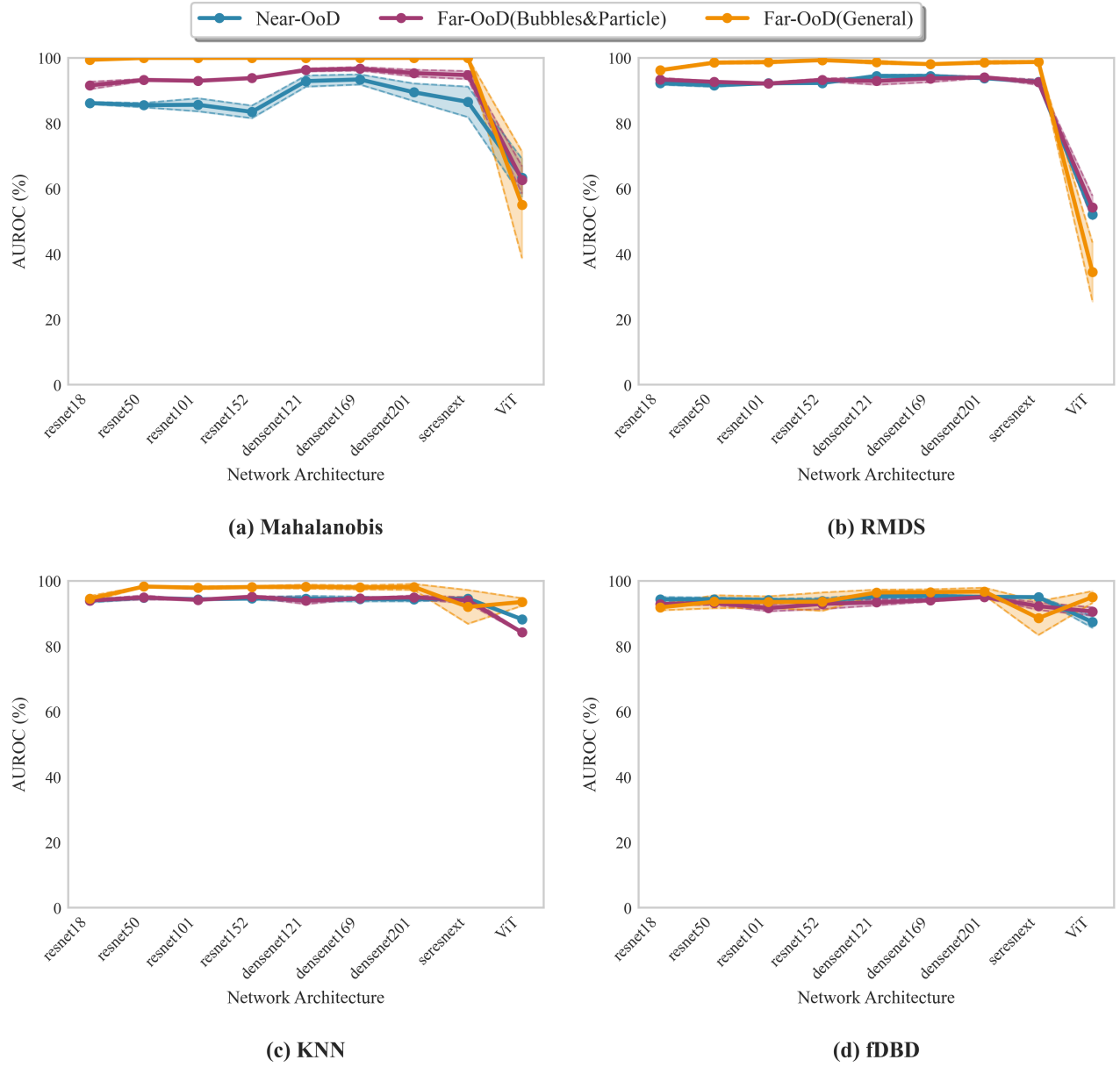


Figure 2. Distance-based Methods. The solid points on the line graph represent the average values, with the standard deviation range illustrated by the shaded area between the dashed lines.

4.8. SE-ResNeXt-50

Tables 24 and 25 show the comprehensive performance of the SE-ResNeXt-50 network on the Far-OoD and Near-OoD benchmarks.

4.9. ViT

Tables 26 and 27 show the comprehensive performance of the ViT network on the Far-OoD and Near-OoD benchmarks.

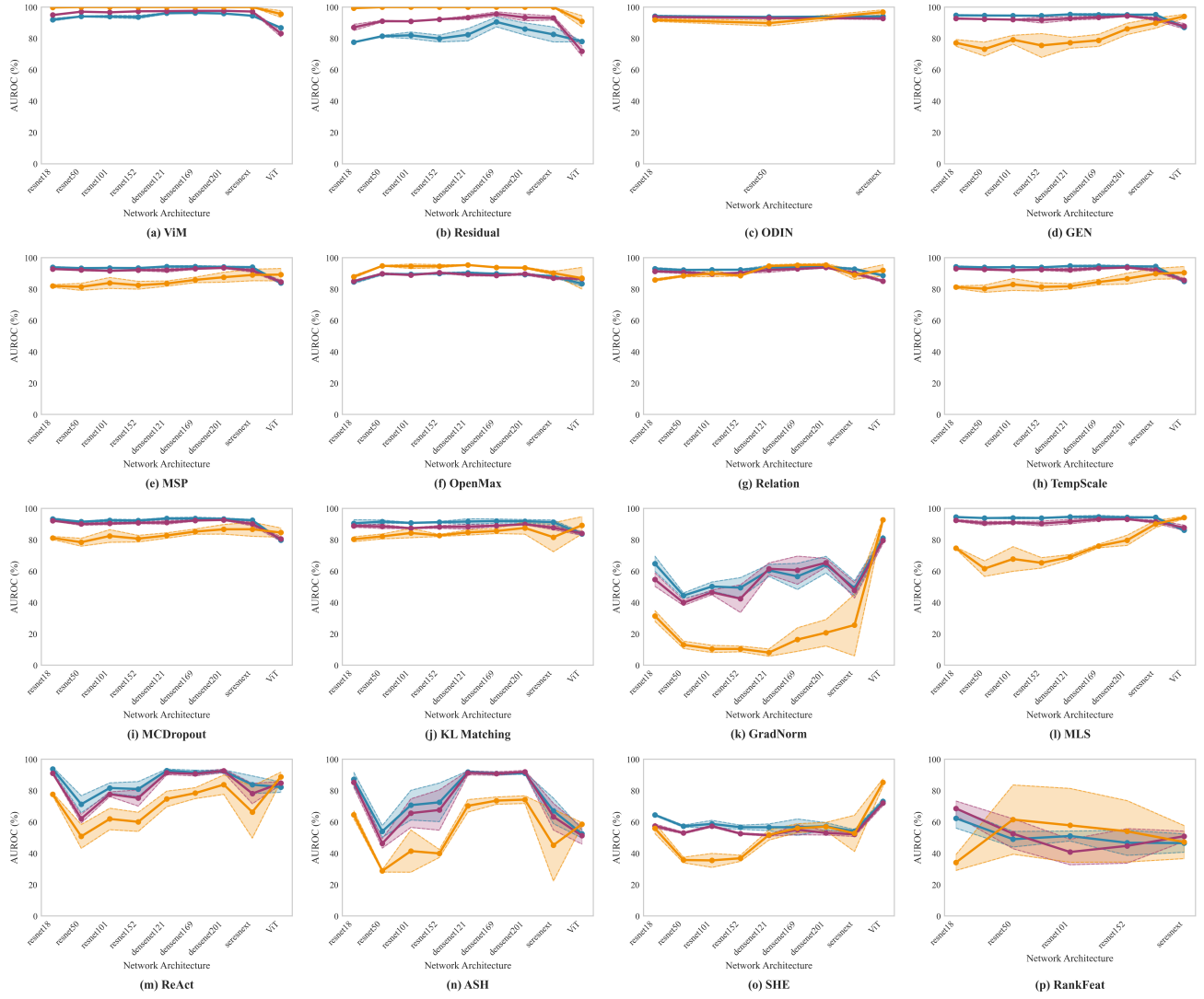
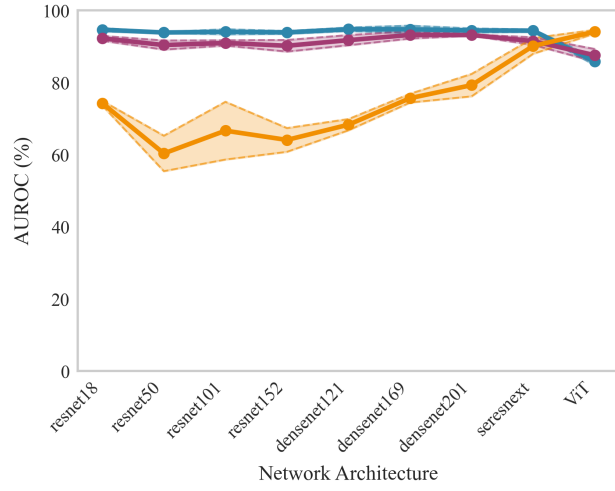
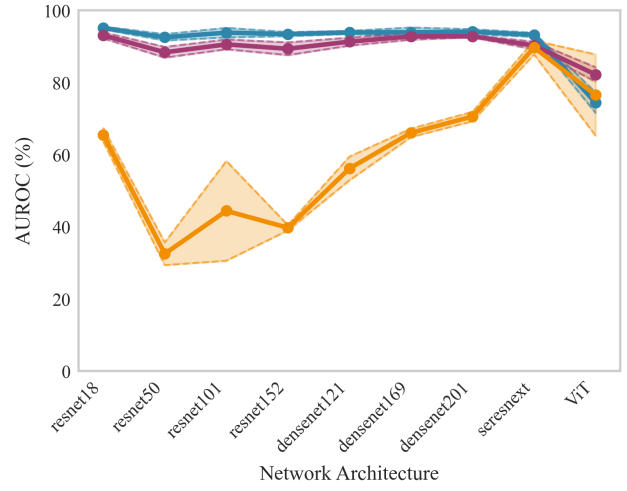


Figure 3. Classification-based Methods. The solid points on the line graph represent the average values, with the standard deviation range illustrated by the shaded area between the dashed lines.



(a) Energy



(b) DICE

Figure 4. Density-based Methods. The solid points on the line graph represent the average values, with the standard deviation range illustrated by the shaded area between the dashed lines.

