国际人工智能会议
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Bi-Classifier Determinacy Maximization for Unsupervised Domain Adaptation

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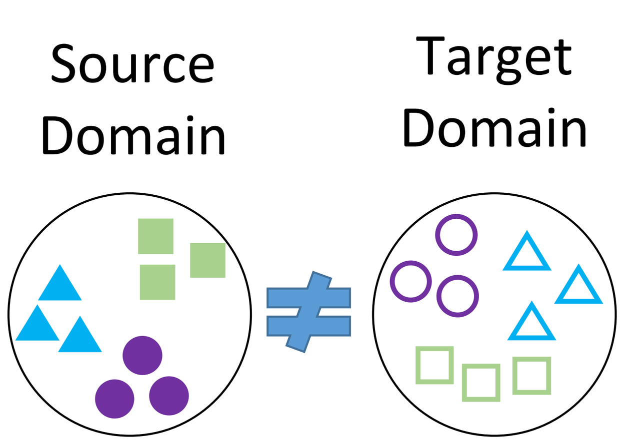
paper

code

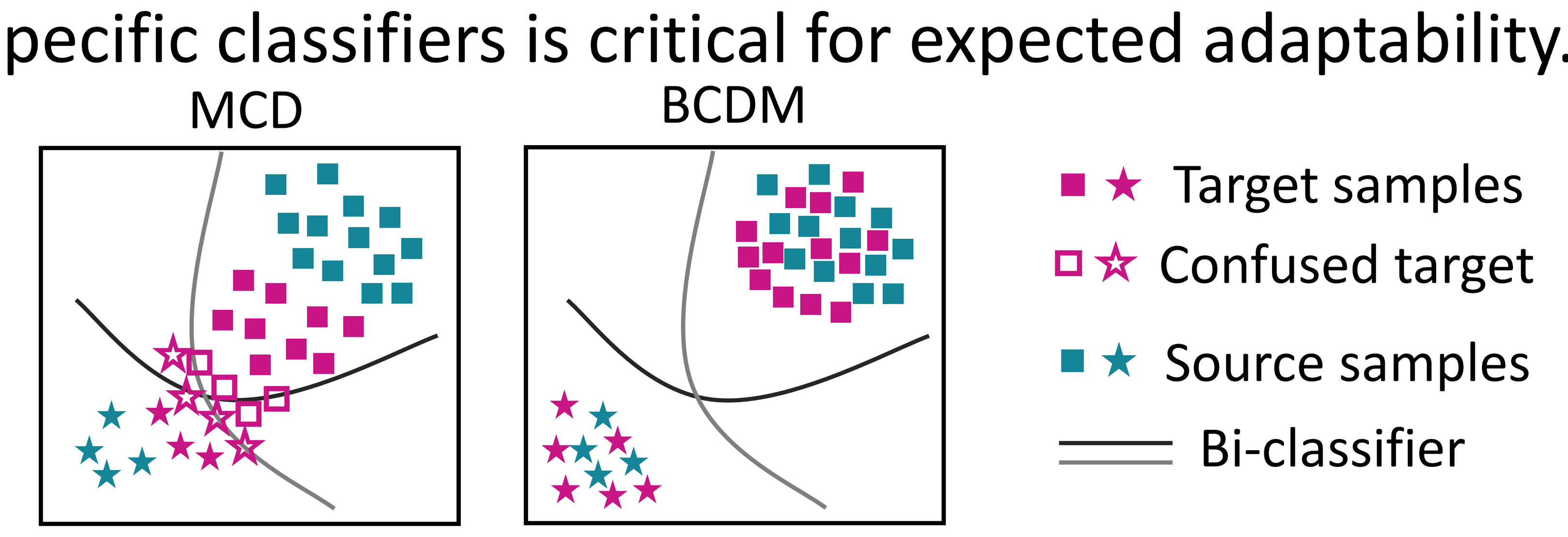
Domain Adaptation

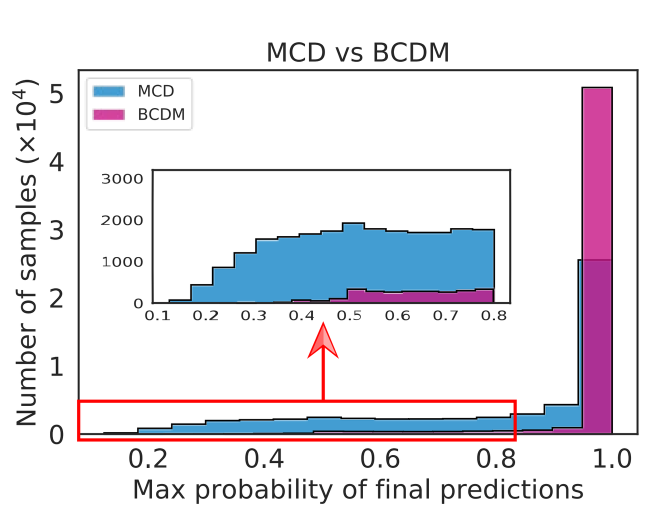


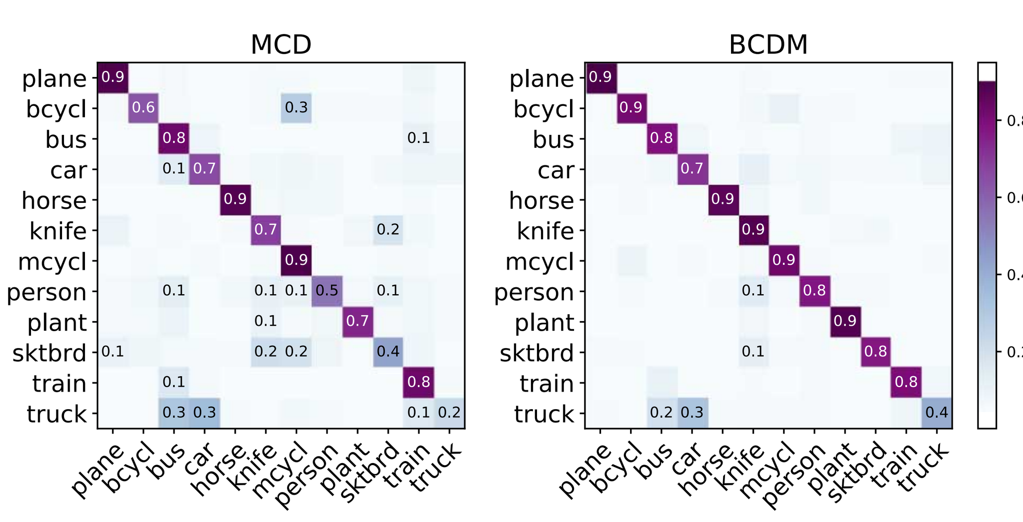
Labeled source data and unlabeled target data follow different joint distributions, i.e., $P(X_s, Y_s) \neq P(X_t, Y_t)$.

Bi-Classifier Adversarial

There exist two popular paradigms to conduct adversarial domain adaptation either by constructing a domain discriminator or by utilizing two distinct classifiers. As for the second paradigm, the selection of classifier discrepancy loss between two task-specific classifiers is critical for expected adaptability.





