Survey on Image Classification in the Domain Mixture Scenario

Bachelor Thesis

TECHNISCHE UNIVERSITÄT DARMSTADT

REGELUNGSMETHODEN UND ROBOTIK rmr

Motivation

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Training Set

Test Set

Overview

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- Domain Adaptation
- Domain Mixture Scenario [1]
- Domain Separation Networks (DSN) [2]
- Experimental Setups
- Results
- Conclusion

Definitions

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Domain $\mathcal{D}_S$: A data space with an underlying data distribution.

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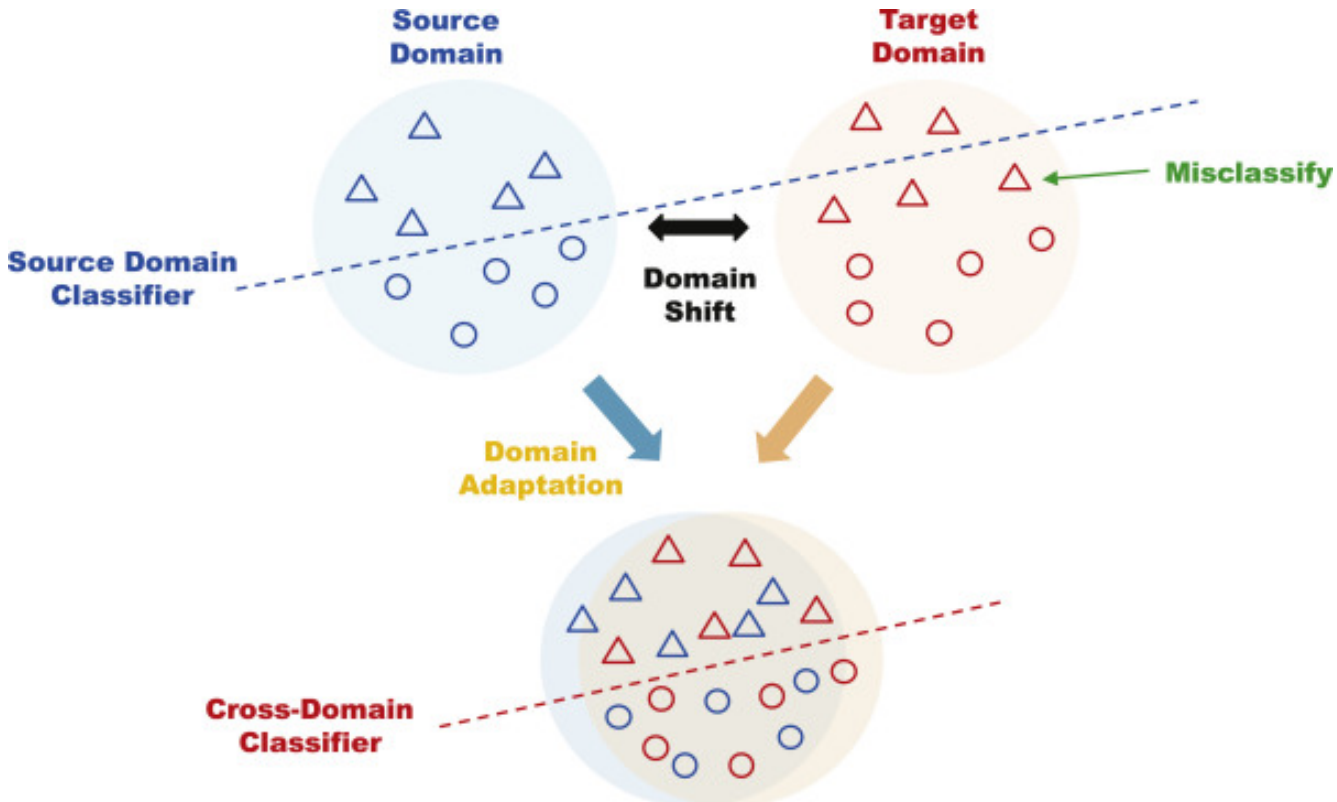
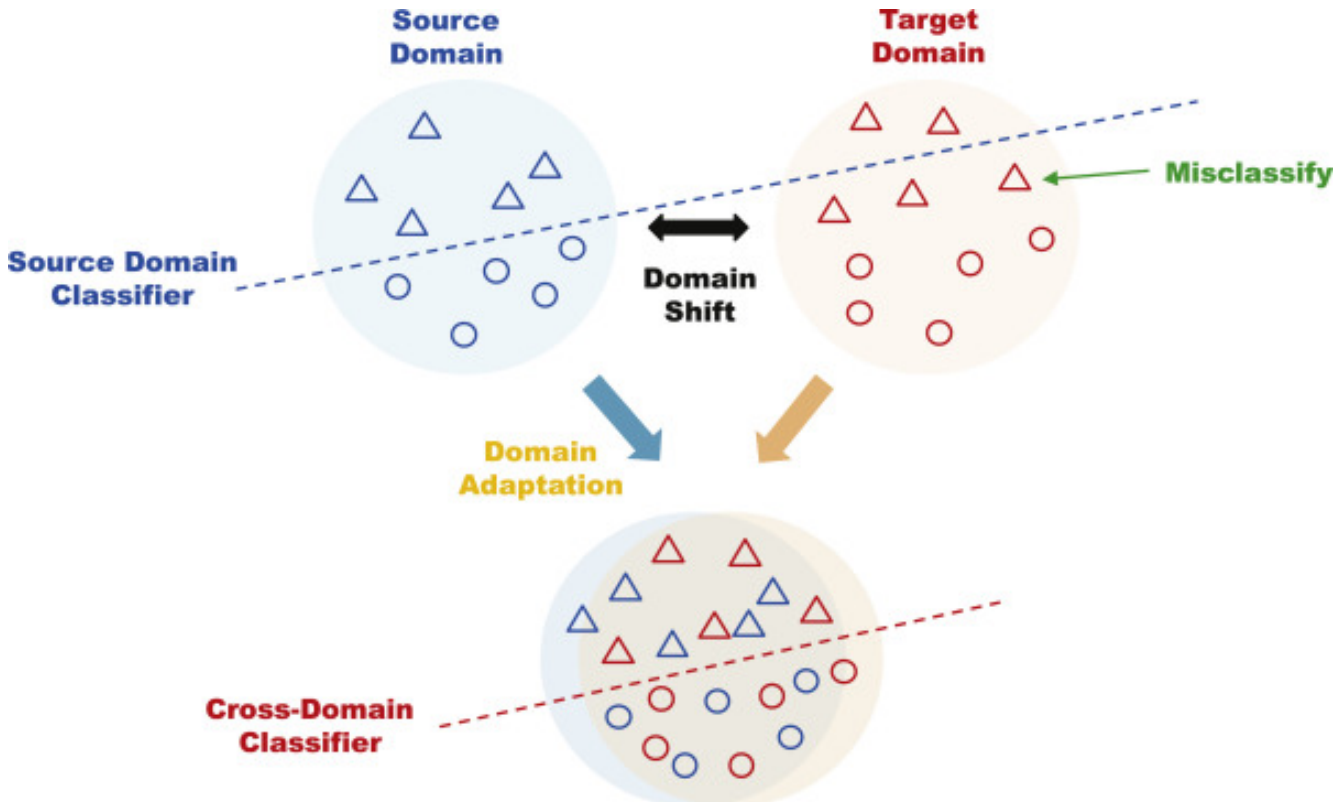
Target Domain $\mathcal{D}_T$: A domain on which the system should perform the task.

