Adaptive SVM+: Learning with Privileged Information for Domain Adaptation

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Introduction

Problem Statement

- Transfer privileged knowledge between source and target domains to improve visual recognition

Motivation

- Leverage privileged information in a domain adaptation setup

Contributions

- Proposed an adaptive learning framework to cope with privileged information in the target domain
- Incorporated information from the source domain as privileged information

Background

Adaptive SVM

$$\underset{w,b}{\text{minimize}}\left\{\frac{1}{2}(||w||^2) + C\sum_{i=1}^{N}\xi_i\right\}$$
$$\text{s.t. } y_i f^s(x_i) + y_i w^T\langle x_i, x_i\rangle \geq 1 - \xi_i,$$
$$\xi_i \geq 0, \qquad i = 1, \dots, N$$

SVM+

$$\underset{w,b,w^*,b^*}{\text{minimize}}\left\{\frac{1}{2}(||w||^2+\gamma||w^*||^2) + C\sum_{i=1}^{N}(\langle w^*, x_i^*\rangle + b^*)\right\}$$
$$\text{s.t. } y_i(\langle w, x_i\rangle + b) \geq 1 - (\langle w^*, x_i^*\rangle + b^*),$$
$$(\langle w^*, x_i^*\rangle + b^*) \geq 0, \qquad i = 1, \dots, N$$

Method

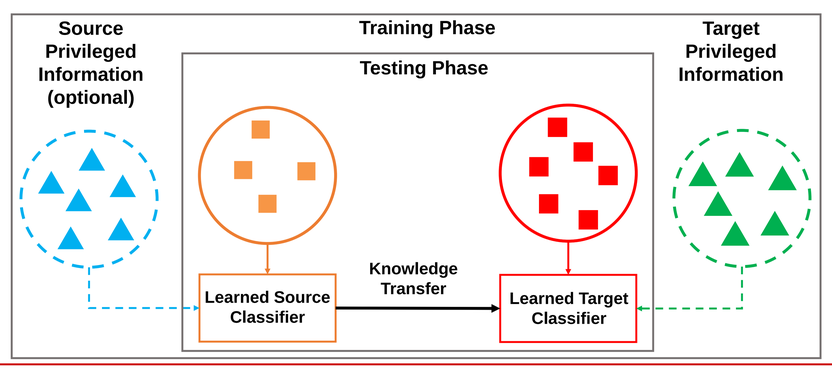
Adaptive SVM+

$$\underset{w,b,w^*,b^*}{\text{minimize}}\left\{\frac{1}{2}(||w||^2+\gamma||w^*||^2) + C\sum_{i=1}^{N}(\langle w^*, x_i^*\rangle + b^*)\right\}$$
$$\text{s.t. } y_i f^s(x_i) + y_i(\langle w, x_i\rangle + b) \geq 1 - (\langle w^*, x_i^*\rangle + b^*),$$
$$(\langle w^*, x_i^*\rangle + b^*) \geq 0, \qquad i = 1, \dots, N$$