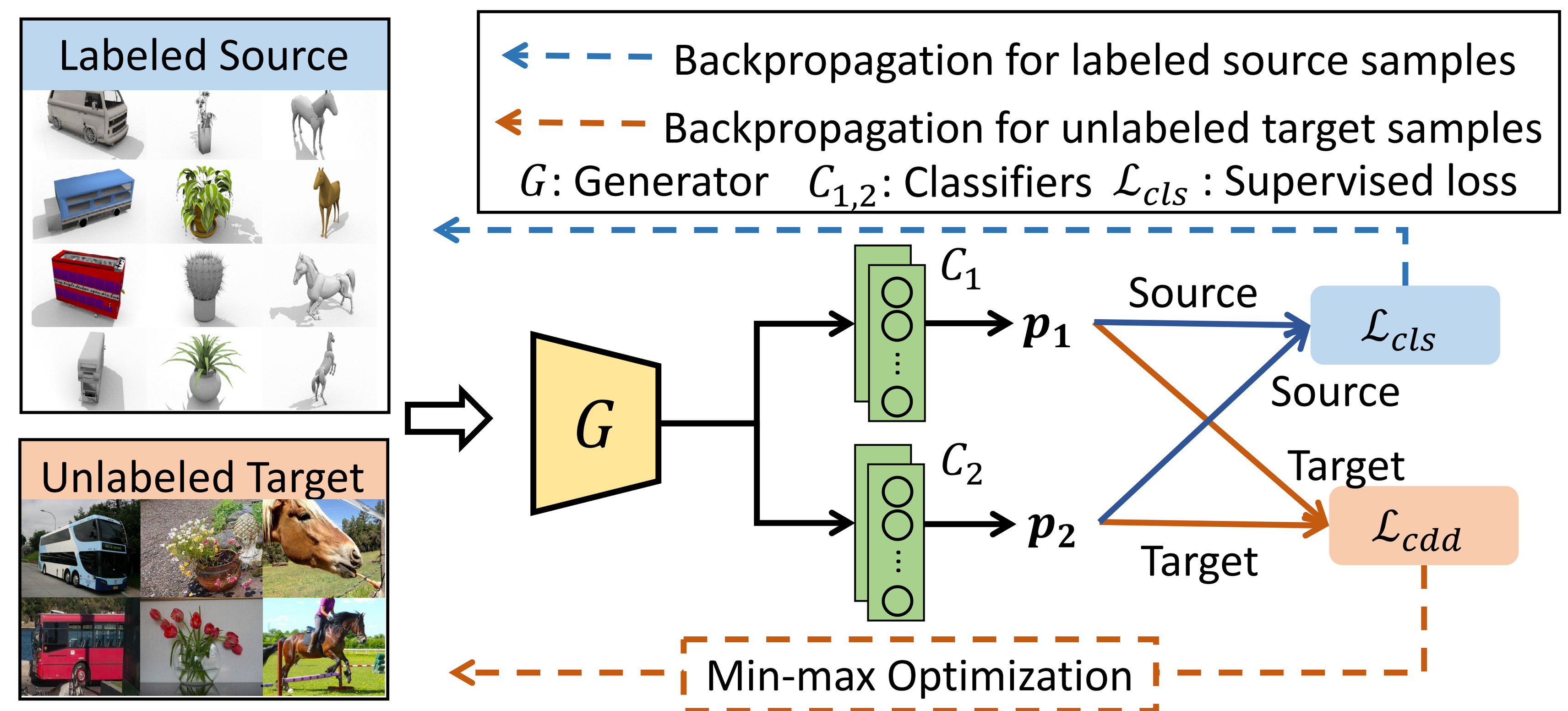


Classifier Determinacy Disparity

Given $\boldsymbol{p}_1$ and $\boldsymbol{p}_2$ as the bi-classifier softmax outputs, we investigate the classifier discrepancy by Bi-classifier Prediction Relevance Matrix $\boldsymbol{A}$: $\boldsymbol{A} = \boldsymbol{p}_1 \boldsymbol{p}_2^T$. Therefore, we define the CDD loss as:

$$\Gamma(\boldsymbol{p}_1, \boldsymbol{p}_2) = \sum_{m,n=1}^{K} \boldsymbol{A}_{mn} - \sum_{m=1}^{K} \boldsymbol{A}_{mm} = \sum_{m \neq n}^{K} \boldsymbol{A}_{mn}$$

- Non-negative;
- $\Gamma(\boldsymbol{p}_1, \boldsymbol{p}_2) = 0$ iff. $\boldsymbol{p}_1 = \boldsymbol{p}_2$ and each of the probabilistic output is one-hot vector;
- Symmetric;
- Satisfies triangle inequality.