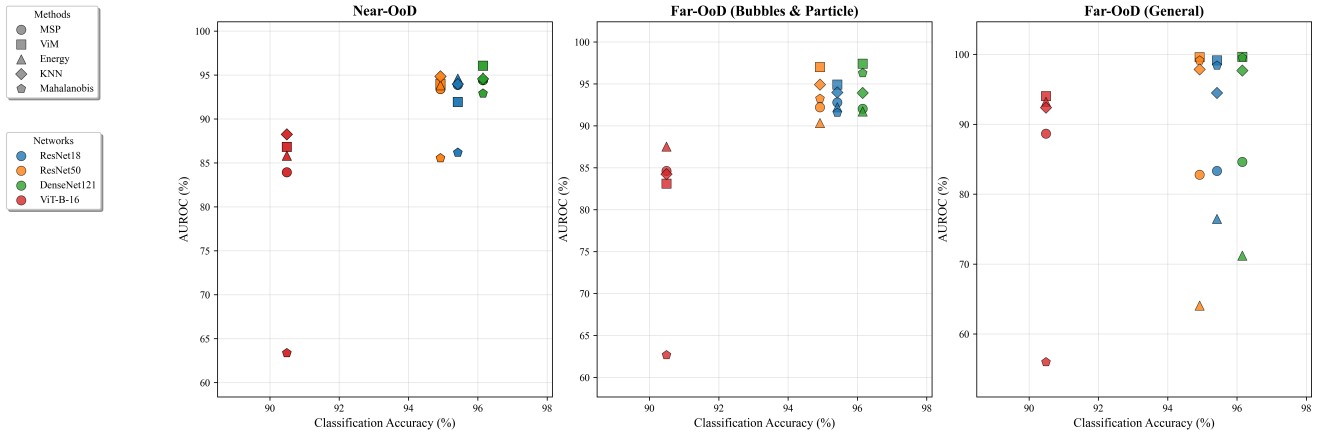


Figure 5. Correlation Between ID Classification Accuracy and OoD Detection Performance. We selected five representative methods: MSP, ViM, Energy, KNN, and Mahalanobis, then we evaluated these methods using four common network architectures: ResNet-18, ResNet-50, DenseNet-121, and ViT, on our Near-OoD, Far-OoD (Bubbles & Particles), and Far-OoD (General) benchmarks. The average performance of these methods across different architectures was plotted on scatter graphs to visually analyze their correlation.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	52.36 ± 16.96	53.45 ± 11.25	70.22 ± 11.39	82.71 ± 7.61	87.14 ± 4.49
DICE	26.89 ± 3.29	19.02 ± 1.78	58.48 ± 1.47	54.73 ± 7.30	95.09 ± 0.40
MCDropout	40.79 ± 2.50	24.47 ± 2.65	73.31 ± 1.28	46.51 ± 8.95	93.26 ± 0.79
Energy	28.82 ± 3.17	20.56 ± 1.16	65.38 ± 2.78	56.55 ± 3.85	94.60 ± 0.48
fDBD	34.24 ± 1.62	21.29 ± 2.46	71.24 ± 2.13	35.39 ± 5.12	94.37 ± 0.70
GEN	29.08 ± 3.58	20.06 ± 1.47	64.74 ± 2.83	47.65 ± 9.13	94.72 ± 0.51
GradNorm	79.11 ± 11.18	88.15 ± 2.82	88.05 ± 9.47	97.37 ± 1.19	64.77 ± 4.85
KL Matching	35.93 ± 3.90	52.50 ± 19.90	69.84 ± 2.27	83.90 ± 5.51	90.51 ± 2.34
KNN	34.91 ± 3.87	21.63 ± 1.23	78.29 ± 2.31	42.22 ± 5.73	93.96 ± 0.59
Mahalanobis	75.03 ± 1.69	34.97 ± 0.62	93.24 ± 1.71	48.20 ± 1.46	86.17 ± 0.36
MLS	29.55 ± 4.33	20.51 ± 1.07	66.08 ± 1.63	56.41 ± 4.01	94.53 ± 0.50
MSP	38.40 ± 3.91	21.26 ± 1.77	69.58 ± 0.63	36.71 ± 3.70	93.87 ± 0.61
ODIN	32.26 ± 2.14	21.50 ± 4.14	74.77 ± 1.73	53.32 ± 4.01	94.19 ± 0.65
OpenMax	96.10 ± 0.16	21.46 ± 2.19	99.71 ± 0.11	35.13 ± 0.78	84.62 ± 1.11
RankFeat	89.07 ± 4.33	88.13 ± 7.45	97.14 ± 1.12	97.01 ± 1.56	62.27 ± 6.25
ReAct	31.38 ± 3.58	26.45 ± 7.00	65.18 ± 2.43	50.54 ± 5.63	93.72 ± 1.26
Relation	37.44 ± 3.20	27.85 ± 2.56	69.99 ± 1.64	48.83 ± 4.86	93.02 ± 0.81
Residual	84.38 ± 0.90	54.43 ± 0.62	96.47 ± 0.78	65.36 ± 1.15	77.53 ± 0.18
RMDS	63.96 ± 1.92	18.93 ± 1.72	93.07 ± 1.41	32.72 ± 1.81	92.24 ± 0.46
SHE	81.91 ± 1.61	85.52 ± 0.57	88.99 ± 0.65	96.48 ± 0.42	64.44 ± 0.50
TempScale	34.79 ± 3.98	20.51 ± 1.85	67.92 ± 1.01	38.18 ± 6.70	94.26 ± 0.61
ViM	56.18 ± 5.94	22.26 ± 1.15	88.34 ± 2.86	34.16 ± 5.96	91.94 ± 0.84

Table 11. Near-OoD on ResNet-18.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	99.97 ± 0.03	90.10 ± 2.23	100.00 ± 0.00	98.45 ± 0.57	46.26 ± 3.00	99.99 ± 0.01	98.02 ± 0.79	100.00 ± 0.00	99.25 ± 0.53	28.73 ± 0.78
DICE	42.40 ± 3.66	54.83 ± 6.83	66.92 ± 4.10	83.61 ± 4.51	88.35 ± 1.49	97.45 ± 2.36	96.69 ± 2.52	99.72 ± 0.12	98.39 ± 1.73	32.51 ± 3.16
MCDropout	51.32 ± 3.88	38.16 ± 3.53	80.02 ± 1.36	71.35 ± 5.67	90.11 ± 0.88	69.19 ± 4.91	82.21 ± 3.82	91.96 ± 1.66	91.39 ± 1.14	78.46 ± 2.51
Energy	39.93 ± 2.84	46.27 ± 8.14	70.97 ± 3.80	83.07 ± 4.01	90.35 ± 1.27	84.47 ± 5.14	90.66 ± 2.77	98.35 ± 0.35	95.01 ± 3.43	60.31 ± 4.92
fDBD	35.51 ± 4.02	27.46 ± 2.78	72.05 ± 1.68	54.64 ± 5.32	93.28 ± 0.68	31.00 ± 10.40	27.69 ± 6.56	67.48 ± 9.32	56.01 ± 13.61	93.62 ± 2.00
GEN	37.05 ± 1.86	32.35 ± 0.73	71.16 ± 3.21	70.88 ± 2.62	92.28 ± 0.17	69.50 ± 4.51	86.39 ± 0.80	93.60 ± 2.44	90.01 ± 1.31	73.19 ± 4.43
GradNorm	99.88 ± 0.13	96.01 ± 0.51	99.99 ± 0.01	99.19 ± 0.19	39.85 ± 1.76	99.99 ± 0.02	99.98 ± 0.01	100.00 ± 0.00	100.00 ± 0.00	13.02 ± 2.36
KL Matching	41.42 ± 2.19	78.48 ± 6.47	75.80 ± 2.35	94.55 ± 0.81	88.53 ± 1.30	53.25 ± 3.70	74.30 ± 2.17	77.72 ± 1.96	82.69 ± 4.17	82.19 ± 1.58
KNN	30.01 ± 3.69	18.96 ± 1.94	67.66 ± 4.29	39.34 ± 3.95	94.93 ± 0.66	10.07 ± 1.77	8.16 ± 0.80	31.80 ± 3.93	17.24 ± 0.37	98.27 ± 0.19
Mahalanobis	39.25 ± 1.14	25.30 ± 1.01	70.13 ± 4.74	40.19 ± 1.86	93.26 ± 0.33	0.01 ± 0.00	0.06 ± 0.03	0.10 ± 0.07	0.11 ± 0.06	99.98 ± 0.01
MLS	38.99 ± 2.50	45.02 ± 7.51	71.91 ± 3.63	82.70 ± 3.94	90.61 ± 1.20	81.30 ± 5.19	90.32 ± 2.63	97.33 ± 1.33	94.77 ± 3.38	61.61 ± 4.96
MSP	43.41 ± 2.49	27.86 ± 2.30	77.44 ± 2.65	62.58 ± 5.78	92.22 ± 0.52	61.95 ± 3.99	80.31 ± 5.35	90.31 ± 1.93	89.15 ± 0.46	81.44 ± 2.24
ODIN	35.90 ± 1.91	28.25 ± 0.33	73.83 ± 1.74	65.16 ± 1.24	92.98 ± 0.19	27.85 ± 4.11	63.61 ± 11.69	51.61 ± 3.64	87.07 ± 1.50	89.76 ± 1.85
OpenMax	79.81 ± 4.55	22.04 ± 1.13	96.18 ± 2.32	51.33 ± 3.42	89.86 ± 0.59	31.82 ± 5.90	18.86 ± 5.23	63.99 ± 4.00	46.55 ± 11.20	94.84 ± 0.22
RankFeat	92.81 ± 6.18	90.87 ± 4.67	97.97 ± 2.01	97.61 ± 1.57	52.43 ± 9.56	69.69 ± 21.01	79.43 ± 16.55	83.01 ± 11.98	93.09 ± 8.41	61.46 ± 22.11
ReAct	93.29 ± 3.95	90.38 ± 1.02	98.84 ± 1.04	96.00 ± 1.91	62.07 ± 2.74	96.31 ± 3.63	90.88 ± 4.93	99.41 ± 0.78	96.05 ± 2.73	50.74 ± 7.60
Relation	40.60 ± 3.22	48.28 ± 5.19	76.19 ± 3.87	65.38 ± 0.24	90.77 ± 0.93	54.11 ± 2.15	42.93 ± 3.33	86.88 ± 2.67	54.95 ± 1.81	88.41 ± 0.54
Residual	48.21 ± 3.05	32.00 ± 1.85	78.09 ± 2.24	48.34 ± 1.40	91.03 ± 0.51	0.02 ± 0.01	0.07 ± 0.03	0.17 ± 0.07	0.21 ± 0.08	99.97 ± 0.01
RMDS	52.96 ± 2.49	20.45 ± 0.66	89.89 ± 1.16	40.12 ± 0.42	92.66 ± 0.23	9.34 ± 3.36	6.53 ± 1.37	30.18 ± 5.52	11.28 ± 1.91	98.56 ± 0.37
SHE	88.24 ± 1.74	90.22 ± 0.77	94.46 ± 1.10	95.44 ± 0.55	52.91 ± 0.55	99.10 ± 0.37	97.51 ± 1.53	99.80 ± 0.15	99.04 ± 0.61	35.68 ± 1.79
TempScale	40.01 ± 2.66	27.87 ± 1.93	73.14 ± 3.38	65.09 ± 5.28	92.54 ± 0.50	62.56 ± 4.05	82.43 ± 4.15	90.33 ± 2.64	89.29 ± 0.61	80.25 ± 2.31
ViM	18.68 ± 1.55	12.33 ± 0.56	48.32 ± 1.94	25.69 ± 1.57	97.02 ± 0.20	0.01 ± 0.01	0.04 ± 0.00	0.06 ± 0.03	0.09 ± 0.03	99.98 ± 0.00