Domain A Domain B Domain C

Domain Adaptation



Domain Adaptation



Goal: Performing well on both domains

Scenarios of Domain Adaptation [1]

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I **Standard**

Domain	1	2	3	4
C	X	X	X	X
B	X	X	X	X
A	O	O	O	O

Class

II **Complete Domain Mixture**

Domain	1	2	3	4
C	X	O	X	X
B	X	O	O	X
A	O	X	X	O

Class

III **Sparse Domain Mixture**

Domain	1	2	3	4
C		O		X
B	X		O	
A	O			O

Class

O = supervised
X = unsupervised [1]

Complete Domain Mixture Scenario[1]

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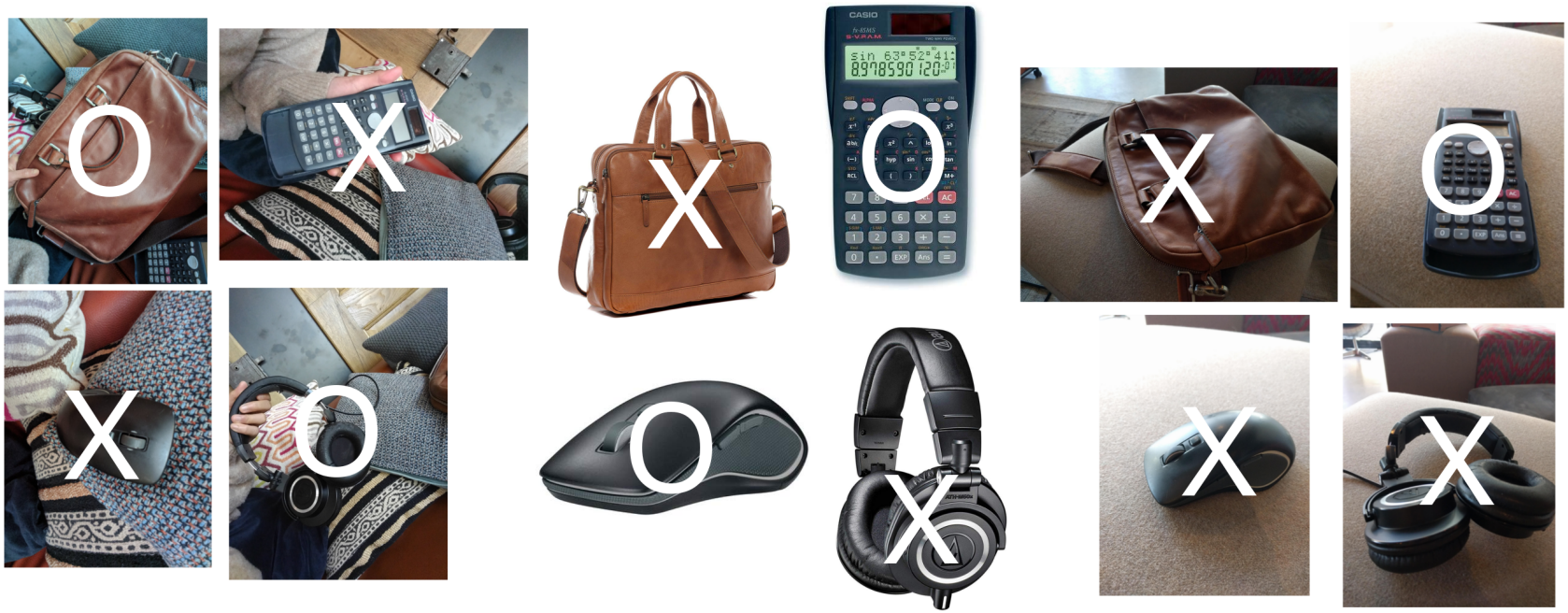