Supervision loss:

$$\min_{\theta_g, \theta_{c_1}, \theta_{c_2}} \frac{1}{n_s} \sum_{i=1}^{n_s} \mathcal{L}_{cls}(x_i^s, y_i^s) = \frac{1}{2n_s} \sum_{i=1}^{n_s} \sum_{j=1}^{2} \mathcal{L}_{ce}(\boldsymbol{p}_{j_i}, y_i^s)$$

Adversarial CDD loss:

$$\max_{\theta_{c_1}, \theta_{c_2}} \min_{\theta_g} \frac{1}{n_t} \sum_{i=1}^{n_t} \mathcal{L}_{cdd}(x_i^t) = \frac{1}{n_t} \sum_{i=1}^{n_t} \Gamma(\boldsymbol{p}_1, \boldsymbol{p}_2)$$

Experimental Results

Accuracy(%) on DomainNet for UDA (ResNet-50)

ResNet‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	14.2	29.6	9.5	43.8	34.3	26.3
inf	21.8	-	23.2	2.3	40.6	20.8	21.7
pnt	24.1	15.0	-	4.6	45.0	29.0	23.5
qdr	12.2	1.5	4.9	-	5.6	5.7	6.0
rel	32.1	17.0	36.7	3.6	-	26.2	23.1
skt	30.4	11.3	27.8	3.4	32.9	-	21.2
Avg.	24.1	11.8	24.4	4.7	33.6	23.2	20.3

MCD‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	15.4	25.5	3.3	44.6	31.2	24.0
inf	24.1	-	24.0	1.6	35.2	19.7	20.9
pnt	31.1	14.8	-	1.7	48.1	22.8	23.7
qdr	8.5	2.1	4.6	-	7.9	7.1	6.0
rel	39.4	17.8	41.2	1.5	-	25.2	25.0
skt	37.3	12.6	27.2	4.1	34.5	-	23.1
Avg.	28.1	12.5	24.5	2.4	34.1	21.2	20.5

CDAN‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	13.5	28.3	9.3	43.8	30.2	25.0
inf	18.9	-	21.4	1.9	36.3	21.3	20.0
pnt	29.6	14.4	-	4.1	45.2	27.4	24.2
qdr	11.8	1.2	4.0	-	9.4	9.5	7.2
rel	36.4	18.3	40.9	3.4	-	24.6	24.7
skt	38.2	14.7	33.9	7.0	36.6	-	26.1
Avg.	27.0	12.4	25.7	5.1	34.3	22.6	21.2

SWD‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	14.7	31.9	10.1	45.3	36.5	27.7
inf	22.9	-	24.2	2.5	33.2	21.3	20.0
pnt	33.6	15.3	-	4.4	46.1	30.7	26.0
qdr	15.5	2.2	6.4	-	11.1	10.2	9.1
rel	41.2	18.1	44.2	4.6	-	31.6	27.9
skt	44.2	15.2	37.3	10.3	44.7	-	30.3
Avg.	31.5	13.1	28.8	6.4	36.1	26.1	23.6

BNM‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	12.1	33.1	6.2	50.8	40.2	28.5
inf	26.6	-	28.5	2.4	38.5	18.1	22.8
pnt	39.9	12.2	-	3.4	54.5	36.2	29.2
qdr	17.8	1.0	3.6	-	9.2	8.3	8.0
rel	48.6	13.2	49.7	3.6	-	33.9	29.8
skt	54.9	12.8	42.3	5.4	51.3	-	33.3
Avg.	37.6	10.3	31.4	4.2	40.9	27.3	25.3

BCDM	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	17.2	35.2	10.6	50.1	40.0	30.6
inf	29.3	-	29.4	3.8	41.3	25.0	25.8
pnt	39.2	17.7	-	4.8	51.2	34.9	29.6
qdr	19.4	2.6	7.2	-	13.6	12.8	11.1
rel	48.2	21.5	48.3	5.4	-	36.7	32.0
skt	50.6	17.3	41.9	10.6	49.0	-	33.9
Avg.	37.3	15.3	32.4	7.0	41.0	29.9	**27.2**

Accuracy(%) on DomainNet for UDA (ResNet-101)

ResNet	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	19.3	37.5	11.1	52.2	41.0	32.2
inf	30.2	-	31.2	3.6	44.0	27.9	27.4
pnt	39.6	18.7	-	4.9	54.5	36.3	30.8
qdr	7.0	0.9	1.4	-	4.1	8.3	4.3
rel	48.4	22.2	49.4	6.4	-	38.8	33.0
skt	46.9	15.4	37.0	10.9	47.0	-	31.4
Avg.	34.4	15.3	31.3	7.4	40.4	30.5	26.5

