



Semi-supervised Person Re-identification by Attribute Similarity Guidance

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Introduction

- Goal
- ✓ Study the semi-supervised person re-identification (Re-ID)
- ✓ Exploit pedestrian attribute annotation as auxiliary information.

Advantages of attribute

- ✓ Easily labeled
- ✓ Provide coarse semantic knowledge of the degree of similarity between different persons



Introduction

Challenge

Ambiguity: different persons may have very similar attributes.



Introduction

- Our method
- ✓ An attribute Similarity Guidance loss (ASG) with the constraint of selective attribute similarity preservation
- ✓ An attribute-guided self training framework



Methodology

- **Attribute Network Pretraining** ullet
- **Guiding RE-ID Network using Attribute Similarity** •

Attribute similarity guidance loss with the constraint of selective attribute similarity preservation

similarity preservation

$$\min \left| s_{a,i}^{R} / s_{a,j}^{R} - s_{a,i}^{A} / s_{a,j}^{A} \right|$$

$$L_{asg} = \begin{cases} \sum_{(a,i,j) \in \mathbb{N}} \left| \frac{s_{a,i}^{R}}{s_{a,j}^{R}} - \frac{s_{a,i}^{A}}{s_{a,j}^{A}} \right|, (s_{a,i}^{R} - s_{a,j}^{R})(s_{a,i}^{A} - s_{a,j}^{A}) < 0, \\ 0, (s_{a,i}^{R} - s_{a,j}^{R})(s_{a,i}^{A} - s_{a,j}^{A}) \ge 0, \end{cases}$$
selective attribute



Methodology

• Attribute-Guided Self Training Framework

$$\checkmark \text{ Memory-based feature learning}$$

$$L^{m} = -\log \frac{\sum_{\substack{\mathbf{v}_{j}^{u} \in K_{i}^{u}}} e^{-s \|f^{R}(\mathbf{x}_{i}^{u}) - \mathbf{v}_{j}^{u}\|_{2}^{2}}}{\sum_{j=1, j \neq i}^{n_{u}} e^{-s \|f^{R}(\mathbf{x}_{i}^{u}) - \mathbf{v}_{j}^{u}\|_{2}^{2}} + \sum_{\substack{\mathbf{v}_{j}^{l} \in K_{i}^{l}}} e^{-s \|f^{R}(\mathbf{x}_{i}^{u}) - \mathbf{v}_{j}^{l}\|_{2}^{2}}}$$

✓ Clustering-based feature learning. $L^{c} = \left[\|f^{R}(\mathbf{x}_{a}^{u}) - f^{R}(\mathbf{x}_{p}^{u})\|_{2}^{2} - \|f^{R}(\mathbf{x}_{a}^{u}) - f^{R}(\mathbf{x}_{n}^{u})\|_{2}^{2} + m \right]_{+} \\ + \left[\|f^{R}(\mathbf{x}_{a}^{u}) - f^{R}(\mathbf{x}_{p}^{u})\|_{2}^{2} - \|f^{R}(\mathbf{x}_{a}^{u}) - f^{R}(\mathbf{x}_{n}^{l})\|_{2}^{2} + m \right]_{+}$

✓ Dynamic Weighted Optimizing.

$$L_{se} = \frac{1}{U} \sum_{i=1}^{U} L_i^m + \frac{1}{U} \sum_{a=1}^{U} L_a^c$$

 $L = aL_{guide} + (1-a)L_{se}$

Results

• Experiment setting

randomly selected 40 identities as labeled data and the remaining identities served as unlabeled data

