Polycentric Clustering and Structural Regularization for Source-free Unsupervised Domain Adaptation

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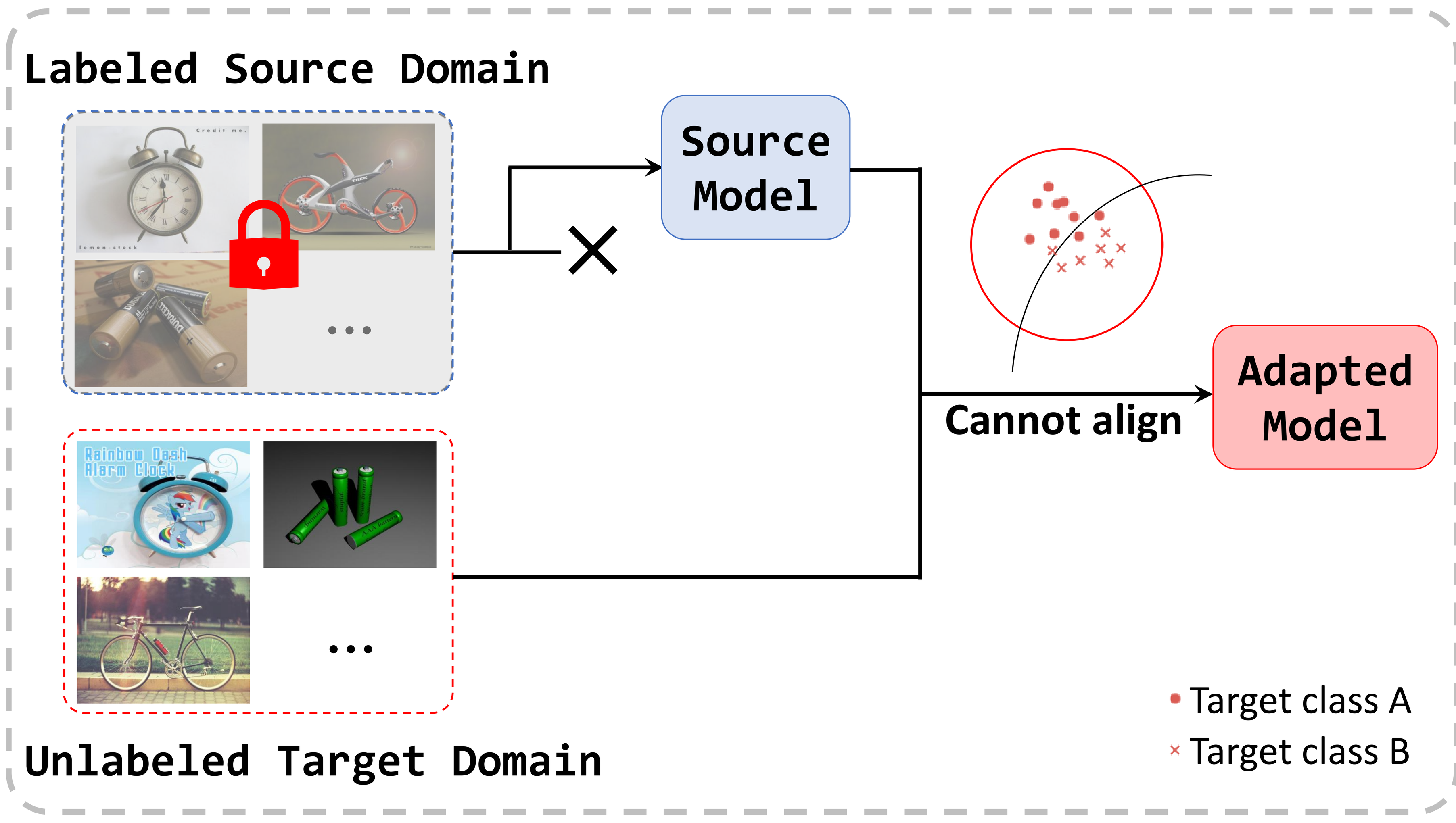
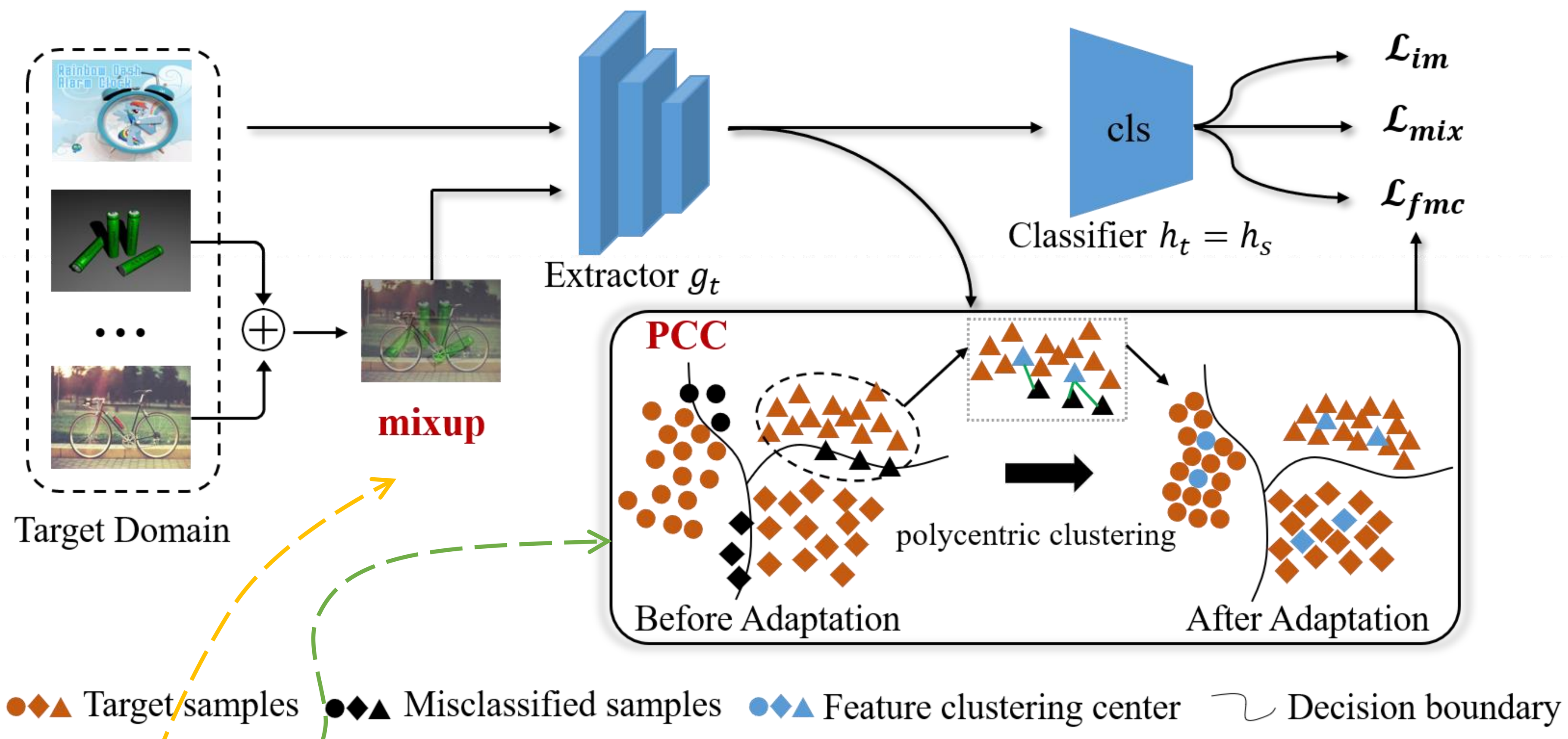
INTRODUCTION