Table 12. Far-OoD on ResNet-50.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	99.97 ± 0.04	79.90 ± 1.24	100.00 ± 0.00	92.13 ± 0.27	53.95 ± 3.71
DICE	31.85 ± 3.57	38.15 ± 4.44	58.01 ± 3.47	70.70 ± 6.06	92.49 ± 0.89
MCDropout	50.50 ± 0.25	30.25 ± 1.12	80.36 ± 1.90	50.44 ± 3.78	91.56 ± 0.22
Energy	31.59 ± 1.18	25.66 ± 0.80	67.42 ± 2.50	59.28 ± 5.49	93.83 ± 0.15
fDBD	33.57 ± 3.83	22.00 ± 1.78	72.61 ± 3.74	35.61 ± 1.17	94.39 ± 0.54
GEN	30.19 ± 1.60	20.49 ± 2.33	67.77 ± 1.79	41.95 ± 5.76	94.62 ± 0.41
GradNorm	100.00 ± 0.00	93.15 ± 2.66	100.00 ± 0.00	98.10 ± 0.44	44.39 ± 1.73
KL Matching	39.48 ± 1.98	36.93 ± 5.62	72.47 ± 2.25	81.26 ± 7.53	91.61 ± 1.01
KNN	32.87 ± 2.08	18.83 ± 0.91	73.19 ± 2.38	34.24 ± 2.92	94.85 ± 0.36
Mahalanobis	74.24 ± 1.48	37.45 ± 0.73	89.39 ± 0.55	48.83 ± 1.83	85.55 ± 0.68
MLS	31.38 ± 2.12	25.35 ± 0.93	69.81 ± 1.44	59.25 ± 5.46	93.87 ± 0.13
MSP	42.34 ± 1.84	22.44 ± 1.96	77.19 ± 2.36	39.11 ± 0.99	93.39 ± 0.36
ODIN	36.92 ± 0.68	23.47 ± 2.11	78.00 ± 2.90	49.75 ± 6.01	93.68 ± 0.24
OpenMax	87.12 ± 3.94	20.41 ± 1.26	99.24 ± 0.48	34.96 ± 1.02	89.69 ± 0.66
RankFeat	93.88 ± 2.85	94.93 ± 2.06	98.92 ± 0.50	98.89 ± 0.30	48.94 ± 4.98
ReAct	88.37 ± 8.11	74.68 ± 5.11	98.02 ± 1.50	90.15 ± 2.30	71.25 ± 5.47
Relation	41.87 ± 1.43	29.76 ± 1.85	77.36 ± 1.06	55.03 ± 2.53	92.22 ± 0.45
Residual	79.69 ± 0.76	45.86 ± 1.85	91.75 ± 1.15	58.52 ± 0.85	81.43 ± 0.48
RMDS	63.52 ± 2.68	20.95 ± 1.01	92.74 ± 1.57	61.38 ± 14.56	91.62 ± 0.50
SHE	92.92 ± 1.53	86.69 ± 0.51	97.70 ± 0.74	95.89 ± 0.63	57.21 ± 0.70
TempScale	37.67 ± 1.76	21.46 ± 1.64	72.09 ± 1.40	38.98 ± 1.01	93.93 ± 0.34
ViM	44.64 ± 3.14	18.13 ± 1.13	79.57 ± 0.76	31.38 ± 0.41	94.01 ± 0.29

Table 13. Near-OoD on ResNet-50.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	89.21 ± 10.26	80.84 ± 7.03	97.80 ± 2.68	94.74 ± 3.25	65.58 ± 9.12	98.02 ± 2.72	94.03 ± 3.01	99.92 ± 0.11	97.72 ± 1.10	41.36 ± 13.47
DICE	35.23 ± 1.81	49.27 ± 8.09	61.51 ± 1.68	79.66 ± 5.34	90.54 ± 1.36	90.30 ± 5.65	91.33 ± 4.34	99.14 ± 0.34	94.77 ± 3.98	44.39 ± 13.83
MCDropout	49.91 ± 2.62	36.74 ± 2.26	79.26 ± 1.10	67.59 ± 6.06	90.43 ± 0.72	61.17 ± 7.89	74.36 ± 9.57	89.11 ± 2.82	88.64 ± 2.54	82.45 ± 4.07
Energy	37.85 ± 1.79	43.57 ± 4.56	70.31 ± 1.26	82.03 ± 2.65	90.94 ± 0.75	76.22 ± 9.19	86.68 ± 3.81	97.61 ± 1.37	91.26 ± 2.86	66.62 ± 8.01
fDBD	41.97 ± 1.81	33.48 ± 4.28	75.91 ± 3.06	61.57 ± 6.38	91.65 ± 0.95	30.61 ± 6.99	27.74 ± 7.29	71.34 ± 8.95	58.91 ± 12.42	93.53 ± 1.74
GEN	38.85 ± 1.94	33.66 ± 1.61	71.93 ± 3.30	69.88 ± 6.67	91.97 ± 0.12	63.32 ± 4.43	82.02 ± 3.06	93.59 ± 1.01	88.02 ± 0.78	79.15 ± 2.86
GradNorm	98.85 ± 0.71	91.90 ± 2.13	99.56 ± 0.36	97.78 ± 0.60	46.49 ± 1.51	100.00 ± 0.00	99.88 ± 0.06	100.00 ± 0.00	99.98 ± 0.02	10.39 ± 2.29
KL Matching	43.90 ± 1.79	85.95 ± 1.24	76.93 ± 2.78	95.82 ± 1.11	87.44 ± 0.29	48.20 ± 7.49	70.41 ± 4.21	74.80 ± 5.68	80.60 ± 3.72	84.34 ± 3.00
KNN	33.03 ± 1.27	21.87 ± 0.39	71.00 ± 1.86	46.47 ± 3.59	94.18 ± 0.03	11.11 ± 2.92	9.40 ± 2.22	34.29 ± 3.63	21.88 ± 8.07	97.91 ± 0.46
Mahalanobis	41.57 ± 4.02	25.73 ± 1.35	76.89 ± 1.15	40.20 ± 2.73	92.98 ± 0.14	0.01 ± 0.00	0.05 ± 0.02	0.12 ± 0.08	0.16 ± 0.09	99.97 ± 0.01
MLS	38.86 ± 1.48	42.73 ± 4.02	69.75 ± 2.02	81.63 ± 2.73	91.03 ± 0.70	74.07 ± 8.76	86.50 ± 3.88	95.10 ± 3.07	91.17 ± 2.90	67.78 ± 7.87
MSP	47.02 ± 1.61	30.41 ± 2.00	78.68 ± 2.86	60.91 ± 8.17	91.67 ± 0.42	58.34 ± 7.60	72.63 ± 10.84	88.25 ± 5.00	87.63 ± 1.70	83.94 ± 3.50
OpenMax	82.69 ± 1.57	26.66 ± 1.93	97.72 ± 0.81	52.85 ± 4.62	88.95 ± 0.21	36.38 ± 10.77	17.29 ± 3.47	70.12 ± 7.58	44.54 ± 14.48	94.58 ± 1.45
RankFeat	92.52 ± 6.35	98.20 ± 1.07	97.27 ± 2.69	99.39 ± 0.40	40.77 ± 8.14	76.55 ± 16.49	81.58 ± 21.55	88.17 ± 9.20	90.87 ± 11.59	57.78 ± 23.57
ReAct	72.23 ± 3.99	74.60 ± 9.83	92.06 ± 1.79	88.79 ± 4.08	77.65 ± 1.52	90.60 ± 4.85	82.44 ± 6.59	98.67 ± 0.76	91.30 ± 3.22	61.87 ± 6.85
Relation	44.85 ± 1.92	55.63 ± 1.92	75.97 ± 3.23	66.32 ± 0.13	89.62 ± 0.59	49.98 ± 7.58	38.70 ± 8.93	83.03 ± 6.14	53.17 ± 6.90	90.03 ± 2.02
Residual	49.13 ± 4.89	32.21 ± 1.07	83.71 ± 2.14	48.71 ± 2.92	90.91 ± 0.27	0.02 ± 0.01	0.10 ± 0.05	0.38 ± 0.33	0.36 ± 0.22	99.95 ± 0.02
RMDS	52.24 ± 4.17	22.18 ± 1.49	92.10 ± 3.05	58.22 ± 18.94	92.13 ± 0.38	6.70 ± 2.87	5.31 ± 1.54	32.06 ± 13.66	9.19 ± 1.66	98.72 ± 0.45
SHE	84.35 ± 3.08	88.25 ± 1.90	90.78 ± 2.90	94.74 ± 0.53	57.26 ± 0.62	98.47 ± 1.31	97.01 ± 0.40	99.62 ± 0.34	98.79 ± 0.31	35.41 ± 4.47
TempScale	43.27 ± 1.56	30.54 ± 2.13	73.77 ± 2.67	63.36 ± 7.77	92.03 ± 0.41	58.40 ± 8.15	75.48 ± 10.01	87.72 ± 5.23	87.79 ± 1.53	82.97 ± 3.80
ViM	19.86 ± 1.46	14.03 ± 0.89	55.87 ± 0.62	27.63 ± 0.66	96.63 ± 0.15	0.01 ± 0.01	0.04 ± 0.01	0.07 ± 0.05	0.12 ± 0.08	99.97 ± 0.01

Table 14. Far-OoD on ResNet-101.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	86.22 ± 14.10	69.81 ± 9.94	96.91 ± 4.24	90.58 ± 3.46	70.67 ± 9.49
DICE	26.34 ± 4.08	31.27 ± 8.87	57.60 ± 2.81	64.18 ± 12.15	93.80 ± 1.33
MCDropout	45.54 ± 2.93	26.60 ± 2.63	76.52 ± 1.11	49.55 ± 4.40	92.43 ± 0.83
Energy	30.16 ± 1.92	24.88 ± 4.18	67.10 ± 3.08	56.61 ± 8.82	94.03 ± 0.71
fDBD	35.31 ± 0.50	22.60 ± 1.51	70.75 ± 2.99	37.86 ± 5.20	94.15 ± 0.44
GEN	32.52 ± 2.61	20.78 ± 1.64	67.02 ± 2.97	42.77 ± 1.12	94.55 ± 0.38
GradNorm	98.60 ± 0.93	91.76 ± 0.26	99.65 ± 0.26	98.67 ± 0.04	50.19 ± 2.93
KL Matching	38.52 ± 1.47	44.59 ± 1.12	71.62 ± 1.84	86.34 ± 3.26	90.78 ± 0.34
KNN	34.82 ± 1.42	20.79 ± 0.47	72.67 ± 2.29	33.61 ± 1.53	94.37 ± 0.17
Mahalanobis	73.16 ± 2.90	36.76 ± 4.82	89.98 ± 0.65	50.83 ± 10.02	85.65 ± 2.00
MLS	32.14 ± 0.66	24.71 ± 3.99	65.44 ± 3.32	56.10 ± 8.93	94.02 ± 0.68
MSP	42.37 ± 2.24	22.13 ± 1.09	74.85 ± 2.34	37.70 ± 2.83	93.50 ± 0.42
OpenMax	86.16 ± 2.90	21.94 ± 0.81	99.13 ± 0.38	38.51 ± 2.99	89.52 ± 0.36
RankFeat	91.72 ± 1.59	94.58 ± 1.40	98.05 ± 0.30	98.45 ± 1.09	50.97 ± 3.17
ReAct	69.61 ± 6.19	58.44 ± 8.60	89.22 ± 4.19	75.72 ± 9.14	81.61 ± 3.29
Relation	41.49 ± 1.53	28.67 ± 0.91	72.52 ± 3.19	57.19 ± 3.65	92.33 ± 0.23
Residual	78.96 ± 1.47	45.35 ± 5.37	93.56 ± 2.46	57.73 ± 7.77	81.97 ± 2.12
RMDS	59.82 ± 3.26	20.03 ± 1.24	91.93 ± 2.10	40.81 ± 8.98	92.23 ± 0.08
SHE	92.48 ± 0.68	87.82 ± 2.56	97.00 ± 0.46	96.44 ± 0.92	58.70 ± 2.30
TempScale	38.37 ± 1.44	21.49 ± 1.85	68.94 ± 2.93	38.38 ± 4.15	93.96 ± 0.43
ViM	41.99 ± 4.62	19.71 ± 1.96	81.29 ± 2.43	29.20 ± 3.08	93.92 ± 0.77