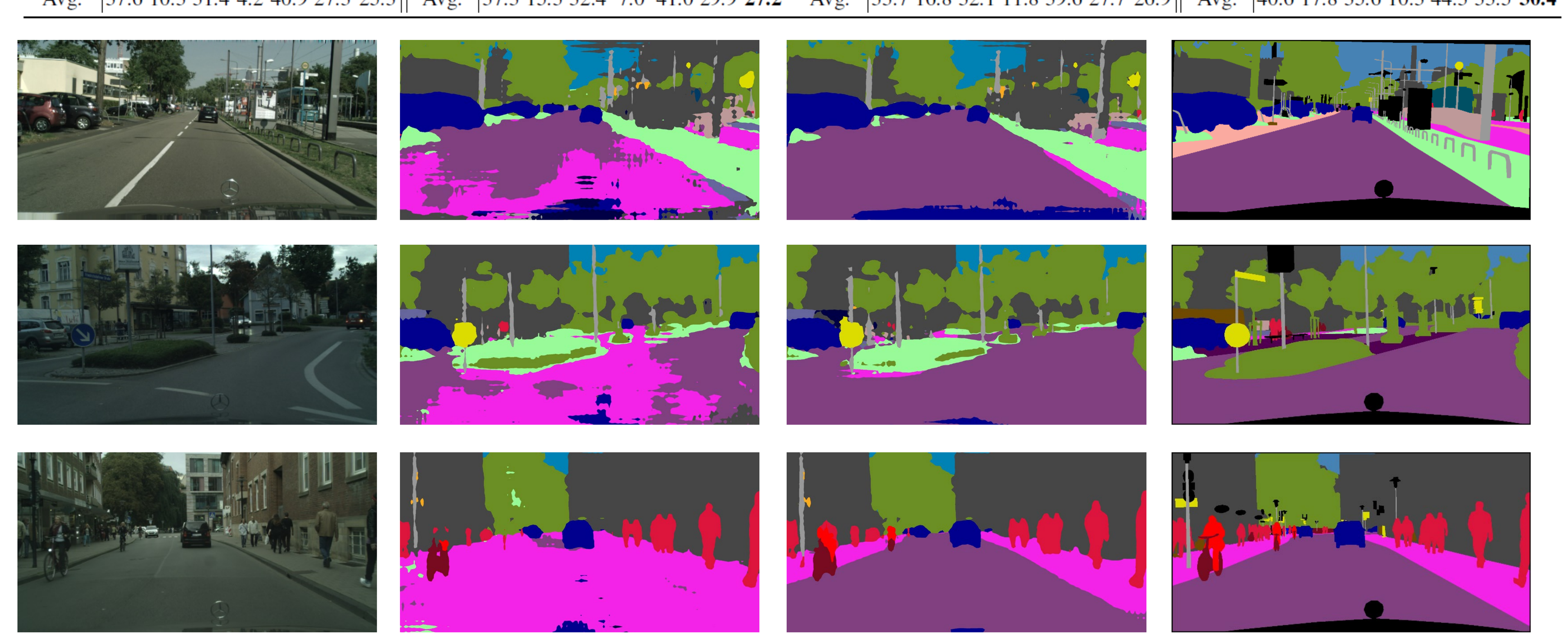
MCD	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	14.2	26.1	1.6	45.0	33.8	24.1
inf	23.6	-	21.2	1.5	36.7	18.0	20.2
pnt	34.4	14.8	-	1.9	50.5	28.4	26.0
qdr	15.0	3.0	7.0	-	11.5	10.2	9.3
rel	42.6	19.6	42.6	2.2	-	29.3	27.2
skt	41.2	13.7	27.6	3.8	34.8	-	24.2
Avg.	31.4	13.1	24.9	2.2	35.7	23.9	21.9