Domain A

Domain B

Domain C

O = supervised
X = unsupervised

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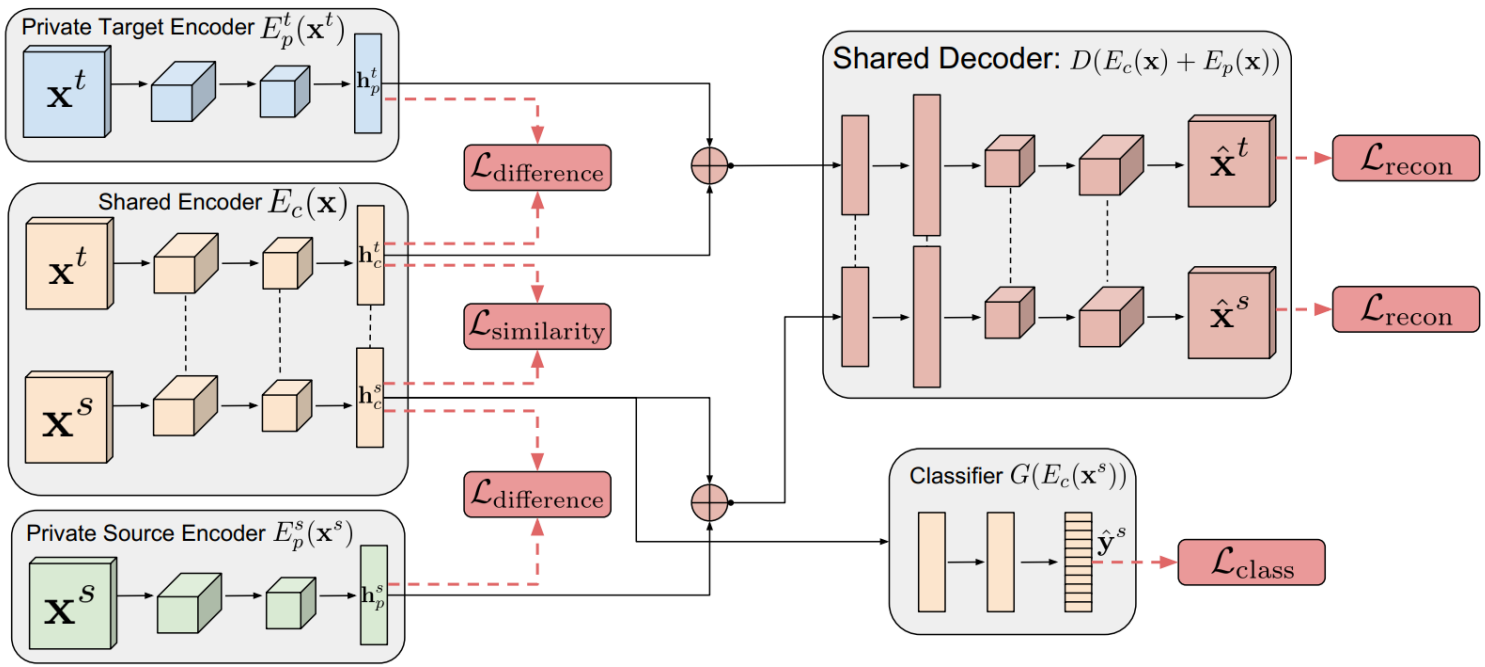
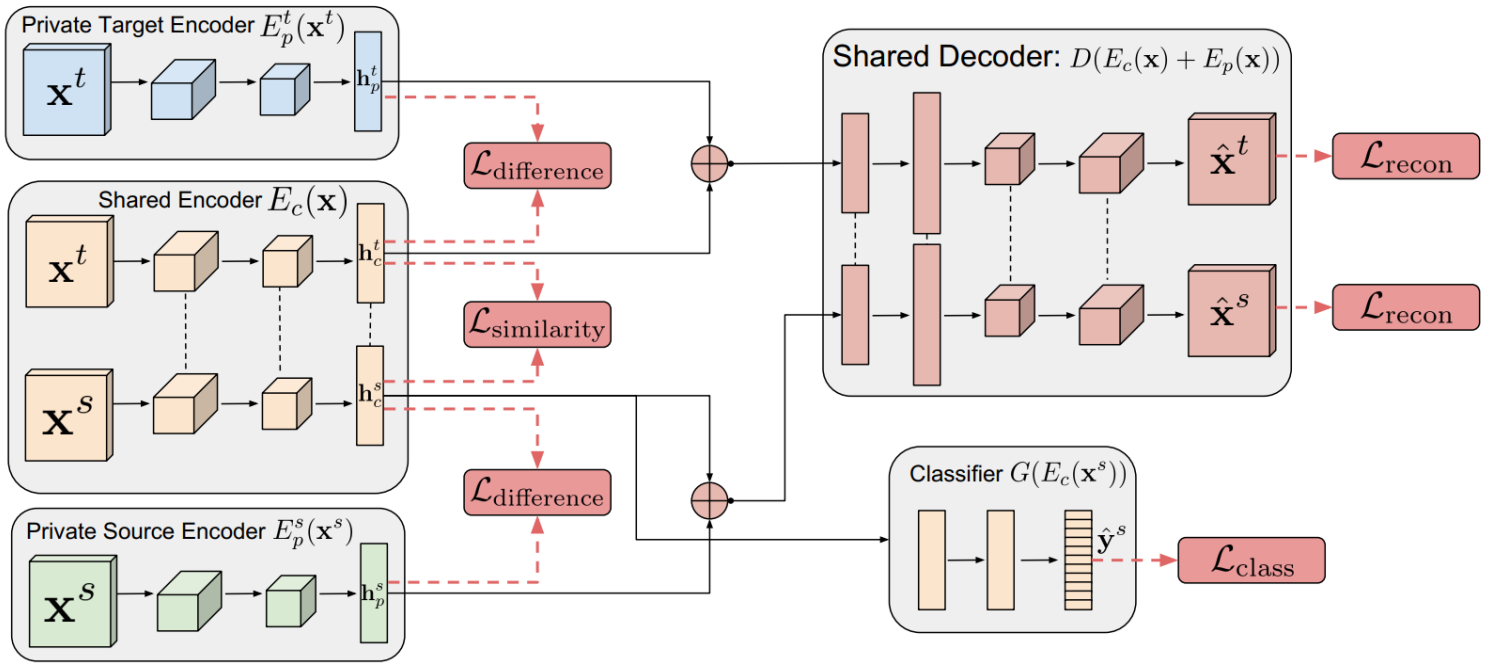
Domain Separation Networks (DSN) [2]