Source-Free Domain Adaptation (SFDA) aims to solve the domain adaptation problem by transferring the knowledge learned from a pre-trained source model to an unseen target domain [1], as shown in the right figure. Most existing methods for assigning pseudo-labels to the target data are not accurate enough. In particular, the **category imbalance** in the target domain and the **data structure of the target domain** are often ignored.

In this work, we aim at designing an **intra-class polycentric clustering and structural regularization strategy** for SFDA, called PCSR. An inter-class-balanced sampling strategy is designed to address the challenge of class imbalance. Furthermore, a polycentric clustering approach is proposed and the mixup regularization is introduced to reduce the noisy labels.



METHOD



■ Inter-class-balanced Sampling

To avoid easy-transfer data dominating the target model, we adopt an inter-class-balanced sampling strategy to construct each class of the target domain to address the challenge of class imbalance.

■ Polycentric Clustering

Furthermore, to reduce the noisy labels for those hard data, we propose a polycentric clustering approach for each class to get more accurate pseudo-labels with a predefined number of clustering centers.

$$\mathcal{L}_{pcc} = -\mathbb{E}_{x \in \mathcal{X}_t} \sum_{k=1}^{K} \mathbb{1}_{[\hat{y}_t = k]} \log \delta_k(f_t(x))$$

■ Mixup Regularization

In addition, the mixup regularization module is introduced to interpolate the target data for consistent training, allowing for better generalization ability.