• Comparison with related methods

source dataset	Market-1501				
target dataset	DukeMTMC				
Methods	labeled IDs	R -1	R-5	R-10	mAP
LSRO [6]	40 IDs	27.1	40.3	47.0	9.0
All-in-one [27]	40 IDs	43.5	58.3	64.3	21.1
Pseudo label [22]	40 IDs	45.2	60.2	66.7	23.5
TCP [3]	40 IDs	65.8	78.2	82.5	44.4
EDS [5]	40 IDs	66.1	78.6	82.1	44.3
PAUL [12]	40 IDs	61.9	74.6	78.9	40.3
SSG [15]	40 IDs	73.8	83.0	86.7	54.3
Ours	40 IDs	75.2	84.0	87.2	55.9
source dataset		Duke	MTMC		
source dataset target dataset		Duke Mark	MTMC et-1501		
source dataset target dataset Methods	labeled IDs	Duke Mark R-1	MTMC et-1501 R-5	R-1 0	mAP
source dataset target dataset Methods LSRO [6]	labeled IDs 40 IDs	Duke Mark R-1 37.2	MTMC et-1501 R-5 54.1	R -10 60.7	mAP 12.6
source dataset target dataset Methods LSRO [6] All-in-one [27]	labeled IDs 40 IDs 40 IDs	Duke Mark R-1 37.2 52.4	MTMC et-1501 R-5 54.1 69.6	R-10 60.7 75.6	mAP 12.6 21.3
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs	Duke Mark R-1 37.2 52.4 54.1	MTMC et-1501 R-5 54.1 69.6 71.7	R-10 60.7 75.6 78.1	mAP 12.6 21.3 24.4
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Duke Mark R-1 37.2 52.4 54.1 75.4	MTMC et-1501 R-5 54.1 69.6 71.7 88.8	R-10 60.7 75.6 78.1 92.6	mAP 12.6 21.3 24.4 48.1
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Duke Mark R-1 37.2 52.4 54.1 75.4 72.4	MTMC et-1501 R-5 54.1 69.6 71.7 88.8 87.2	R-10 60.7 75.6 78.1 92.6 90.7	mAP 12.6 21.3 24.4 48.1 45.0
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Duke Mark R-1 37.2 52.4 54.1 75.4 72.4 69.7	MTMC et-1501 R-5 54.1 69.6 71.7 88.8 87.2 82.9	R-10 60.7 75.6 78.1 92.6 90.7 87.7	mAP 12.6 21.3 24.4 48.1 45.0 41.2
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12] SSG [15]	Iabeled IDs 40 IDs	Duke Mark R-1 37.2 52.4 54.1 75.4 72.4 69.7 82.3	MTMC et-1501 R-5 54.1 69.6 71.7 88.8 87.2 82.9 92.0	R-10 60.7 75.6 78.1 92.6 90.7 87.7 94.5	mAP 12.6 21.3 24.4 48.1 45.0 41.2 61.6