Table 15. Near-OoD on ResNet-101.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	81.97 ± 16.72	79.05 ± 7.56	94.38 ± 7.11	92.79 ± 4.46	67.57 ± 12.88	97.93 ± 2.26	93.16 ± 2.20	99.93 ± 0.09	96.07 ± 1.85	39.85 ± 2.55
DICE	38.92 ± 1.97	52.11 ± 10.44	65.66 ± 0.48	81.71 ± 7.39	89.33 ± 1.77	92.27 ± 2.08	90.51 ± 1.52	99.17 ± 0.67	93.41 ± 1.65	39.71 ± 0.74
MCDropout	49.36 ± 1.53	33.50 ± 2.28	79.55 ± 1.15	63.89 ± 3.01	90.84 ± 0.53	65.04 ± 2.76	77.92 ± 6.53	91.18 ± 0.93	89.36 ± 1.07	80.74 ± 2.11
Energy	41.64 ± 2.03	47.06 ± 14.22	73.47 ± 3.26	83.51 ± 7.05	90.15 ± 1.62	80.56 ± 4.20	87.08 ± 0.60	98.02 ± 0.91	89.59 ± 1.29	64.05 ± 3.30
fDBD	38.52 ± 6.57	27.61 ± 5.63	74.17 ± 5.66	51.27 ± 11.03	92.97 ± 1.59	31.02 ± 12.07	26.73 ± 11.40	68.82 ± 16.81	50.92 ± 16.62	93.64 ± 2.83
GEN	39.12 ± 3.37	36.51 ± 15.04	73.60 ± 2.43	67.43 ± 15.23	91.77 ± 1.97	67.15 ± 11.53	81.54 ± 6.66	92.88 ± 6.05	88.63 ± 1.30	75.49 ± 7.60
GradNorm	97.48 ± 2.57	93.72 ± 3.77	99.19 ± 0.77	98.43 ± 0.88	42.45 ± 8.85	100.00 ± 0.00	99.71 ± 0.16	100.00 ± 0.00	99.92 ± 0.06	10.38 ± 1.83
KL Matching	42.72 ± 1.73	77.93 ± 2.75	76.52 ± 2.72	95.43 ± 1.22	88.23 ± 0.92	50.00 ± 2.19	75.58 ± 4.23	75.00 ± 1.02	83.42 ± 6.12	82.79 ± 0.64
KNN	28.38 ± 2.72	18.53 ± 0.58	61.24 ± 3.77	40.24 ± 2.27	95.17 ± 0.29	10.08 ± 1.97	8.93 ± 1.94	28.91 ± 4.61	20.35 ± 3.84	98.13 ± 0.33
Mahalanobis	32.85 ± 0.39	25.78 ± 1.49	65.58 ± 3.69	42.01 ± 1.61	93.81 ± 0.17	0.00 ± 0.00	0.03 ± 0.01	0.06 ± 0.03	0.08 ± 0.01	99.99 ± 0.01
MLS	40.51 ± 2.21	45.93 ± 13.84	73.66 ± 3.27	83.33 ± 7.16	90.40 ± 1.56	76.92 ± 4.01	86.96 ± 0.58	96.71 ± 1.88	89.50 ± 1.31	65.30 ± 3.34
MSP	45.33 ± 1.88	27.57 ± 1.54	77.29 ± 2.55	54.37 ± 1.45	92.14 ± 0.43	60.89 ± 3.57	75.28 ± 10.04	89.43 ± 3.15	88.26 ± 0.69	82.47 ± 2.51
OpenMax	74.93 ± 2.04	24.07 ± 0.20	95.99 ± 1.92	48.37 ± 0.63	90.45 ± 0.26	30.42 ± 2.80	20.34 ± 7.32	67.87 ± 2.47	49.95 ± 16.15	94.62 ± 1.02
RankFeat	96.29 ± 2.42	95.93 ± 2.95	99.34 ± 0.32	98.69 ± 1.57	44.67 ± 11.03	80.03 ± 15.33	85.44 ± 16.24	87.29 ± 10.38	93.93 ± 7.73	53.97 ± 19.59
ReAct	78.80 ± 8.49	73.37 ± 11.05	94.25 ± 3.28	85.52 ± 7.51	75.24 ± 5.17	97.05 ± 0.93	84.98 ± 2.41	99.79 ± 0.11	91.88 ± 2.62	60.01 ± 6.10
Relation	41.87 ± 2.08	52.70 ± 1.35	74.47 ± 2.10	65.53 ± 0.29	90.44 ± 0.37	53.40 ± 2.73	41.05 ± 0.52	85.27 ± 3.67	56.07 ± 1.62	88.58 ± 0.30
Residual	39.97 ± 0.76	31.45 ± 1.27	73.91 ± 3.84	49.15 ± 2.13	92.15 ± 0.23	0.01 ± 0.00	0.06 ± 0.00	0.11 ± 0.03	0.15 ± 0.01	99.98 ± 0.01
RMDS	45.05 ± 4.38	20.05 ± 1.85	87.18 ± 3.63	41.74 ± 2.95	93.27 ± 0.44	2.97 ± 0.81	3.56 ± 0.71	18.75 ± 4.05	7.59 ± 1.38	99.30 ± 0.15
SHE	90.47 ± 0.46	90.76 ± 1.82	95.21 ± 1.15	96.00 ± 0.76	52.52 ± 0.52	99.64 ± 0.11	97.03 ± 1.00	99.91 ± 0.03	98.64 ± 0.79	36.78 ± 1.99
TempScale	42.35 ± 1.29	27.73 ± 2.18	75.67 ± 1.54	57.59 ± 1.48	92.44 ± 0.50	61.14 ± 3.33	78.57 ± 7.78	91.12 ± 2.69	88.45 ± 0.98	81.39 ± 2.64
ViM	15.75 ± 1.73	11.89 ± 0.96	43.89 ± 2.78	25.25 ± 1.49	97.28 ± 0.28	0.00 ± 0.00	0.03 ± 0.00	0.04 ± 0.02	0.10 ± 0.04	99.99 ± 0.00

Table 16. Far-OoD on ResNet-152.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	79.05 ± 18.09	69.73 ± 7.88	93.59 ± 7.75	87.20 ± 3.40	72.47 ± 12.33
DICE	29.69 ± 0.78	32.43 ± 3.43	63.90 ± 1.73	65.63 ± 7.18	93.38 ± 0.57
MCDropout	46.18 ± 2.84	26.57 ± 2.13	76.60 ± 3.25	52.30 ± 8.33	92.30 ± 0.61
Energy	34.44 ± 2.49	23.60 ± 2.37	69.58 ± 2.83	59.68 ± 6.45	93.86 ± 0.40
fDBD	35.34 ± 5.52	24.20 ± 2.61	73.16 ± 5.03	40.70 ± 0.91	93.88 ± 0.87
GEN	33.07 ± 3.56	20.14 ± 0.64	69.99 ± 4.35	45.10 ± 4.77	94.46 ± 0.38
GradNorm	96.77 ± 2.75	92.18 ± 1.11	99.04 ± 0.72	97.15 ± 0.80	49.45 ± 6.45
KL Matching	39.07 ± 0.81	46.34 ± 7.49	72.87 ± 3.82	79.01 ± 2.16	91.27 ± 0.48
KNN	32.84 ± 1.96	20.40 ± 1.53	70.75 ± 4.20	35.76 ± 3.05	94.62 ± 0.40
Mahalanobis	72.29 ± 4.53	43.06 ± 4.62	90.41 ± 2.53	58.64 ± 2.59	83.48 ± 1.93
MLS	33.65 ± 3.19	23.20 ± 1.82	70.31 ± 3.39	59.69 ± 6.41	93.91 ± 0.39
MSP	42.54 ± 1.23	22.24 ± 0.31	76.05 ± 5.94	40.78 ± 2.27	93.43 ± 0.27
OpenMax	82.81 ± 0.50	22.04 ± 1.51	99.07 ± 0.46	38.14 ± 4.04	89.98 ± 0.66
RankFeat	96.68 ± 2.84	91.94 ± 4.77	99.39 ± 0.43	96.72 ± 2.61	46.65 ± 8.02
ReAct	70.43 ± 5.50	59.17 ± 10.53	91.61 ± 2.37	73.38 ± 9.48	80.95 ± 4.80
Relation	40.68 ± 2.19	30.05 ± 0.67	74.85 ± 5.09	54.18 ± 5.34	92.36 ± 0.39
Residual	77.91 ± 3.79	52.52 ± 5.16	92.92 ± 1.19	67.50 ± 0.78	79.90 ± 2.20
RMDS	60.75 ± 2.98	19.68 ± 0.54	91.99 ± 0.55	42.59 ± 4.09	92.32 ± 0.22
SHE	95.16 ± 1.70	88.65 ± 0.63	97.99 ± 0.89	96.39 ± 0.16	56.58 ± 1.32
TempScale	39.22 ± 1.00	21.38 ± 0.17	73.83 ± 5.35	41.65 ± 4.42	93.88 ± 0.27
ViM	42.34 ± 5.76	20.78 ± 4.08	79.52 ± 2.86	32.16 ± 1.96	93.61 ± 0.98