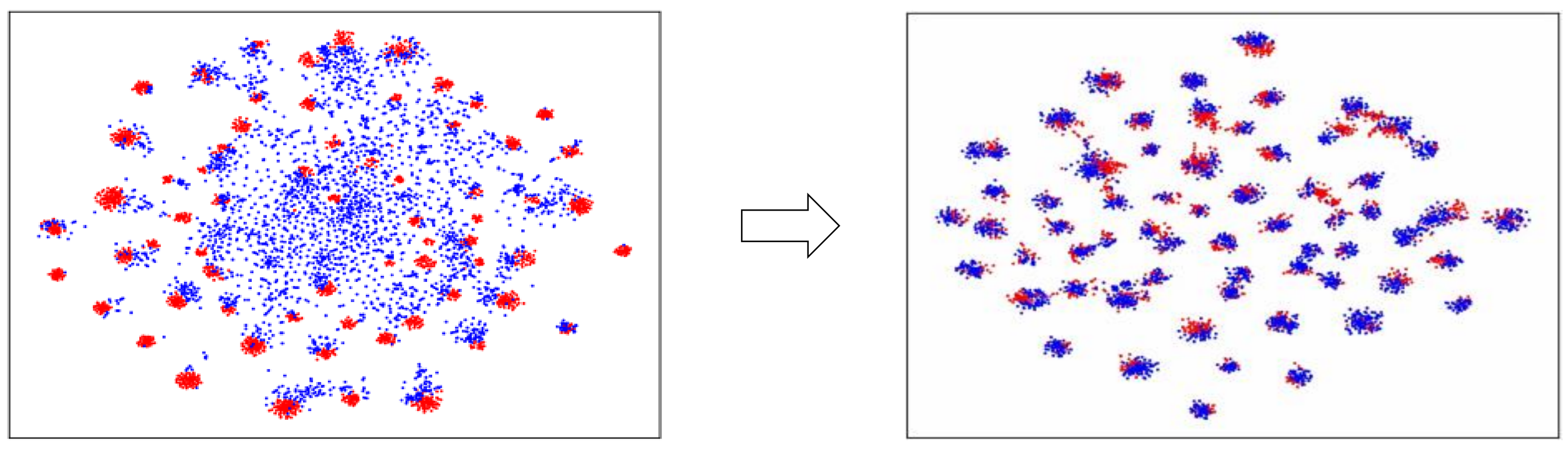
$$\mathcal{L}_{mix} = \mathbb{E}_{x_i, x_j \in \mathcal{X}_t} l_{ce}((\lambda f_t^{'}(x_i) + (1-\lambda) f_t^{'}(x_j)), f_t(\lambda x_i) + (1-\lambda) x_j)$$