source dataset	-				
target dataset	DukeMTMC				
Methods	labeled IDs	R-1	R-5	R-10	mAP
LSRO [6]	40 IDs	22.9	35.7	42.3	8.8
All-in-one [27]	40 IDs	32.5	48.6	56.7	16.7
Pseudo label [22]	40 IDs	40.6	56.5	63.8	21.3
TCP [3]	40 IDs	51.9	67.4	72.3	31.1
EDS [5]	40 IDs	53.2	68.2	73.8	30.1
PAUL [12]	40 IDs	51.1	67.5	73.9	29.7
SSG [15]	40 IDs	65.6	78.0	81.6	46.0
Ours	40 IDs	71.9	81.4	84.7	51.5
MVC [4]	1/3 of all IDs	55.7	-	-	37.8
Ours	1/3 of all IDs	76.7	86.3	88.6	58.1
source dataset		-	-		
source dataset target dataset		Marke	- t-1501		
source dataset target dataset Methods	labeled IDs	Marke	t-1501 R-5	R-1 0	mAP
source dataset target dataset Methods LSRO [6]	labeled IDs 40 IDs	Marke R-1 33.2	- t-1501 R-5 51.6	R-10 60.4	mAP 11.5
source dataset target dataset Methods LSRO [6] All-in-one [27]	labeled IDs 40 IDs 40 IDs	Marke R-1 33.2 44.4	- t-1501 R-5 51.6 66.0	R-10 60.4 73.9	mAP 11.5 19.2
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs	Marke R-1 33.2 44.4 46.7	t-1501 R-5 51.6 66.0 67.2	R-10 60.4 73.9 75.2	mAP 11.5 19.2 21.7
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Marke R-1 33.2 44.4 46.7 60.7	t-1501 R-5 51.6 66.0 67.2 77.2	R-10 60.4 73.9 75.2 83.1	mAP 11.5 19.2 21.7 32.1
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Marke R-1 33.2 44.4 46.7 60.7 50.3	t-1501 R-5 51.6 66.0 67.2 77.2 68.0	R-10 60.4 73.9 75.2 83.1 75.8	mAP 11.5 19.2 21.7 32.1 24.2
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12]	labeled IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs 40 IDs	Marke R-1 33.2 44.4 46.7 60.7 50.3 51.9	t-1501 R-5 51.6 66.0 67.2 77.2 68.0 68.3	R-10 60.4 73.9 75.2 83.1 75.8 75.0	mAP 11.5 19.2 21.7 32.1 24.2 24.4
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12] SSG [15]	Iabeled IDs 40 IDs	Marke R-1 33.2 44.4 46.7 60.7 50.3 51.9 70.9	t-1501 R-5 51.6 66.0 67.2 77.2 68.0 68.3 85.0	R-10 60.4 73.9 75.2 83.1 75.8 75.0 89.8	mAP 11.5 19.2 21.7 32.1 24.2 24.4 46.2
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12] SSG [15] Ours	labeled IDs 40 IDs	Marke R -1 33.2 44.4 46.7 60.7 50.3 51.9 70.9 78.1	t-1501 R-5 51.6 66.0 67.2 77.2 68.0 68.3 85.0 89.1	R-10 60.4 73.9 75.2 83.1 75.8 75.0 89.8 92.0	mAP 11.5 19.2 21.7 32.1 24.2 24.4 46.2 52.7
source dataset target dataset Methods LSRO [6] All-in-one [27] Pseudo label [22] TCP [3] EDS [5] PAUL [12] SSG [15] Ours MVC [4]	Iabeled IDs 40 IDs	Marke R-1 33.2 44.4 46.7 60.7 50.3 51.9 70.9 78.1 75.3	t-1501 R-5 51.6 66.0 67.2 77.2 68.0 68.3 85.0 89.1	R-10 60.4 73.9 75.2 83.1 75.8 75.0 89.8 92.0	mAP 11.5 19.2 21.7 32.1 24.2 24.4 46.2 52.7 52.6

Results

• Ablation study

source dataset	-		-	
target dataset	Market-1501		Dukel	MTMC
method	R -1	mAP	R-1	mAP
attribute net	50.5	26.8	44.0	23.0
reid net	60.4	34.3	51.2	30.2
reid net + ASG	65.3	37.3	57.6	36.3
reid net + ASG (w/o ASP)	57.0	30.6	48.3	27.4
reid net + ASG + SE	78.1	52.7	71.9	51.5

source dataset	DukeMTMC		Market-1501	
target dataset	Market-1501		DukeMTMC	
method	R-1	mAP	R -1	mAP
attribute net	62.4	34.9	57.9	36.8
reid net	71.7	44.2	63.8	42.4
reid net + ASG	73.6	45.3	65.8	44.5
reid net + ASG (w/o ASP)	72.0	43.6	64.0	42.8
reid net $+$ ASG $+$ SE	84.4	63.7	75.2	55.9

• Analysis on the number of known identities

source dataset	DukeMTMC		Market-1501		
target dataset	Market-1501		DukeMTMC		
known identities	R -1	mAP	R -1	mAP	
20	82.8	59.4	72.3	53.9	
40	84.4	63.7	75.2	55.9	
80	85.5	65.5	76.1	56.2	
fully supervised	93.3	78.3	83.9	70.3	