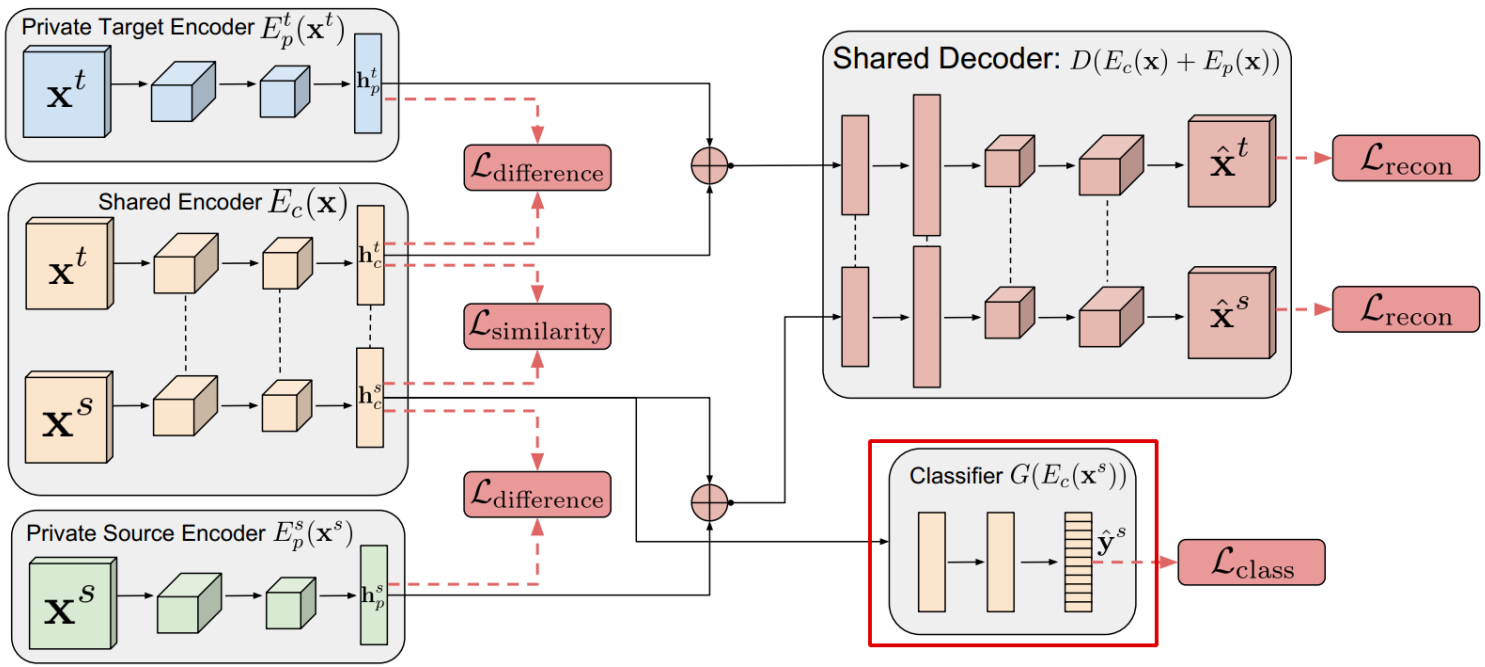


Domain Separation Networks (DSN) [2]



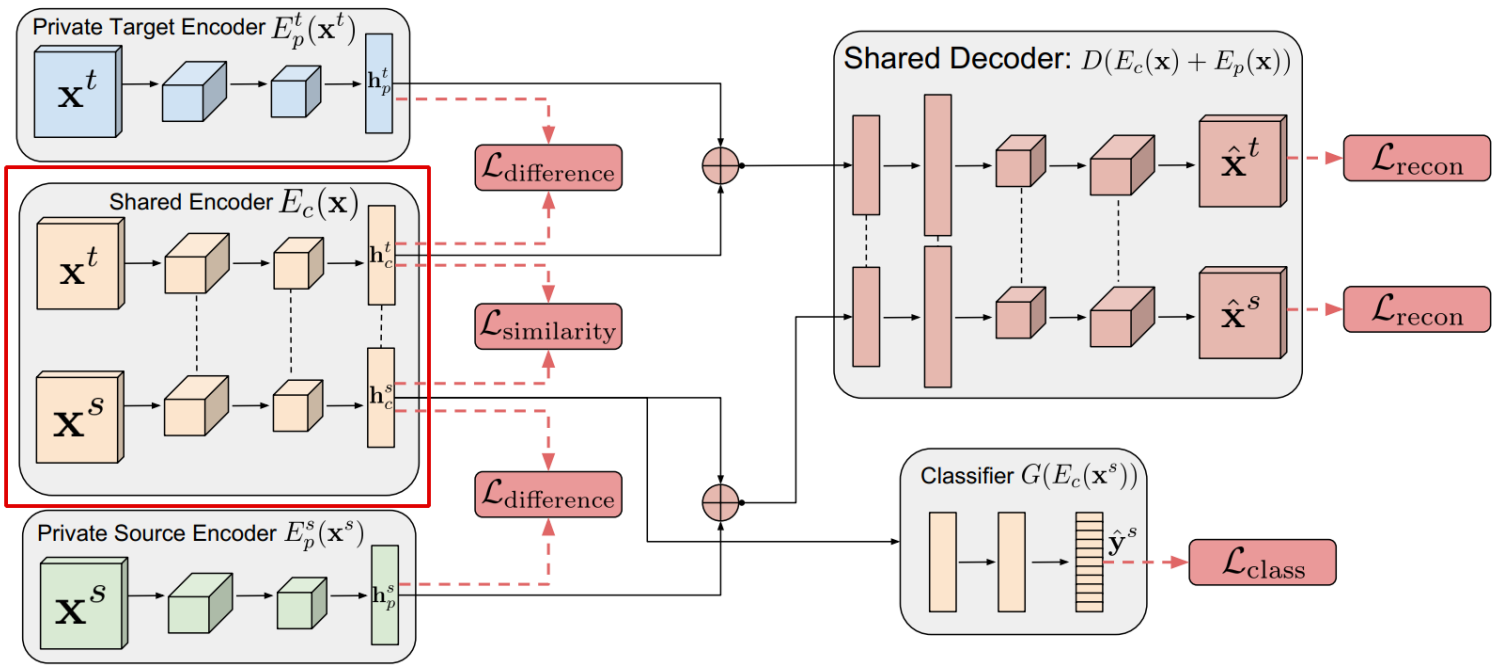
DSN =

Domain Separation Networks (DSN) [2]