Table 17. Near-OoD on ResNet-152.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	37.59 ± 3.02	42.22 ± 8.59	62.09 ± 1.26	68.99 ± 6.99	91.27 ± 1.27	68.51 ± 3.52	82.65 ± 3.99	91.96 ± 1.67	86.93 ± 1.22	70.22 ± 3.99
DICE	25.73 ± 1.05	57.08 ± 9.26	55.93 ± 3.19	86.97 ± 6.00	91.30 ± 1.12	70.44 ± 3.93	86.17 ± 0.23	88.98 ± 1.11	87.31 ± 0.67	56.14 ± 3.29
MCDropout	40.09 ± 1.28	42.52 ± 7.55	71.91 ± 5.09	83.35 ± 6.45	91.09 ± 1.13	53.58 ± 1.88	81.29 ± 5.01	84.37 ± 5.49	89.56 ± 2.26	82.76 ± 1.72
Energy	27.66 ± 1.39	52.45 ± 14.86	59.70 ± 2.85	87.10 ± 8.43	91.71 ± 1.42	60.98 ± 0.65	86.13 ± 0.72	88.87 ± 2.99	86.98 ± 0.61	68.28 ± 1.57
fDBD	30.28 ± 2.61	29.39 ± 4.52	67.15 ± 4.74	57.22 ± 7.98	93.42 ± 0.92	17.37 ± 4.69	14.68 ± 3.63	57.40 ± 11.98	34.34 ± 6.41	96.44 ± 0.89
GEN	29.03 ± 2.06	38.03 ± 7.34	63.95 ± 4.93	82.69 ± 6.50	92.67 ± 1.04	53.61 ± 4.02	85.30 ± 2.48	84.95 ± 6.81	87.42 ± 0.98	77.23 ± 3.49
GradNorm	78.72 ± 3.50	88.19 ± 1.52	84.87 ± 1.84	96.00 ± 0.76	61.51 ± 3.80	99.90 ± 0.01	98.64 ± 0.24	99.96 ± 0.01	99.44 ± 0.16	8.04 ± 2.34
KL Matching	36.51 ± 0.91	74.24 ± 14.62	72.58 ± 2.41	94.01 ± 0.91	88.30 ± 1.48	44.56 ± 1.27	69.17 ± 5.38	76.23 ± 3.60	80.50 ± 4.22	84.70 ± 1.67
KNN	33.35 ± 5.44	22.55 ± 3.44	81.30 ± 8.72	43.31 ± 5.00	93.93 ± 1.04	8.26 ± 3.49	6.22 ± 1.66	44.31 ± 15.94	11.66 ± 2.31	98.24 ± 0.62
Mahalanobis	22.36 ± 2.91	14.02 ± 1.45	63.35 ± 6.72	25.35 ± 2.82	96.30 ± 0.46	0.00 ± 0.00	0.03 ± 0.00	0.01 ± 0.00	0.04 ± 0.00	99.98 ± 0.00
MLS	27.92 ± 1.55	52.44 ± 14.85	62.17 ± 3.12	87.12 ± 8.40	91.66 ± 1.42	59.45 ± 0.92	86.15 ± 0.73	88.16 ± 3.25	87.02 ± 0.60	69.01 ± 1.58
MSP	37.88 ± 1.42	35.22 ± 9.32	72.49 ± 3.58	80.39 ± 8.10	92.04 ± 1.12	51.06 ± 1.45	82.40 ± 4.04	84.78 ± 3.79	87.83 ± 0.83	83.54 ± 1.67
OpenMax	87.03 ± 3.02	24.83 ± 5.04	99.04 ± 0.35	59.24 ± 6.52	89.33 ± 0.88	41.06 ± 0.61	11.07 ± 0.61	69.02 ± 1.77	26.39 ± 4.61	95.37 ± 0.12
ReAct	42.83 ± 2.60	41.44 ± 10.36	66.04 ± 2.26	67.58 ± 9.13	91.32 ± 1.18	76.99 ± 4.45	74.36 ± 8.24	96.72 ± 1.35	84.55 ± 4.14	74.67 ± 4.98
Relation	34.36 ± 2.35	39.68 ± 11.93	68.29 ± 3.44	60.98 ± 7.29	92.24 ± 1.51	29.97 ± 0.93	18.19 ± 3.46	75.96 ± 3.92	34.64 ± 5.02	94.76 ± 0.73
Residual	36.38 ± 4.07	26.46 ± 4.73	82.03 ± 3.37	44.73 ± 5.94	93.27 ± 1.15	0.00 ± 0.00	0.03 ± 0.00	0.01 ± 0.00	0.06 ± 0.02	99.98 ± 0.00
RMDS	31.23 ± 3.07	24.27 ± 4.85	81.69 ± 2.80	85.31 ± 9.95	92.93 ± 1.16	6.71 ± 3.31	5.14 ± 1.73	33.68 ± 13.14	8.52 ± 1.87	98.67 ± 0.52
SHE	89.02 ± 1.77	93.44 ± 0.90	92.32 ± 1.26	96.41 ± 0.50	51.47 ± 0.55	94.73 ± 1.29	89.65 ± 2.20	97.39 ± 1.20	93.73 ± 0.83	51.69 ± 3.26
TempScale	34.51 ± 1.39	38.48 ± 10.15	69.19 ± 3.99	82.38 ± 8.95	92.24 ± 1.18	51.38 ± 1.06	84.12 ± 2.88	85.84 ± 4.87	87.60 ± 0.74	81.78 ± 1.76
ViM	14.39 ± 1.71	11.92 ± 1.67	44.85 ± 3.04	22.97 ± 1.77	97.41 ± 0.36	0.00 ± 0.00	0.04 ± 0.00	0.04 ± 0.02	0.08 ± 0.03	99.98 ± 0.00

Table 18. Far-OoD on DenseNet-121.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	38.23 ± 3.10	36.06 ± 2.86	67.45 ± 3.41	61.35 ± 1.62	91.86 ± 0.69
DICE	22.17 ± 2.63	33.61 ± 2.68	58.19 ± 5.58	78.94 ± 7.13	93.86 ± 0.43
MCDropout	36.95 ± 5.03	24.31 ± 2.49	69.81 ± 7.15	57.81 ± 1.83	93.62 ± 0.59
Energy	23.63 ± 3.93	21.46 ± 2.95	57.49 ± 4.99	73.07 ± 10.07	94.73 ± 0.49
fDBD	28.06 ± 5.33	18.78 ± 2.67	64.04 ± 7.54	30.93 ± 1.18	95.29 ± 0.77
GEN	25.44 ± 4.35	18.11 ± 2.26	60.78 ± 4.84	48.69 ± 4.52	95.33 ± 0.47
GradNorm	80.86 ± 3.16	90.95 ± 0.20	86.80 ± 1.43	97.38 ± 0.98	60.49 ± 3.86
KL Matching	33.51 ± 5.48	44.48 ± 12.54	69.93 ± 6.33	80.01 ± 11.82	91.66 ± 1.78
KNN	33.01 ± 5.72	19.94 ± 2.40	84.53 ± 10.63	34.01 ± 4.27	94.56 ± 0.88
Mahalanobis	45.98 ± 10.52	21.71 ± 4.26	86.19 ± 3.22	37.16 ± 4.49	92.90 ± 1.71
MLS	23.89 ± 4.11	21.55 ± 2.98	59.85 ± 5.11	73.06 ± 10.09	94.67 ± 0.50
MSP	35.29 ± 4.85	18.85 ± 2.01	70.51 ± 5.46	44.59 ± 7.69	94.41 ± 0.50
OpenMax	89.04 ± 3.50	17.32 ± 1.30	99.50 ± 0.08	34.39 ± 2.77	90.35 ± 0.69
ReAct	43.56 ± 1.07	25.64 ± 5.25	71.27 ± 2.26	48.66 ± 5.34	92.73 ± 1.02
Relation	34.00 ± 5.38	24.52 ± 4.99	67.74 ± 4.34	38.60 ± 9.34	93.74 ± 1.42
Residual	76.66 ± 3.69	48.07 ± 8.65	90.91 ± 0.68	63.22 ± 10.15	82.35 ± 3.94
RMDS	31.53 ± 1.40	15.70 ± 1.34	88.43 ± 2.08	45.21 ± 6.73	94.46 ± 0.39
SHE	90.44 ± 1.06	92.16 ± 0.90	94.41 ± 1.08	96.59 ± 1.05	56.55 ± 2.16
TempScale	31.79 ± 4.33	18.71 ± 2.46	67.10 ± 6.49	50.91 ± 9.52	94.77 ± 0.47
ViM	23.28 ± 1.96	14.21 ± 1.12	69.90 ± 7.58	27.36 ± 2.43	96.05 ± 0.42

