

Supplementary Material
Difficulty-Aware Simulator for Open Set Recognition
WonJun Moon, Junho Park, Hyun Seok Seong, Cheol-Ho Cho, and Jae-Pil Heo*
Sungkyunkwan University

1 Split Information

As we elaborated in the main paper, we adopted the protocols from [2] and [4] for evaluations with AUROC and F1-score, respectively. To further encourage the fair comparison, we publicize the split details. Specifically, we enumerate categories that are used for closed-set in Tab. 1 and Tab. 2 for measuring F1-score and AUROC, respectively. Note that for CIFAR+, we show the categories of open-set classes since CIFAR+ experiments utilize the non-animal classes in CIFAR10 dataset, i.e., airplain, automobile, ship, and truck, as the closed-set. We sincerely hope future works use pre-defined standard split information to prevent confusion in understanding the effectiveness of their methods and for a fair comparison.

Table 1. Data splits for Tab. 3 in the main paper. This split information is used for measuring F1-scores. The numbers in the table represent the class indices for closed set except CIFAR+ cases. For CIFAR+ experiments, we provide open-set class indices, since animal classes are utilized for closed set.

|       | 0     | 1     | 2     | 3     | 4     |
|-------|-------|-------|-------|-------|-------|
| MNIST | 2, 3, 4, 6, 7, 8 | 0, 1, 4, 6, 7, 9 | 1, 2, 4, 6, 7, 8 | 1, 3, 4, 6, 7, 8 | 1, 2, 3, 5, 7, 8 |
| SVHN  | 2, 3, 4, 6, 7, 8 | 0, 1, 4, 6, 7, 9 | 1, 2, 4, 6, 7, 8 | 1, 3, 4, 6, 7, 8 | 1, 2, 3, 5, 7, 8 |
| CIFAR10| 2, 3, 4, 6, 7, 8 | 0, 1, 4, 6, 7, 9 | 1, 2, 4, 6, 7, 8 | 1, 3, 4, 6, 7, 8 | 1, 2, 3, 5, 7, 8 |
| CIFAR+10| 27, 46, 98, 38, 72, 31, 36, 66 | 98, 46, 14, 1, 93, 11 | 79, 98, 67, 7 | 77, 42, 36, 65 | 65, 66, 79, 21 | 50, 24, 93, 75 | 27, 36 |
| CIFAR+50| 27, 46, 98, 38, 72, 31, 36, 66 | 98, 46, 14, 1, 93, 11 | 79, 98, 67, 7 | 77, 42, 36, 65 | 65, 66, 79, 21 | 50, 24, 93, 75 | 27, 36 |

* Corresponding author
Table 2. Data splits for Tab. 1 in the main paper. This split information is used for measuring AUROC scores. The numbers in the table represent the class indices for closed set except CIFAR+ cases. For CIFAR+ experiments, we provide open-set class indices, since animal classes are utilized for closed set.

| AUROC Split Information | 0 | 1 | 2 | 3 | 4 |
|-------------------------|---|---|---|---|---|
| MNIST                   | 0, 1, 2, 4, 5, 9 | 0, 3, 5, 7, 8, 9 | 0, 1, 5, 6, 7, 8 | 3, 4, 5, 7, 8, 9 | 0, 1, 2, 3, 7, 8 |
| SVHN                    | 0, 1, 2, 4, 5, 9 | 0, 3, 5, 7, 8, 9 | 0, 1, 5, 6, 7, 8 | 3, 4, 5, 7, 8, 9 | 0, 1, 2, 3, 7, 8 |
| CIFAR10                 | 0, 1, 2, 4, 5, 9 | 0, 3, 5, 7, 8, 9 | 0, 1, 5, 6, 7, 8 | 3, 4, 5, 7, 8, 9 | 0, 1, 2, 3, 7, 8 |
| CIFAR+10                | 26, 31, 34, 44, 45, 63, 65, 77, 93, 98 | 7, 11, 66, 75, 97, 93, 95, 97, 98, 99 | 2, 11, 15, 24, 32, 34, 63, 88, 93, 95 | 1, 11, 38, 42, 44, 45, 63, 64, 66, 67 | 3, 15, 19, 21, 42, 46, 66, 72 |
| CIFAR+50                | 1, 2, 7, 9, 10, 12, 15, 18, 21, 23, 26, 30, 32, 33, 35, 39, 41, 45, 47, 49, 50, 51, 52, 55, 56, 59, 60, 61, 63, 65, 66, 67, 68, 71, 73, 76, 78, 80, 83, 87, 91, 92, 96, 98 | 0, 2, 4, 5, 6, 9, 10, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 26, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 43, 44, 46, 47, 49, 50, 51, 52, 55, 56, 59, 60, 61, 63, 65, 66, 67, 68, 71, 73, 76, 78, 80, 83, 87, 91, 92, 96, 98 | 0, 4, 10, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 26, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 43, 44, 46, 47, 49, 50, 51, 52, 55, 56, 59, 60, 61, 63, 65, 66, 67, 68, 71, 73, 76, 78, 80, 83, 87, 91, 92, 96, 98 | 0, 2, 5, 6, 9, 10, 11, 12, 14, 15, 17, 18, 20, 21, 23, 24, 26, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 43, 44, 46, 47, 49, 50, 51, 52, 55, 56, 59, 60, 61, 63, 65, 66, 67, 68, 71, 73, 76, 78, 80, 83, 87, 91, 92, 96, 98 |
| Tiny-IN                 | 2, 3, 13, 30, 44, 45, 64, 66, 76, 101, 111, 121, 128, 130, 136, 158, 167, 170, 187, 193 | 4, 11, 32, 42, 51, 53, 67, 84, 87, 104, 116, 140, 144, 145, 148, 149, 155, 168, 185, 193 | 3, 9, 10, 20, 23, 28, 29, 45, 54, 74, 133, 143, 146, 147, 150, 156, 159, 161, 170, 184, 195 | 1, 5, 17, 31, 36, 44, 66, 69, 84, 89, 102, 137, 154, 160, 163, 170, 177, 182, 147, 161, 166, 168, 172, 173 | 4, 14, 16, 33, 34, 39, 59, 69, 77, 92, 101, 103, 130, 133, 147, 161, 166, 168, 172, 173 |

2 Regularization Loss

As we introduced in the main paper, we simply used cross entropy loss function for regularization loss, $L_{reg}$. In this section, we simply examine the influence of $L_{reg}$ with two datasets: CIFAR10 and Tiny-ImageNet. Results in Tab. 3 show that DIAS is not very sensitive to the ratio for $L_{reg}$.

| Loss Ratio | 0.1 | 0.2 | 1.0 | 1.5 |
|------------|-----|-----|-----|-----|
| CIFAR10    | 0.852±0.02 | 0.851±0.03 | 0.850±0.02 | 0.851±0.03 |
| Tiny-ImageNet | 0.713±0.02 | 0.729±0.01 | 0.731±0.01 | 0.726±0.01 |

Table 3. AUROC score with varying ratios of $L_{reg}$.

3 Implementation details

DIAS is an end-to-end framework that all components are learned from the scratch. For the Copycat and the classifier, we use vanilla CNN [3], which is composed of 9 convolution layers. For the subgroups of convolutional layers, each group contains three 3x3 convolution layers. Additionally, the backbone network
for the generator and the discriminator each contains 4 convolutional layers. Moreover, we adopt multi-batch normalization layers to process generated images from GAN separately, as we hope to prevent the problem from distribution mismatch, following [1]. Note that features from the Copycat do not need to be processed separately. For scaling parameters, we fix both $\lambda$, and $\beta$ to 0.1.
References

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