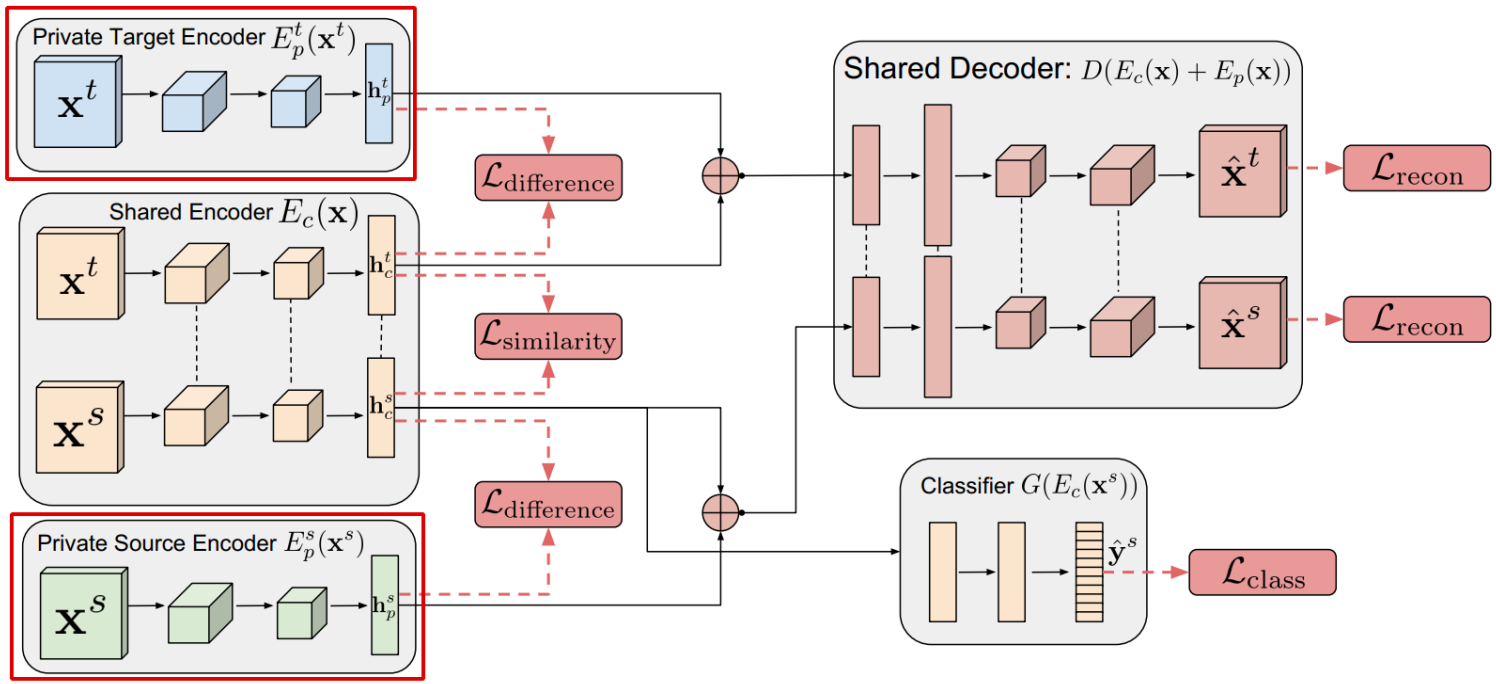
DSN = Classifier +

Domain Separation Networks (DSN) [2]



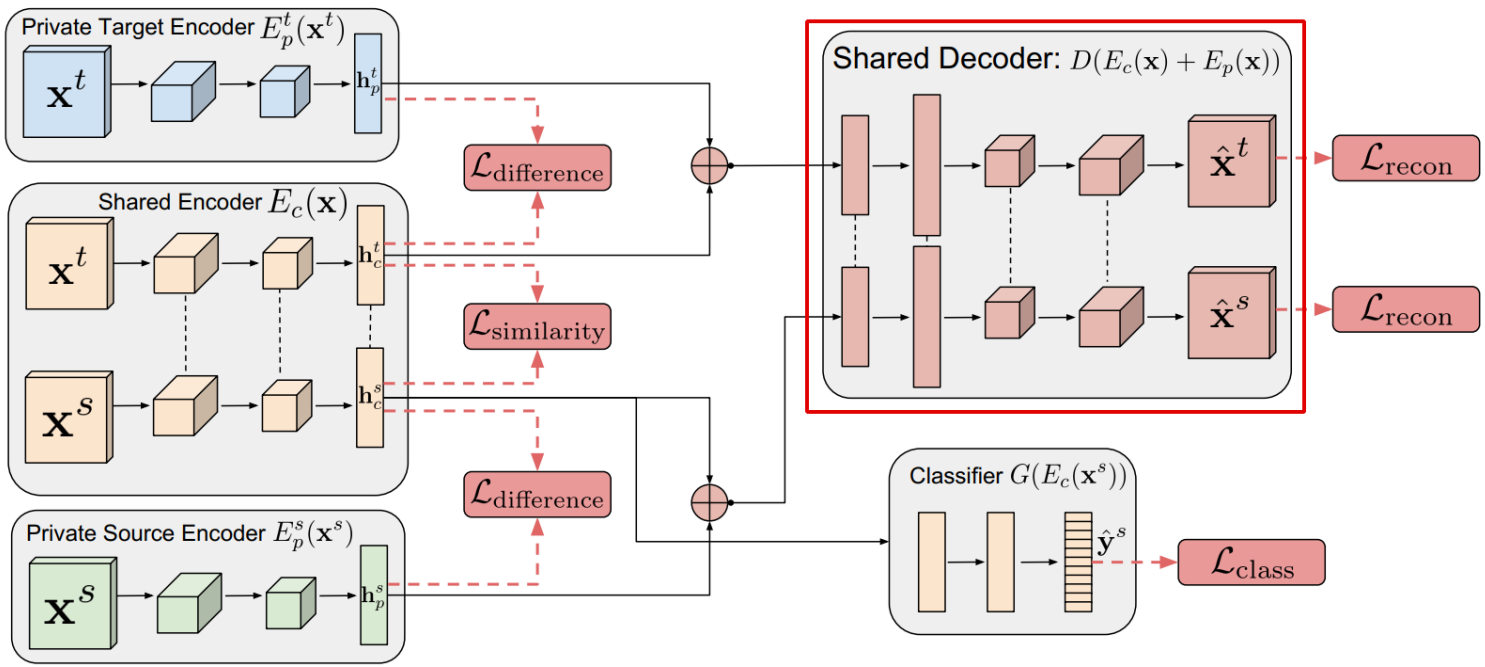
DSN = Classifier + Shared Encoder +

Domain Separation Networks (DSN) [2]