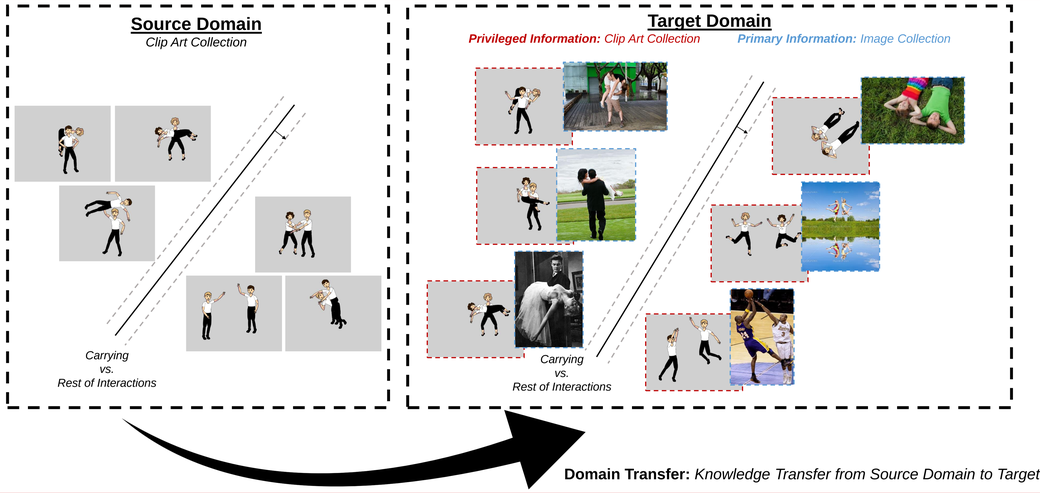
Decision function of Adaptive SVM+

$$\boldsymbol{f(x)} = \boldsymbol{f^s(x)} + \sum_{i=1}^{N} y_i a_i \mathrm{K}(x_i, x) + b = \sum_{i=1}^{N} y_i^s a_i^s \mathrm{K}(x_i^s, x) + b^s + \sum_{i=1}^{N} y_i a_i \mathrm{K}(x_i, x) + b$$

Training and testing phases of Adaptive SVM+



Overview



Domain Transfer: *Knowledge Transfer from Source Domain to Target Domain*

Results

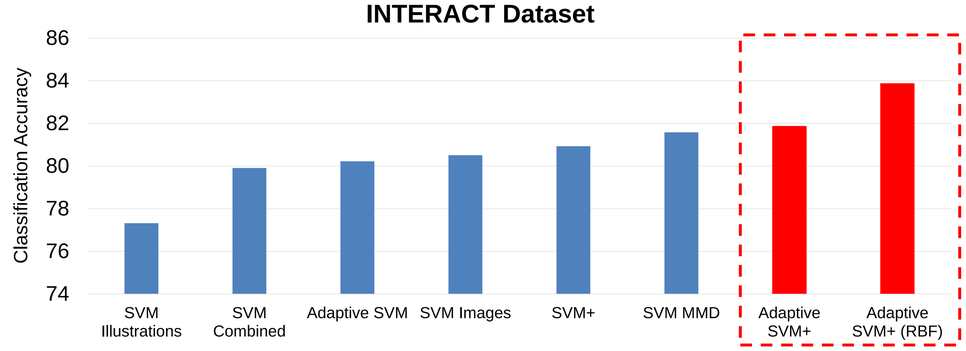
Animals with Attributes Dataset

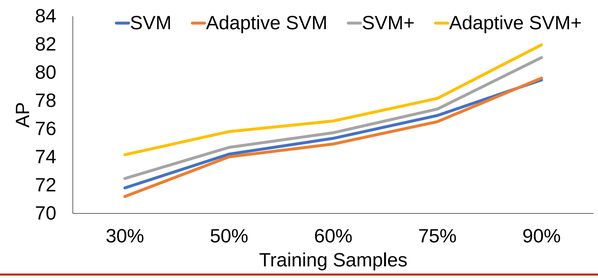
Method	AP
SVM	87.32
SVM+ [1]	87.58
Adaptive SVM [2]	87.94
RankTr [3]	87.93
LIR [4]	88.13
LMIBPI [5]	88.38
Adaptive SVM+	**88.66**

Animals with Attributes Dataset

Method (Domain)	AP
SVM (easy)	87.32
SVM+ (easy)	87.58
SVM (hard)	87.94
Adaptive SVM (hard)	87.93
SVM+ (hard)	88.13
Adaptive SVM+ (hard)	**88.66**

INTERACT Dataset





Key Takeaway

Embedding the LUPI paradigm in a domain adaptation setup improves the recognition performance up to 3% in both the Animals with Attributes and INTERACT datasets.

References

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[4] Z. Wang and Q. Ji. Classifier learning with hidden information. In Proc. IEEE Conference on Computer Vision and Pattern Recognition, Boston, MA, June 2015.
[5] S. Motiian, M. Piccirilli, D. Adjeroh, and G. Doretto. Information bottleneck learning using privileged information for visual recognition. In Proc. IEEE Conference on Computer Vision and Pattern Recognition, Las Vegas, NV, June 2016.

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