Table 19. Near-OoD on DenseNet-121.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	37.79 ± 2.04	45.07 ± 7.44	61.07 ± 4.12	67.59 ± 5.11	90.83 ± 1.11	62.87 ± 2.37	80.65 ± 3.53	83.22 ± 3.65	86.61 ± 0.86	73.54 ± 2.36
DICE	22.96 ± 0.34	47.63 ± 10.28	53.71 ± 3.38	88.95 ± 3.78	92.75 ± 0.92	59.48 ± 2.61	85.82 ± 0.53	80.42 ± 0.55	86.80 ± 0.68	66.02 ± 1.18
MCDropout	36.42 ± 1.68	33.33 ± 3.18	71.47 ± 3.09	78.33 ± 1.50	92.31 ± 0.40	47.48 ± 1.64	74.19 ± 11.14	82.36 ± 2.14	89.87 ± 3.67	85.27 ± 1.68
Energy	25.28 ± 0.79	37.72 ± 12.26	57.56 ± 2.51	87.72 ± 6.04	93.16 ± 1.02	50.71 ± 0.82	85.49 ± 1.15	81.47 ± 1.73	87.53 ± 1.20	75.63 ± 1.23
fDBD	30.75 ± 2.41	25.65 ± 1.31	67.00 ± 2.70	51.58 ± 6.59	94.07 ± 0.38	18.49 ± 3.92	14.00 ± 4.27	56.25 ± 0.74	29.81 ± 8.80	96.55 ± 0.88
GEN	26.12 ± 0.27	34.41 ± 12.74	59.61 ± 3.35	81.71 ± 9.47	93.43 ± 1.08	48.30 ± 2.55	83.96 ± 2.70	80.80 ± 1.53	87.69 ± 1.30	78.75 ± 3.88
GradNorm	77.83 ± 8.29	87.82 ± 7.50	83.90 ± 7.09	96.10 ± 2.77	60.63 ± 8.97	97.49 ± 2.96	94.99 ± 3.18	98.70 ± 1.55	96.21 ± 2.69	16.36 ± 7.52
KL Matching	34.04 ± 0.76	78.58 ± 5.89	71.96 ± 1.56	94.84 ± 2.20	89.03 ± 0.54	41.07 ± 3.43	69.22 ± 7.85	74.81 ± 5.26	84.52 ± 5.97	85.64 ± 1.63
KNN	30.59 ± 1.56	19.92 ± 0.57	82.65 ± 4.62	34.75 ± 1.86	94.62 ± 0.16	9.00 ± 4.13	7.21 ± 2.46	46.77 ± 8.48	12.69 ± 3.82	98.01 ± 0.64
Mahalanobis	21.44 ± 5.44	11.90 ± 1.45	61.01 ± 7.79	22.96 ± 2.72	96.67 ± 0.57	0.00 ± 0.00	0.03 ± 0.00	0.00 ± 0.00	0.04 ± 0.00	99.98 ± 0.00
MLS	25.79 ± 0.46	37.60 ± 12.18	57.93 ± 2.41	87.72 ± 6.04	93.10 ± 1.02	49.51 ± 0.49	85.50 ± 1.16	80.31 ± 2.64	87.56 ± 1.19	76.06 ± 1.16
MSP	35.00 ± 1.39	26.88 ± 3.43	71.04 ± 1.76	75.65 ± 2.66	93.00 ± 0.43	45.88 ± 2.42	74.09 ± 12.23	82.00 ± 2.08	87.97 ± 2.18	85.89 ± 1.78
OpenMax	91.02 ± 0.92	23.23 ± 2.94	99.31 ± 0.29	58.84 ± 1.47	88.69 ± 0.42	55.12 ± 1.32	13.01 ± 0.97	76.30 ± 0.78	28.42 ± 1.22	93.84 ± 0.08
ReAct	44.50 ± 7.01	44.74 ± 6.67	71.52 ± 2.71	63.79 ± 5.12	90.64 ± 1.29	69.07 ± 6.93	66.24 ± 11.34	93.88 ± 3.17	80.12 ± 6.94	78.35 ± 3.49
Relation	31.90 ± 1.16	35.62 ± 5.60	66.63 ± 2.71	61.96 ± 3.91	92.91 ± 0.64	25.10 ± 3.23	16.92 ± 4.53	72.30 ± 3.77	31.26 ± 6.66	95.25 ± 0.86
Residual	27.66 ± 8.66	16.28 ± 4.08	66.49 ± 9.49	27.87 ± 5.89	95.65 ± 1.32	0.00 ± 0.00	0.04 ± 0.01	0.03 ± 0.00	0.08 ± 0.03	99.97 ± 0.01
RMDS	30.05 ± 4.82	19.97 ± 2.17	90.76 ± 3.49	64.87 ± 20.83	93.70 ± 1.11	10.47 ± 1.00	6.70 ± 0.46	50.49 ± 5.83	10.19 ± 0.59	98.07 ± 0.21
SHE	86.65 ± 0.66	92.09 ± 1.75	90.40 ± 0.80	95.43 ± 1.07	54.97 ± 3.20	88.98 ± 0.71	88.92 ± 2.00	94.49 ± 0.65	92.63 ± 1.74	55.96 ± 2.87
TempScale	31.81 ± 0.56	28.54 ± 5.50	64.10 ± 2.51	80.46 ± 4.47	93.26 ± 0.56	45.36 ± 2.29	78.73 ± 8.31	79.48 ± 3.02	87.89 ± 1.80	84.52 ± 1.74
ViM	13.43 ± 0.80	11.15 ± 1.60	41.78 ± 4.64	23.80 ± 3.74	97.56 ± 0.30	0.01 ± 0.01	0.05 ± 0.01	0.17 ± 0.08	0.18 ± 0.07	99.97 ± 0.00

Table 20. Far-OoD on DenseNet-169.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	41.03 ± 1.21	39.30 ± 6.88	70.31 ± 4.63	60.17 ± 5.14	90.85 ± 0.97
DICE	21.79 ± 4.54	34.73 ± 10.01	56.35 ± 7.85	71.57 ± 13.31	93.91 ± 1.31
MCDropout	35.14 ± 3.17	24.30 ± 3.14	71.42 ± 3.60	61.42 ± 11.89	93.66 ± 0.82
Energy	22.99 ± 4.95	24.46 ± 4.98	57.05 ± 5.62	65.01 ± 16.18	94.72 ± 1.02
fDBD	29.95 ± 4.24	18.18 ± 1.43	67.25 ± 1.04	32.54 ± 2.52	95.36 ± 0.57
GEN	24.16 ± 5.43	20.35 ± 3.40	60.81 ± 7.15	55.39 ± 10.77	95.10 ± 0.85
GradNorm	80.86 ± 6.15	92.17 ± 3.57	88.20 ± 3.72	97.30 ± 0.78	56.65 ± 8.35
KL Matching	32.31 ± 4.02	39.27 ± 12.61	71.18 ± 4.00	88.75 ± 3.57	91.97 ± 1.34
KNN	33.36 ± 6.44	20.34 ± 1.79	86.68 ± 5.44	37.08 ± 2.67	94.45 ± 0.72
Mahalanobis	44.58 ± 11.99	21.09 ± 3.85	82.60 ± 4.99	34.60 ± 3.99	93.40 ± 1.56
MLS	23.60 ± 5.21	24.48 ± 4.90	57.87 ± 5.96	65.01 ± 16.16	94.65 ± 1.02
MSP	33.48 ± 3.29	19.93 ± 1.25	70.45 ± 2.97	49.03 ± 13.38	94.37 ± 0.68
OpenMax	90.24 ± 1.12	18.63 ± 0.07	99.50 ± 0.22	35.06 ± 4.04	89.84 ± 0.22
ReAct	46.12 ± 9.26	34.96 ± 6.15	79.66 ± 1.32	52.05 ± 6.21	91.52 ± 1.45
Relation	32.55 ± 3.24	23.60 ± 2.39	68.09 ± 4.29	38.82 ± 4.42	94.05 ± 0.83
Residual	56.93 ± 9.57	30.05 ± 9.38	85.08 ± 4.45	42.79 ± 13.57	90.49 ± 3.11
RMDS	29.11 ± 1.50	16.51 ± 1.76	91.35 ± 1.05	49.26 ± 13.15	94.45 ± 0.47
SHE	90.44 ± 1.57	92.45 ± 2.04	93.62 ± 1.33	96.55 ± 0.77	56.61 ± 5.25
TempScale	29.60 ± 4.38	19.72 ± 1.77	64.31 ± 4.82	52.30 ± 14.55	94.68 ± 0.78
ViM	23.08 ± 1.57	14.14 ± 0.26	64.25 ± 2.93	26.46 ± 1.67	96.26 ± 0.01

Table 21. Near-OoD on DenseNet-169.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	40.61 ± 6.18	36.37 ± 4.42	77.14 ± 15.52	60.53 ± 6.30	91.89 ± 1.03	73.21 ± 4.57	74.00 ± 6.65	94.72 ± 4.00	85.51 ± 3.03	74.20 ± 2.46
DICE	27.72 ± 4.21	40.92 ± 2.82	59.71 ± 0.17	81.04 ± 4.21	92.78 ± 0.28	60.47 ± 4.39	83.24 ± 2.22	87.75 ± 2.61	87.37 ± 1.24	70.55 ± 1.32
MCDropout	39.43 ± 2.45	28.45 ± 3.56	75.70 ± 0.85	70.63 ± 4.53	92.67 ± 0.29	50.03 ± 5.16	63.23 ± 15.03	86.45 ± 2.95	86.43 ± 6.56	86.71 ± 3.08
Energy	31.03 ± 4.19	32.01 ± 3.43	63.81 ± 1.02	79.77 ± 3.43	93.13 ± 0.19	51.86 ± 1.99	77.45 ± 7.26	86.78 ± 1.64	86.92 ± 3.01	79.24 ± 3.11
fDBD	29.25 ± 1.79	18.81 ± 1.63	71.31 ± 1.92	37.19 ± 3.93	95.05 ± 0.33	16.43 ± 6.01	11.92 ± 3.33	56.69 ± 10.33	26.71 ± 4.09	96.74 ± 1.18
GEN	29.91 ± 2.27	21.79 ± 2.77	66.82 ± 1.59	60.75 ± 9.73	94.30 ± 0.19	42.86 ± 5.98	65.14 ± 15.74	81.36 ± 6.17	85.19 ± 5.66	86.05 ± 3.64
GradNorm	76.45 ± 2.37	82.88 ± 3.21	83.02 ± 1.93	93.44 ± 1.24	65.39 ± 2.75	98.65 ± 0.83	96.98 ± 1.93	99.41 ± 0.43	98.15 ± 1.15	20.71 ± 8.44
KL Matching	36.80 ± 1.98	66.07 ± 10.19	72.12 ± 3.53	91.81 ± 0.38	89.94 ± 0.35	41.88 ± 5.81	60.20 ± 10.97	73.63 ± 6.21	80.89 ± 5.32	87.57 ± 3.98
KNN	30.22 ± 2.48	17.03 ± 2.24	79.63 ± 7.89	31.96 ± 4.21	94.96 ± 0.60	7.89 ± 3.94	6.91 ± 2.61	38.64 ± 16.73	13.56 ± 2.93	98.15 ± 0.93
Mahalanobis	29.06 ± 5.25	17.44 ± 3.95	68.53 ± 8.88	29.96 ± 6.45	95.33 ± 1.03	0.00 ± 0.00	0.03 ± 0.00	0.00 ± 0.00	0.03 ± 0.00	99.98 ± 0.00
MLS	30.41 ± 3.70	31.77 ± 3.51	65.64 ± 0.65	79.75 ± 3.42	93.13 ± 0.20	50.02 ± 2.81	77.25 ± 7.46	86.05 ± 3.01	86.92 ± 3.02	79.69 ± 3.26
MSP	37.32 ± 2.26	22.16 ± 3.08	71.26 ± 3.53	61.67 ± 11.49	93.54 ± 0.39	47.38 ± 5.07	60.33 ± 16.91	82.25 ± 5.59	84.20 ± 6.56	87.58 ± 3.19
OpenMax	85.71 ± 4.04	18.67 ± 2.53	98.93 ± 0.47	42.04 ± 5.59	89.69 ± 0.77	57.73 ± 3.03	12.97 ± 0.25	83.88 ± 2.62	24.47 ± 1.05	93.62 ± 0.42
ReAct	42.99 ± 4.52	30.05 ± 5.93	68.54 ± 6.06	50.47 ± 9.09	92.55 ± 1.19	65.53 ± 16.12	51.74 ± 13.87	88.30 ± 8.50	67.46 ± 11.66	83.77 ± 6.20
Relation	33.71 ± 2.20	25.77 ± 2.67	67.99 ± 3.46	52.87 ± 4.21	93.82 ± 0.48	27.08 ± 6.18	14.49 ± 2.03	72.47 ± 7.55	30.26 ± 1.33	95.43 ± 0.92
Residual	37.06 ± 9.63	24.93 ± 7.39	77.45 ± 12.03	40.10 ± 9.91	93.34 ± 2.14	0.00 ± 0.00	0.04 ± 0.00	0.02 ± 0.01	0.05 ± 0.01	99.98 ± 0.00
RMDS	35.93 ± 1.63	16.48 ± 1.80	90.20 ± 3.89	43.55 ± 12.64	94.06 ± 0.22	7.57 ± 4.72	5.44 ± 1.58	34.76 ± 7.53	8.29 ± 1.70	98.61 ± 0.47
SHE	90.08 ± 1.89	91.45 ± 2.51	92.31 ± 1.97	96.17 ± 1.18	52.93 ± 1.30	87.61 ± 1.45	85.92 ± 2.75	92.32 ± 1.30	91.95 ± 1.29	56.96 ± 2.74
TempScale	34.07 ± 1.86	22.75 ± 3.54	68.46 ± 2.60	65.32 ± 10.22	93.77 ± 0.35	45.94 ± 6.00	64.08 ± 15.83	82.48 ± 5.45	84.87 ± 5.69	86.69 ± 3.51
ViM	13.82 ± 1.18	10.27 ± 0.43	45.59 ± 2.32	21.08 ± 1.47	97.57 ± 0.12	0.01 ± 0.01	0.05 ± 0.01	0.14 ± 0.12	0.16 ± 0.10	99.97 ± 0.01