DSN = Classifier + Shared Encoder + Private Encoders +

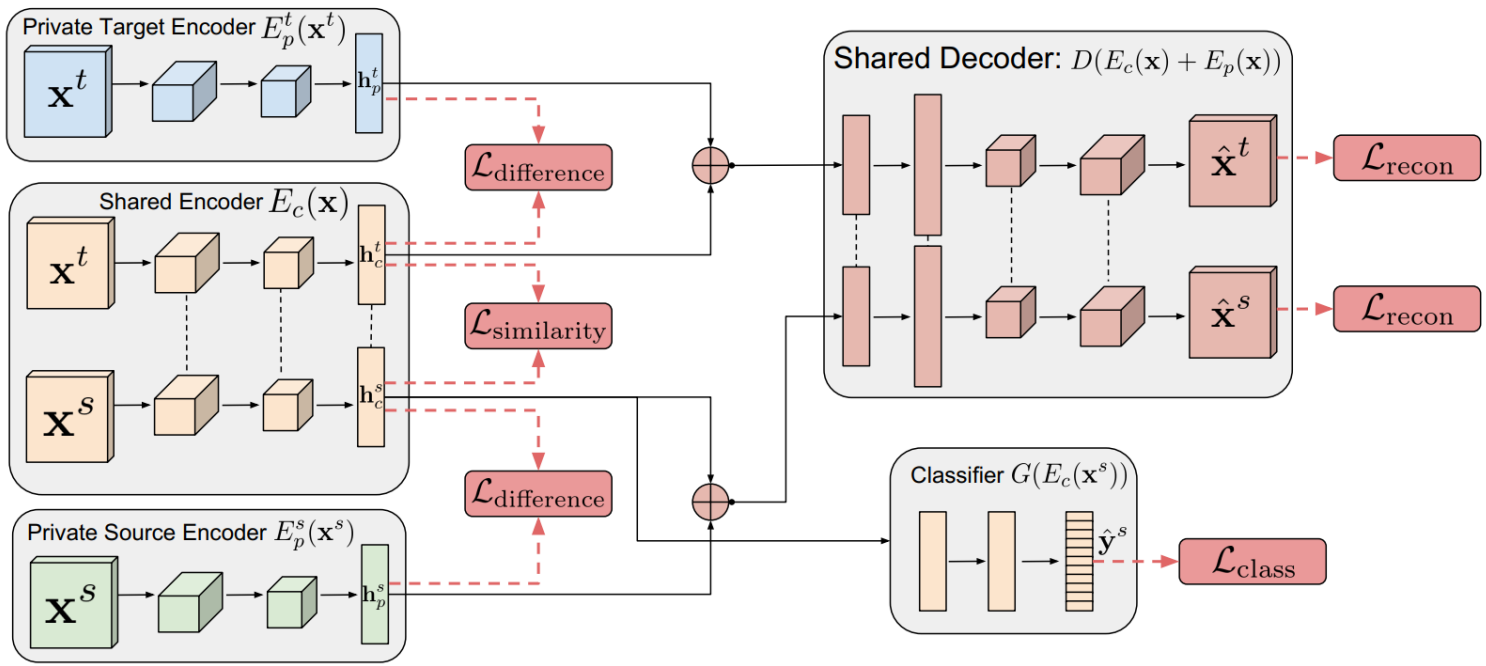
Domain Separation Networks (DSN) [2]



DSN = Classifier + Shared Encoder + Private Encoders + Decoder

DSN: Loss Functions

$$\mathcal{L} = \mathcal{L}_{Task} + \alpha\mathcal{L}_{recon} + \beta\mathcal{L}_{difference} + \gamma\mathcal{L}_{similarity}$$



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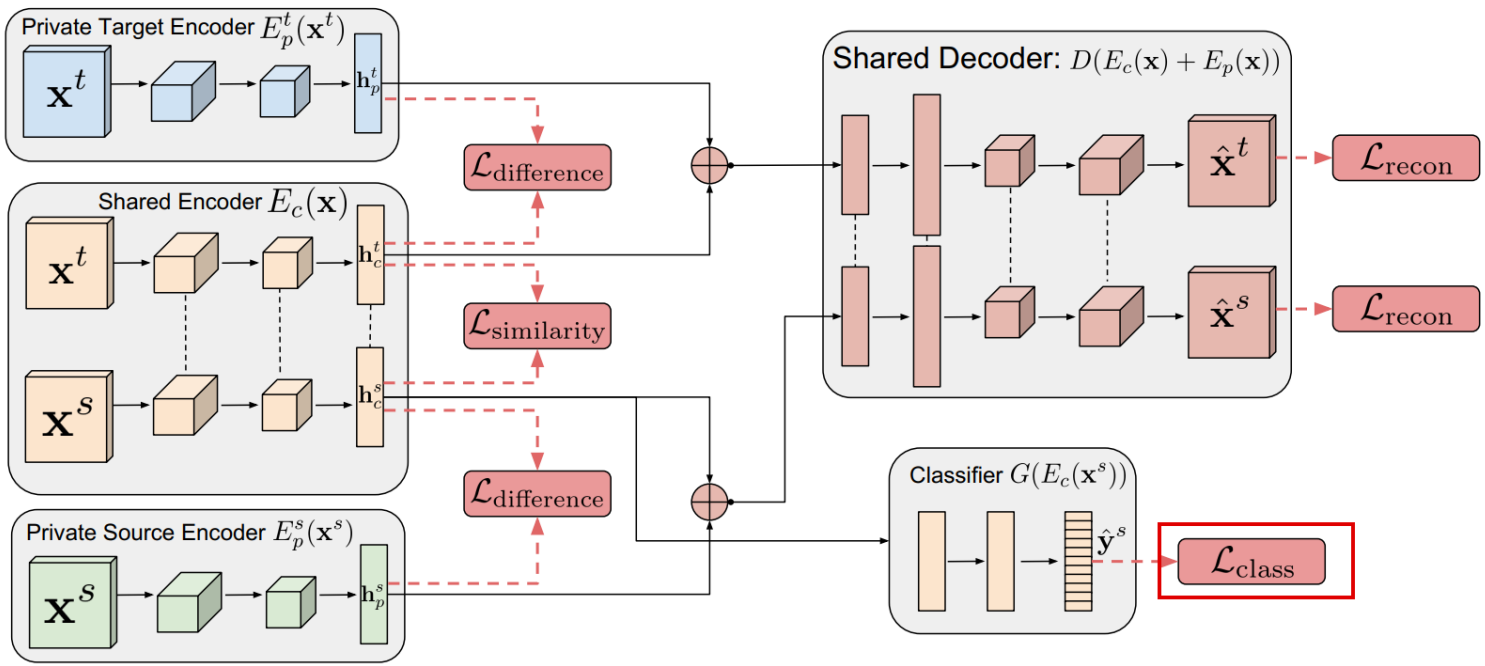