RESULT

➢ **The comparison between our method and other methods on Office-Home.**

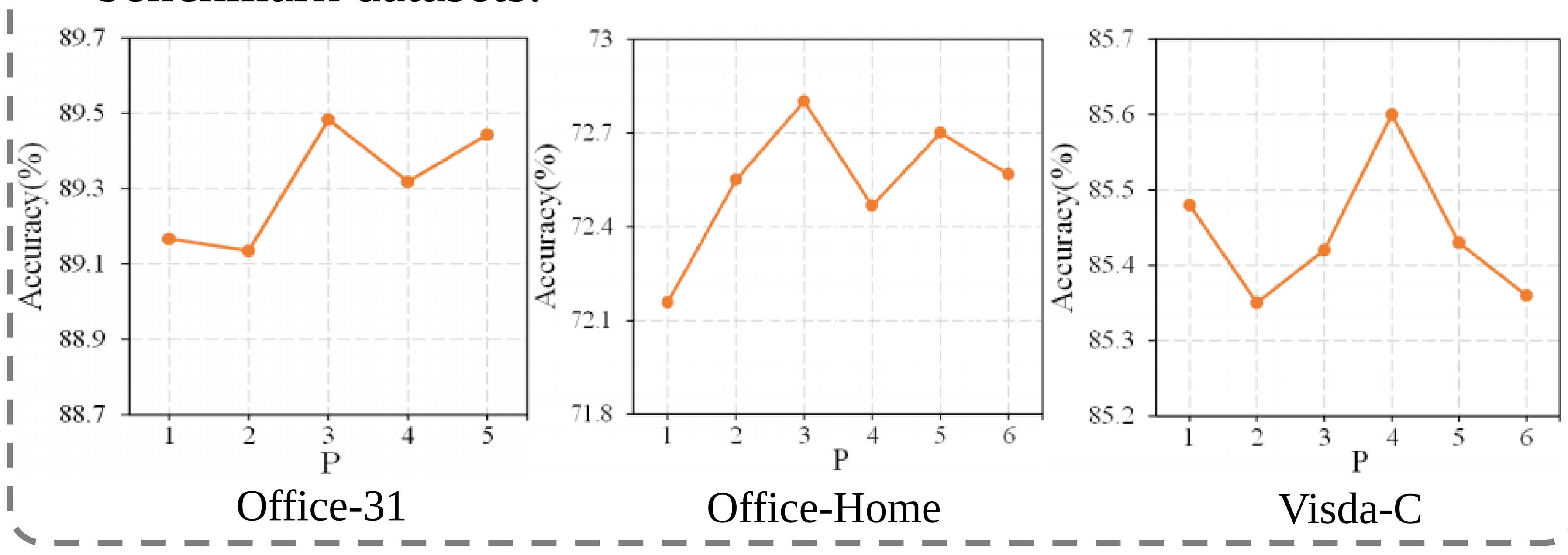
Method	SF	Ar→Cl	Ar→Pr	Ar→Re	Cl→Ar	Cl→Pr	Cl→Re	Pr→Ar	Pr→Cl	Pr→Re	Re→Ar	Re→Cl	Re→Pr	Avg.
ResNet-50(2016)	✗	34.9	50.0	58.0	37.4	41.9	46.2	38.5	31.2	60.4	53.9	41.2	59.9	46.1
CDAN(2018b)	✗	50.7	70.6	76.0	57.6	70.0	70.0	57.4	50.9	77.3	70.9	56.7	81.6	65.8
BNM(2020)	✗	52.3	73.9	80.0	63.3	72.9	74.9	61.7	49.5	79.7	70.5	53.6	82.2	67.9
SAFN(2019)	✗	52.0	71.7	76.3	64.2	69.9	71.9	63.7	51.4	77.1	70.9	57.1	81.5	67.3
SRDC(2020)	✗	52.3	76.3	81.0	69.5	76.2	78.0	68.7	53.8	81.7	76.3	57.1	85.0	71.3
LAMDA(2021)	✗	57.2	78.4	82.6	66.1	80.2	81.2	65.6	55.1	82.8	71.6	59.2	83.9	72.0
Source-only	✓	44.0	67.0	73.5	50.7	60.3	63.6	52.6	40.4	73.5	65.7	46.2	78.2	59.6
SFDA(2021)	✓	48.4	73.4	76.9	64.3	69.8	71.7	62.7	45.3	76.6	69.8	50.5	79.0	65.7
SHOT(2020a)	✓	57.1	78.1	81.5	68.0	78.2	78.1	67.4	54.9	82.2	73.3	58.8	84.3	71.8
BAIT(2020)	✓	57.4	77.5	**82.4**	68.0	77.2	75.1	67.1	55.5	81.9	73.9	59.5	84.2	71.6
G-SFDA(2021b)	✓	57.9	78.6	81.0	66.7	77.2	77.2	65.6	56.0	82.2	72.0	57.8	83.4	71.3
NRC(2021a)	✓	57.7	**80.3**	82.0	**68.1**	**79.8**	78.6	65.3	56.4	**83.0**	71.0	58.7	**85.6**	72.2
BNM-S(2021)	✓	57.4	77.8	81.7	67.8	77.6	**79.3**	67.6	55.7	82.2	73.5	59.5	84.7	72.1
ours	✓	**58.1**	78.5	82.1	67.9	79.1	78.8	**69.0**	**57.9**	82.3	**75.2**	**60.0**	84.7	**72.8**

➢ **The t-SNE feature visualizations on Office-Home.**



➡ Our model achieves the best performance on Office-Home and is higher than the second-best NRC [2] by a margin of 0.6% and reduces the discrepancy between two different domains without source data effectively.

☐ Ablation study of **the number of clustering centers P** on three benchmark datasets.



CONCLUSION

In this paper, we have proposed a polycentric clustering and structure regularization (PCSR) strategy for source-free domain adaptation. Specifically different from the previous monocentric clustering, our PCSR strategy reduced the negative transfer of hard data in the target domain by considering intra-class polycentric clustering through inter-class-balanced sampling.

In the future, we intend to apply the method to other vision tasks, such as semantic segmentation and target detection.

REFERENCE

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