CDAN‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	17.8	35.7	15.3	51.3	37.2	31.4
inf	25.4	-	28.9	5.8	38.2	22.8	24.2
pnt	37.1	17.9	-	7.9	51.4	34.0	29.7
qdr	20.5	2.3	7.7	-	14.6	12.6	11.5
rel	43.6	19.4	46.1	8.3	-	33.2	30.1
skt	45.4	18.3	40.4	14.5	48.3	-	33.4
Avg.	34.4	15.1	31.7	10.4	40.8	27.9	26.7

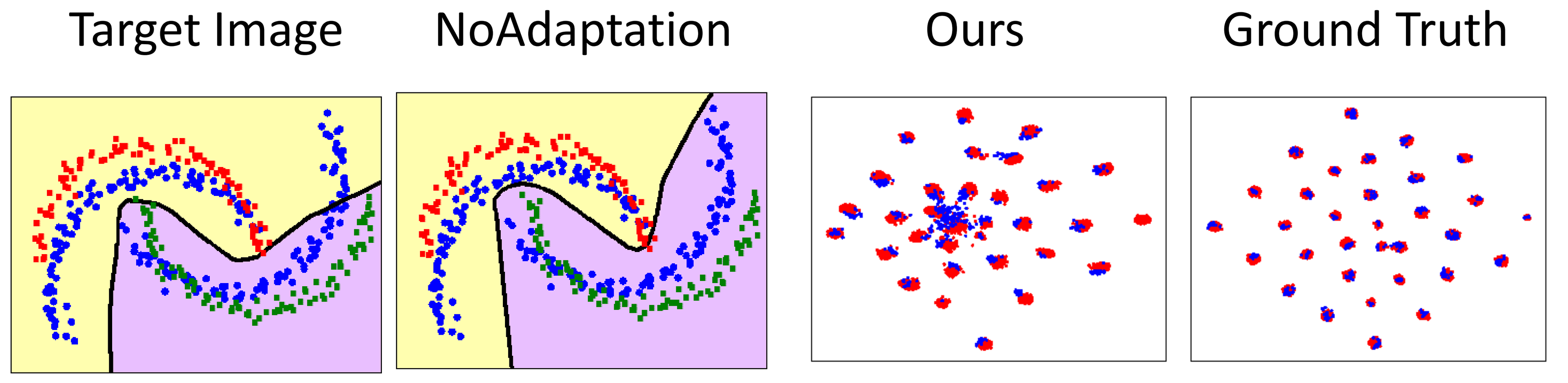
SWD‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	16.6	35.3	12.8	48.7	41.0	30.9
inf	26.9	-	27.6	2.7	38.1	25.4	24.1
pnt	37.3	16.9	-	5.9	48.7	34.6	28.7
qdr	19.3	3.0	8.1	-	14.2	13.3	11.6
rel	47.0	19.9	47.1	6.1	-	36.8	31.4
skt	48.8	17.3	41.1	12.2	49.1	-	33.7
Avg.	35.9	14.7	31.8	7.9	39.8	30.2	26.7

BNM‡	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	19.4	35.6	16.1	49.8	36.3	31.4
inf	24.6	-	27.8	7.9	35.0	22.0	23.5
pnt	36.0	20.2	-	9.7	51.8	34.2	30.4
qdr	21.3	3.8	10.5	-	14.0	12.9	12.5
rel	43.4	21.7	47.0	9.9	-	32.9	31.0
skt	43.1	19.1	39.5	15.6	47.0	-	32.7
Avg.	33.7	16.8	32.1	11.8	39.6	27.7	26.9

BCDM	clp	inf	pnt	qdr	rel	skt	Avg.
clp	-	19.9	38.5	15.1	53.2	43.9	34.1
inf	31.9	-	32.7	6.9	44.7	28.5	28.9
pnt	42.5	19.8	-	7.9	54.5	38.5	32.6
qdr	23.0	4.0	9.5	-	16.9	16.2	13.9
rel	51.9	24.9	51.2	8.7	-	40.6	35.5
skt	53.7	20.5	46.0	13.1	53.4	-	37.1
Avg.	40.6	17.8	35.6	10.3	44.3	33.5	**30.4**



Target Image NoAdaptation Ours Ground Truth



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