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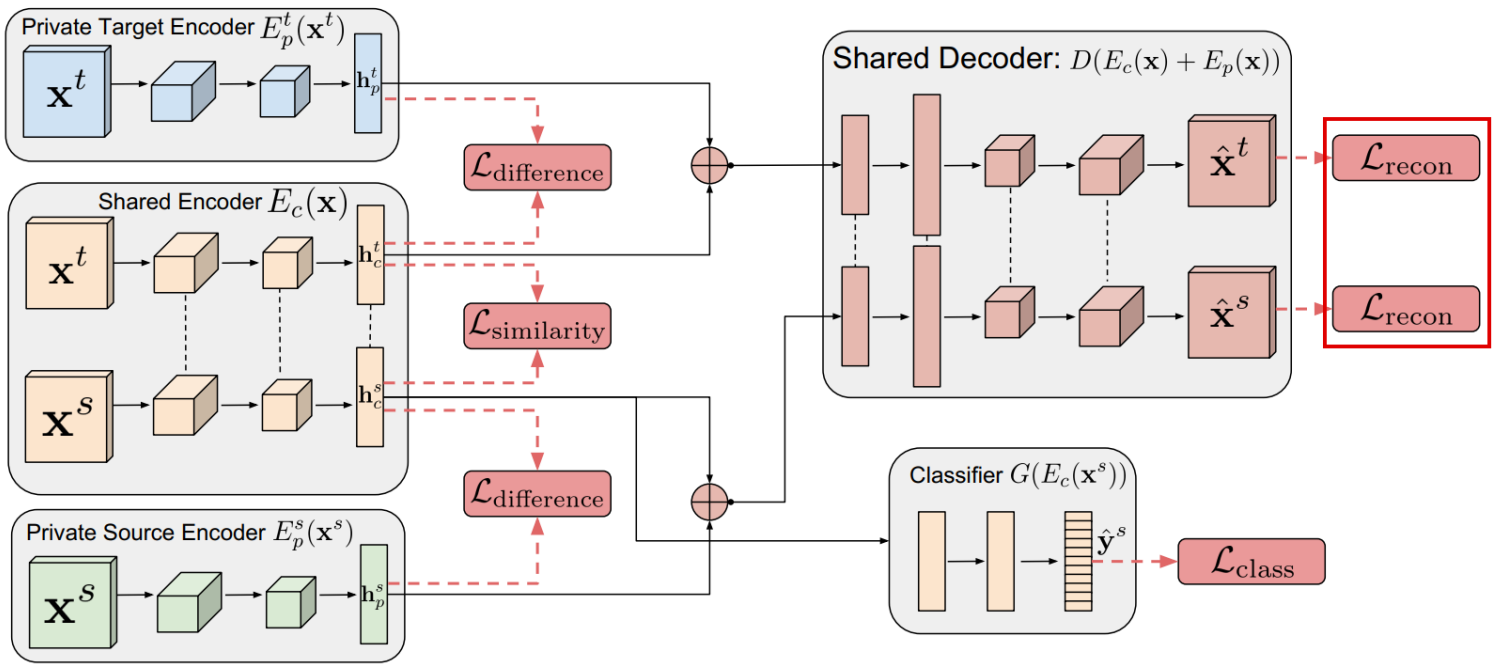

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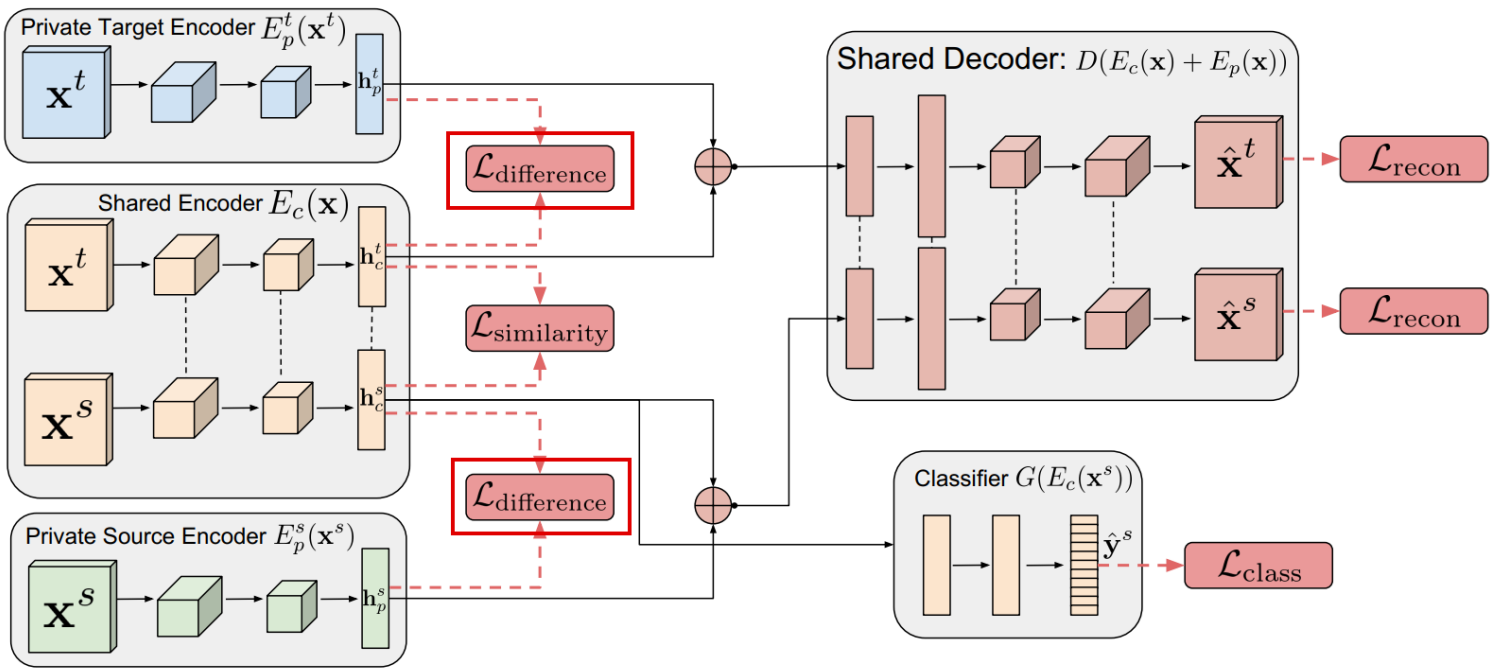