Table 22. Far-OoD on DenseNet-201.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	46.85 ± 4.61	37.22 ± 2.97	83.83 ± 11.70	61.45 ± 2.27	91.04 ± 0.63
DICE	22.44 ± 3.25	31.02 ± 7.62	60.69 ± 5.55	79.16 ± 11.18	94.05 ± 0.70
MCDropout	37.44 ± 1.46	24.41 ± 5.23	74.74 ± 1.67	67.04 ± 11.20	93.34 ± 0.64
Energy	24.50 ± 3.10	23.58 ± 5.24	61.63 ± 4.31	75.99 ± 12.26	94.40 ± 0.57
fDBD	30.10 ± 1.27	19.41 ± 2.33	69.99 ± 3.34	33.28 ± 0.78	95.11 ± 0.28
GEN	25.93 ± 1.90	18.64 ± 3.70	64.89 ± 4.14	52.49 ± 9.05	95.07 ± 0.48
GradNorm	77.97 ± 6.00	87.77 ± 3.60	85.26 ± 4.27	96.04 ± 1.65	64.17 ± 5.31
KL Matching	33.68 ± 1.44	41.49 ± 7.04	69.70 ± 4.69	84.88 ± 5.32	91.89 ± 1.06
KNN	33.89 ± 1.61	20.59 ± 3.58	83.60 ± 7.99	36.83 ± 5.83	94.34 ± 0.60
Mahalanobis	64.48 ± 11.91	30.02 ± 5.16	87.27 ± 3.04	42.93 ± 4.23	89.47 ± 2.70
MLS	24.62 ± 2.36	23.19 ± 5.05	63.52 ± 4.00	75.98 ± 12.28	94.34 ± 0.61
MSP	34.47 ± 0.41	20.42 ± 3.42	69.41 ± 4.88	55.71 ± 6.24	94.11 ± 0.59
OpenMax	91.26 ± 2.23	19.17 ± 2.10	99.68 ± 0.22	42.78 ± 4.22	89.25 ± 0.50
ReAct	45.66 ± 6.21	26.49 ± 1.77	77.59 ± 5.23	45.89 ± 2.22	92.38 ± 0.80
Relation	34.24 ± 1.19	23.61 ± 2.33	67.89 ± 4.31	36.14 ± 3.70	94.15 ± 0.64
Residual	70.51 ± 6.49	39.59 ± 10.02	90.97 ± 1.97	53.58 ± 10.93	86.00 ± 3.88
RMDS	41.67 ± 8.60	15.93 ± 2.26	89.92 ± 4.07	54.69 ± 22.25	93.76 ± 0.18
SHE	90.01 ± 0.95	90.57 ± 2.47	93.59 ± 0.57	96.51 ± 1.35	57.17 ± 2.34
TempScale	31.18 ± 1.38	19.98 ± 3.26	66.26 ± 4.33	60.70 ± 9.70	94.42 ± 0.62
ViM	25.99 ± 2.12	15.08 ± 0.89	73.08 ± 2.08	29.02 ± 4.84	95.87 ± 0.07

Table 23. Near-OoD on DenseNet-201.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	89.39 ± 14.21	85.11 ± 5.08	95.68 ± 6.04	93.68 ± 3.11	63.32 ± 8.53	89.30 ± 15.12	90.04 ± 7.58	98.10 ± 2.69	96.50 ± 2.90	45.13 ± 22.91
DICE	35.57 ± 3.77	50.73 ± 5.21	62.76 ± 3.97	85.02 ± 0.06	90.22 ± 1.08	34.80 ± 5.91	54.80 ± 13.08	65.70 ± 7.32	79.37 ± 8.42	89.68 ± 1.94
MCDropout	46.67 ± 2.36	40.68 ± 6.56	73.66 ± 2.65	75.40 ± 5.71	90.13 ± 1.23	59.79 ± 13.55	44.02 ± 12.45	85.33 ± 7.95	75.73 ± 11.49	86.74 ± 4.51
Energy	36.51 ± 3.35	42.23 ± 7.83	66.57 ± 0.28	85.36 ± 0.72	91.45 ± 1.06	43.43 ± 16.27	45.69 ± 7.51	78.62 ± 7.61	78.82 ± 7.12	90.11 ± 2.19
fDBD	36.64 ± 2.87	32.95 ± 5.81	72.82 ± 1.55	67.94 ± 10.20	92.26 ± 1.17	46.48 ± 16.85	29.89 ± 10.52	83.05 ± 8.40	49.48 ± 16.42	88.61 ± 5.17
GEN	37.19 ± 2.59	32.20 ± 6.54	67.05 ± 1.57	72.50 ± 6.71	92.41 ± 1.11	48.29 ± 16.24	37.56 ± 10.64	84.11 ± 7.89	71.34 ± 11.70	89.77 ± 3.30
GradNorm	97.67 ± 2.57	91.15 ± 1.66	99.30 ± 0.80	96.94 ± 0.42	47.79 ± 4.95	99.49 ± 0.73	97.79 ± 2.28	99.98 ± 0.02	99.71 ± 0.32	25.62 ± 19.66
KL Matching	40.15 ± 2.60	82.52 ± 4.77	73.59 ± 1.37	95.79 ± 1.64	87.69 ± 1.24	45.45 ± 13.65	77.86 ± 16.31	72.10 ± 6.89	89.26 ± 8.19	81.66 ± 9.25
KNN	32.24 ± 5.27	21.75 ± 3.67	77.05 ± 5.86	49.24 ± 7.81	94.07 ± 0.97	34.51 ± 19.09	25.10 ± 13.99	62.61 ± 16.49	39.44 ± 17.13	92.04 ± 5.17
Mahalanobis	29.03 ± 3.85	21.84 ± 6.86	64.32 ± 5.08	38.77 ± 10.29	94.73 ± 1.24	0.00 ± 0.00	0.08 ± 0.06	0.03 ± 0.03	0.13 ± 0.10	99.97 ± 0.03
MLS	36.59 ± 3.29	41.39 ± 8.47	66.48 ± 1.96	85.36 ± 0.72	91.52 ± 1.08	44.39 ± 16.56	44.99 ± 7.75	79.24 ± 10.17	78.64 ± 7.13	90.10 ± 2.27
MSP	43.57 ± 2.52	31.18 ± 5.43	72.05 ± 1.33	68.47 ± 9.48	91.90 ± 1.08	56.69 ± 13.93	35.60 ± 11.83	84.91 ± 6.65	68.62 ± 13.22	89.03 ± 3.69
ODIN	35.48 ± 2.78	33.75 ± 6.30	67.43 ± 0.44	71.63 ± 2.11	92.72 ± 0.71	15.53 ± 9.56	13.44 ± 6.77	35.53 ± 14.63	40.99 ± 21.58	96.78 ± 1.48
OpenMax	88.74 ± 1.18	28.67 ± 5.01	99.00 ± 0.16	59.13 ± 9.77	86.94 ± 0.91	82.50 ± 5.63	16.33 ± 1.63	96.93 ± 0.93	24.09 ± 4.69	90.23 ± 1.11
RankFeat	92.12 ± 4.17	95.61 ± 1.37	96.99 ± 2.89	99.00 ± 0.31	50.82 ± 3.32	81.00 ± 12.90	90.94 ± 5.37	88.03 ± 10.85	94.54 ± 5.18	47.10 ± 10.55
ReAct	70.25 ± 15.60	70.00 ± 10.49	89.22 ± 11.52	88.29 ± 9.09	78.06 ± 6.50	81.53 ± 21.59	67.33 ± 21.87	94.86 ± 6.85	83.54 ± 16.13	66.26 ± 16.62
Relation	41.13 ± 2.47	56.19 ± 4.15	69.75 ± 1.89	66.45 ± 1.21	90.19 ± 0.96	54.13 ± 12.53	33.67 ± 2.73	82.45 ± 8.18	47.30 ± 8.18	89.03 ± 2.81
Residual	37.82 ± 1.91	27.75 ± 7.25	74.24 ± 7.10	43.96 ± 9.40	93.02 ± 1.29	0.00 ± 0.00	0.08 ± 0.02	0.07 ± 0.06	0.16 ± 0.07	99.97 ± 0.01
RMDS	47.18 ± 5.29	23.07 ± 2.82	90.98 ± 0.52	54.26 ± 11.94	92.55 ± 0.81	7.66 ± 3.03	6.04 ± 1.25	20.46 ± 2.44	11.80 ± 1.63	98.75 ± 0.34
SHE	90.21 ± 1.02	89.56 ± 1.22	93.20 ± 0.99	94.69 ± 0.18	52.08 ± 1.39	87.88 ± 9.55	79.55 ± 5.23	91.55 ± 7.13	88.20 ± 0.71	52.67 ± 11.56
TempScale	39.90 ± 2.66	31.04 ± 6.19	68.63 ± 1.32	70.99 ± 7.37	92.19 ± 1.12	51.98 ± 15.60	35.46 ± 12.08	82.56 ± 8.24	69.11 ± 13.15	89.77 ± 3.45
ViM	15.59 ± 1.62	12.11 ± 0.92	53.09 ± 6.46	24.06 ± 2.52	97.13 ± 0.29	0.00 ± 0.00	0.04 ± 0.01	0.03 ± 0.01	0.09 ± 0.03	99.98 ± 0.01

Table 24. Far-OoD on SE-ResNeXt-50.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	90.91 ± 12.00	73.13 ± 4.03	98.28 ± 2.37	88.15 ± 0.98	67.02 ± 8.17
DICE	27.94 ± 3.33	35.80 ± 2.75	59.41 ± 4.87	73.66 ± 4.89	93.19 ± 0.56
MCDropout	43.79 ± 2.20	26.51 ± 1.75	71.21 ± 4.00	56.46 ± 3.08	92.48 ± 0.51
Energy	28.00 ± 1.77	23.00 ± 3.00	63.52 ± 2.60	63.99 ± 4.34	94.35 ± 0.35
fDBD	30.48 ± 1.27	18.95 ± 1.52	69.87 ± 3.11	30.68 ± 1.34	95.02 ± 0.24
GEN	29.57 ± 2.94	18.20 ± 1.82	63.61 ± 3.79	35.74 ± 0.90	95.15 ± 0.40
GradNorm	99.30 ± 0.99	92.26 ± 1.21	99.94 ± 0.08	97.68 ± 0.82	49.21 ± 4.73
KL Matching	36.60 ± 2.12	43.95 ± 11.45	70.63 ± 0.50	86.16 ± 4.27	91.24 ± 1.41
KNN	33.04 ± 2.12	19.57 ± 0.97	82.40 ± 5.01	33.32 ± 1.55	94.57 ± 0.33
Mahalanobis	67.40 ± 5.87	36.08 ± 12.23	87.33 ± 2.01	49.56 ± 10.85	86.54 ± 4.67
MLS	28.47 ± 2.18	22.90 ± 3.26	63.29 ± 4.06	62.32 ± 4.10	94.33 ± 0.38
MSP	40.24 ± 2.00	19.85 ± 2.01	69.41 ± 1.06	37.43 ± 0.39	94.01 ± 0.35
ODIN	32.60 ± 1.04	21.96 ± 2.22	72.12 ± 3.97	61.20 ± 3.22	94.07 ± 0.35
OpenMax	92.19 ± 0.64	19.90 ± 1.00	99.53 ± 0.08	32.14 ± 2.83	88.13 ± 0.63
RankFeat	95.83 ± 0.68	92.79 ± 2.83	99.16 ± 0.39	97.80 ± 0.88	46.47 ± 5.84
ReAct	69.58 ± 17.92	49.00 ± 12.14	92.74 ± 7.66	67.40 ± 11.46	83.71 ± 5.65
Relation	39.60 ± 1.79	28.09 ± 1.50	68.18 ± 2.43	52.31 ± 8.62	92.83 ± 0.61
Residual	76.52 ± 3.68	44.66 ± 13.05	90.73 ± 0.75	56.32 ± 10.89	82.53 ± 4.79
RMDS	58.16 ± 4.46	18.58 ± 1.07	90.18 ± 1.18	36.25 ± 5.71	92.70 ± 0.50
SHE	93.50 ± 1.67	89.99 ± 0.65	96.62 ± 1.46	97.00 ± 0.54	54.02 ± 1.06
TempScale	35.05 ± 2.72	19.49 ± 2.14	65.68 ± 1.53	39.29 ± 0.86	94.47 ± 0.39
ViM	38.20 ± 4.60	17.43 ± 0.07	83.01 ± 0.97	27.64 ± 1.83	94.45 ± 0.41

Table 25. Near-OoD on SE-ResNeXt-50.

Method	Far-OoD(Bubbles & Particles)					Far-OoD(General)				
	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	93.84 ± 1.87	94.74 ± 3.61	97.94 ± 1.01	98.85 ± 0.81	51.22 ± 5.38	99.64 ± 0.25	72.79 ± 3.88	99.98 ± 0.02	84.06 ± 1.52	58.53 ± 1.05
DICE	68.72 ± 4.69	54.40 ± 4.94	90.06 ± 2.02	71.99 ± 5.59	82.19 ± 2.01	84.53 ± 10.98	44.95 ± 11.82	97.22 ± 2.92	55.78 ± 10.57	76.49 ± 11.28
MCDropout	76.52 ± 0.96	56.86 ± 4.28	93.14 ± 0.19	78.66 ± 2.59	80.53 ± 1.42	70.29 ± 8.15	43.30 ± 5.60	90.39 ± 4.16	60.85 ± 5.65	84.63 ± 2.97
Energy	57.44 ± 5.19	42.73 ± 4.94	87.94 ± 1.48	64.10 ± 4.68	87.53 ± 1.74	36.48 ± 3.05	18.22 ± 1.87	83.46 ± 9.45	30.12 ± 3.04	94.05 ± 0.52
fDBD	49.53 ± 4.25	33.41 ± 4.25	82.01 ± 1.61	53.63 ± 5.05	90.63 ± 1.27	31.38 ± 12.99	14.50 ± 3.55	76.34 ± 7.43	24.81 ± 4.01	95.06 ± 1.81
GEN	57.13 ± 5.74	42.72 ± 5.50	86.65 ± 2.42	67.65 ± 6.58	87.79 ± 1.72	35.81 ± 9.39	19.71 ± 1.92	77.06 ± 13.44	33.23 ± 2.65	94.10 ± 1.24
GradNorm	66.89 ± 3.78	71.40 ± 4.23	88.15 ± 1.60	90.22 ± 3.39	79.57 ± 1.93	32.88 ± 6.05	29.79 ± 7.30	68.84 ± 7.49	55.30 ± 11.48	92.79 ± 1.42
KL Matching	60.27 ± 1.19	73.84 ± 10.21	83.18 ± 2.04	96.31 ± 2.63	84.12 ± 1.24	48.57 ± 14.96	38.54 ± 21.89	76.47 ± 7.69	67.50 ± 8.16	89.27 ± 5.52
KNN	59.43 ± 1.15	61.92 ± 0.30	83.97 ± 1.98	82.23 ± 1.42	84.24 ± 0.24	38.59 ± 9.12	21.93 ± 1.19	65.83 ± 8.54	34.08 ± 3.41	93.54 ± 1.18
Mahalanobis	88.43 ± 3.44	89.47 ± 2.18	96.95 ± 1.90	97.52 ± 0.44	62.67 ± 4.17	82.73 ± 9.98	88.60 ± 6.95	93.53 ± 4.08	96.93 ± 1.86	55.04 ± 16.29
MLS	56.81 ± 5.11	42.44 ± 4.88	86.91 ± 1.44	64.24 ± 4.71	87.72 ± 1.67	35.54 ± 5.17	18.09 ± 2.19	81.10 ± 9.33	30.21 ± 3.24	94.19 ± 0.79
MSP	70.20 ± 1.15	47.81 ± 4.18	90.52 ± 1.88	71.12 ± 3.77	84.63 ± 1.02	59.46 ± 16.38	31.27 ± 5.78	84.19 ± 10.62	45.40 ± 6.04	89.23 ± 3.95
OpenMax	52.73 ± 0.33	54.19 ± 2.32	85.15 ± 2.47	72.12 ± 2.86	86.63 ± 0.64	52.45 ± 23.36	31.92 ± 15.86	85.81 ± 12.44	43.71 ± 15.47	86.96 ± 6.93
ReAct	64.67 ± 1.41	53.70 ± 6.16	89.47 ± 0.43	76.16 ± 5.42	84.72 ± 1.02	59.31 ± 16.85	27.61 ± 6.91	87.99 ± 9.16	43.45 ± 4.06	88.75 ± 2.99
Relation	61.44 ± 1.45	64.57 ± 3.55	86.73 ± 1.22	87.34 ± 3.86	85.08 ± 0.81	47.00 ± 20.47	25.08 ± 4.51	77.03 ± 14.03	38.30 ± 0.74	92.02 ± 3.55
Residual	85.27 ± 2.19	71.79 ± 6.06	96.31 ± 0.71	87.10 ± 3.34	71.81 ± 3.14	40.46 ± 18.78	21.15 ± 9.15	78.03 ± 11.89	32.88 ± 10.05	90.91 ± 3.62
RMDS	95.57 ± 0.77	92.47 ± 1.96	99.50 ± 0.25	98.13 ± 0.59	54.24 ± 3.57	96.63 ± 1.73	97.49 ± 1.64	99.08 ± 0.56	99.45 ± 0.32	34.51 ± 8.99
SHE	79.53 ± 3.09	72.57 ± 6.65	93.28 ± 1.18	83.48 ± 4.41	72.04 ± 1.60	49.60 ± 16.06	51.64 ± 4.82	75.52 ± 8.61	64.27 ± 2.74	85.21 ± 2.45
TempScale	64.88 ± 1.83	46.85 ± 4.38	89.83 ± 1.79	70.26 ± 4.18	85.63 ± 1.12	52.58 ± 18.72	28.82 ± 5.87	82.42 ± 12.09	42.82 ± 5.93	90.53 ± 3.91
ViM	71.98 ± 3.15	53.66 ± 4.57	93.46 ± 1.54	73.74 ± 2.48	83.12 ± 2.07	24.35 ± 14.02	11.10 ± 4.26	65.25 ± 23.53	18.43 ± 4.90	95.59 ± 2.18

Table 26. Far-OoD on ViT.

Method	FPR95-ID↓	FPR95-OoD↓	FPR99-ID↓	FPR99-OoD↓	AUROC↑
ASH	95.63 ± 1.54	94.36 ± 1.32	98.51 ± 0.91	98.84 ± 0.38	52.41 ± 2.66
DICE	79.40 ± 4.97	72.98 ± 1.25	95.72 ± 0.68	83.75 ± 2.44	74.35 ± 2.85
MCDropout	77.16 ± 0.86	61.11 ± 6.32	93.30 ± 0.29	81.73 ± 7.33	79.78 ± 0.49
Energy	63.40 ± 4.01	52.34 ± 8.65	91.81 ± 1.45	72.17 ± 10.20	85.81 ± 0.98
fDBD	53.15 ± 1.90	56.78 ± 16.50	86.77 ± 0.72	77.89 ± 15.94	87.39 ± 1.77
GEN	58.71 ± 2.94	50.24 ± 10.76	88.40 ± 1.65	70.22 ± 12.19	87.00 ± 0.92
GradNorm	67.72 ± 3.63	63.24 ± 2.75	90.33 ± 2.44	85.43 ± 1.28	81.05 ± 1.96
KL Matching	63.93 ± 2.01	65.25 ± 7.04	85.96 ± 0.85	79.38 ± 5.46	83.71 ± 1.11
KNN	62.67 ± 0.72	35.83 ± 0.71	88.61 ± 0.46	52.44 ± 2.81	88.25 ± 0.22
Mahalanobis	85.26 ± 3.77	88.94 ± 4.86	96.10 ± 1.47	97.05 ± 1.72	63.36 ± 5.76
MLS	62.38 ± 3.81	52.15 ± 8.67	90.47 ± 1.29	72.29 ± 10.14	86.10 ± 0.94
MSP	70.51 ± 1.61	52.44 ± 7.47	90.24 ± 1.83	72.76 ± 9.99	83.92 ± 0.86
OpenMax	51.92 ± 3.60	72.13 ± 8.25	81.09 ± 5.34	91.22 ± 7.35	83.41 ± 1.56
ReAct	70.75 ± 5.97	59.83 ± 11.37	92.16 ± 1.89	76.60 ± 10.55	82.20 ± 3.34
Relation	60.40 ± 2.37	36.66 ± 2.40	86.86 ± 0.08	46.93 ± 3.58	88.67 ± 0.53
Residual	80.07 ± 3.03	60.62 ± 0.91	95.05 ± 1.34	77.03 ± 2.39	78.08 ± 0.29
RMDS	96.10 ± 0.58	93.73 ± 1.46	99.48 ± 0.33	98.62 ± 0.77	52.03 ± 1.36
SHE	80.57 ± 2.05	66.99 ± 3.19	93.47 ± 1.47	76.30 ± 2.54	73.06 ± 1.73
TempScale	65.82 ± 1.32	52.73 ± 8.65	89.92 ± 1.73	72.49 ± 10.69	84.95 ± 0.90
ViM	67.63 ± 1.54	39.23 ± 0.84	93.15 ± 0.68	54.53 ± 1.06	86.82 ± 0.34

Table 27. Near-OoD on ViT.