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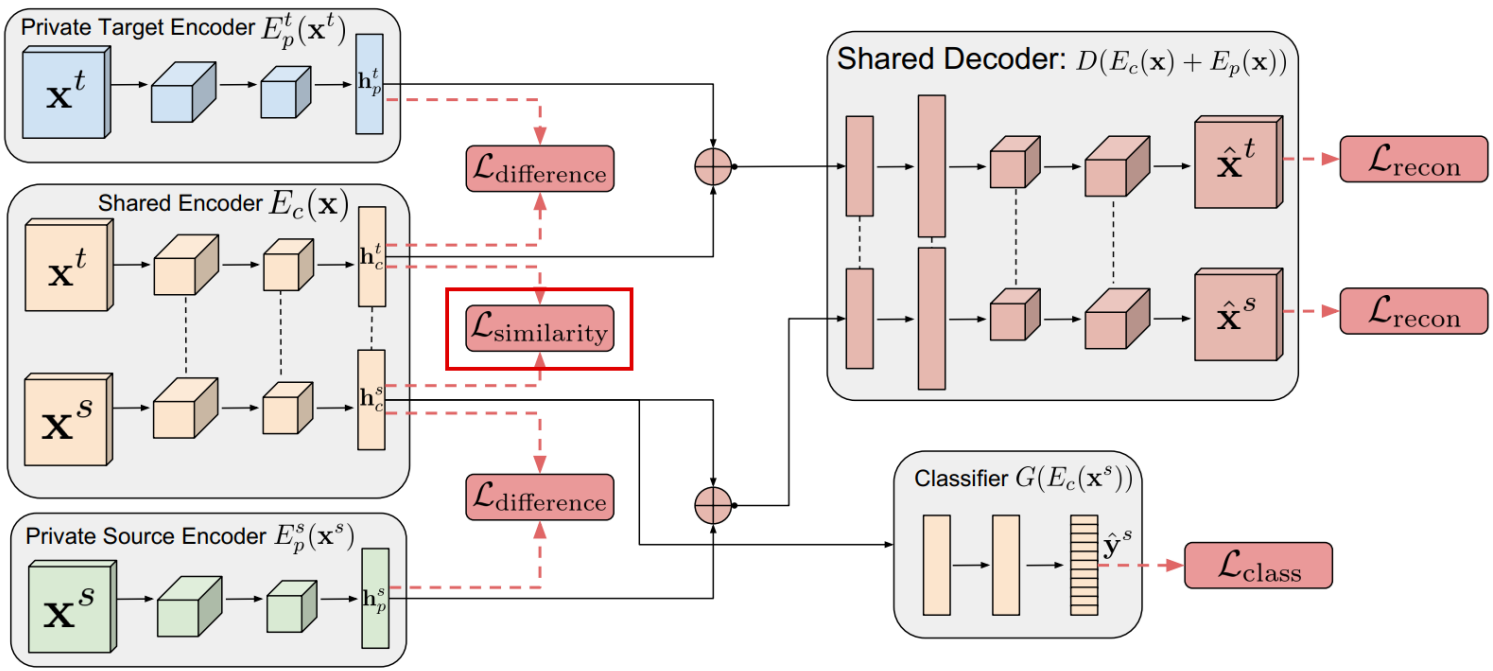

Datasets

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MNIST (S):

MNIST-M (M):

Experimental Setups

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Objectives:

Investigating the Complete Domain Mixture Scenario using DSN with different loss combinations

Experimental Setups

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Investigating the Complete Domain Mixture Scenario using DSN with different loss combinations

Procedures:

- Different mixtures in the Complete Domain Mixture Scenario
- Different loss combinations of the DSN
- Each cases 10 runs

Experimental Setups: Example

supervised

unsupervised

Training Set

Test Set

Number of supervised class $m = 6$

Experimental Setups

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$$\mathcal{L} = \mathcal{L}_{Task} + \alpha\mathcal{L}_{recon} + \beta\mathcal{L}_{difference} + \gamma\mathcal{L}_{similarity}$$

Experimental Setups

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$$\mathcal{L} = \mathcal{L}_{Task} + \alpha\mathcal{L}_{recon} + \beta\mathcal{L}_{difference} + \gamma\mathcal{L}_{similarity}$$

- DSN = all losses activated

Experimental Setups

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$$\mathcal{L} = \mathcal{L}_{Task} + \alpha\mathcal{L}_{recon} + \beta\mathcal{L}_{difference} + \gamma\mathcal{L}_{similarity}$$

- DSN = all losses activated
- noDA = no domain adaptation = no loss activated

Experimental Setups

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$$\mathcal{L} = \mathcal{L}_{Task} + \alpha\mathcal{L}_{recon} + \beta\mathcal{L}_{difference} + \gamma\mathcal{L}_{similarity}$$

- DSN = all losses activated
- noDA = no domain adaptation = no loss activated
- sim = only $\mathcal{L}_{similarity}$ activated

Experimental Setups

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Experimental Setups

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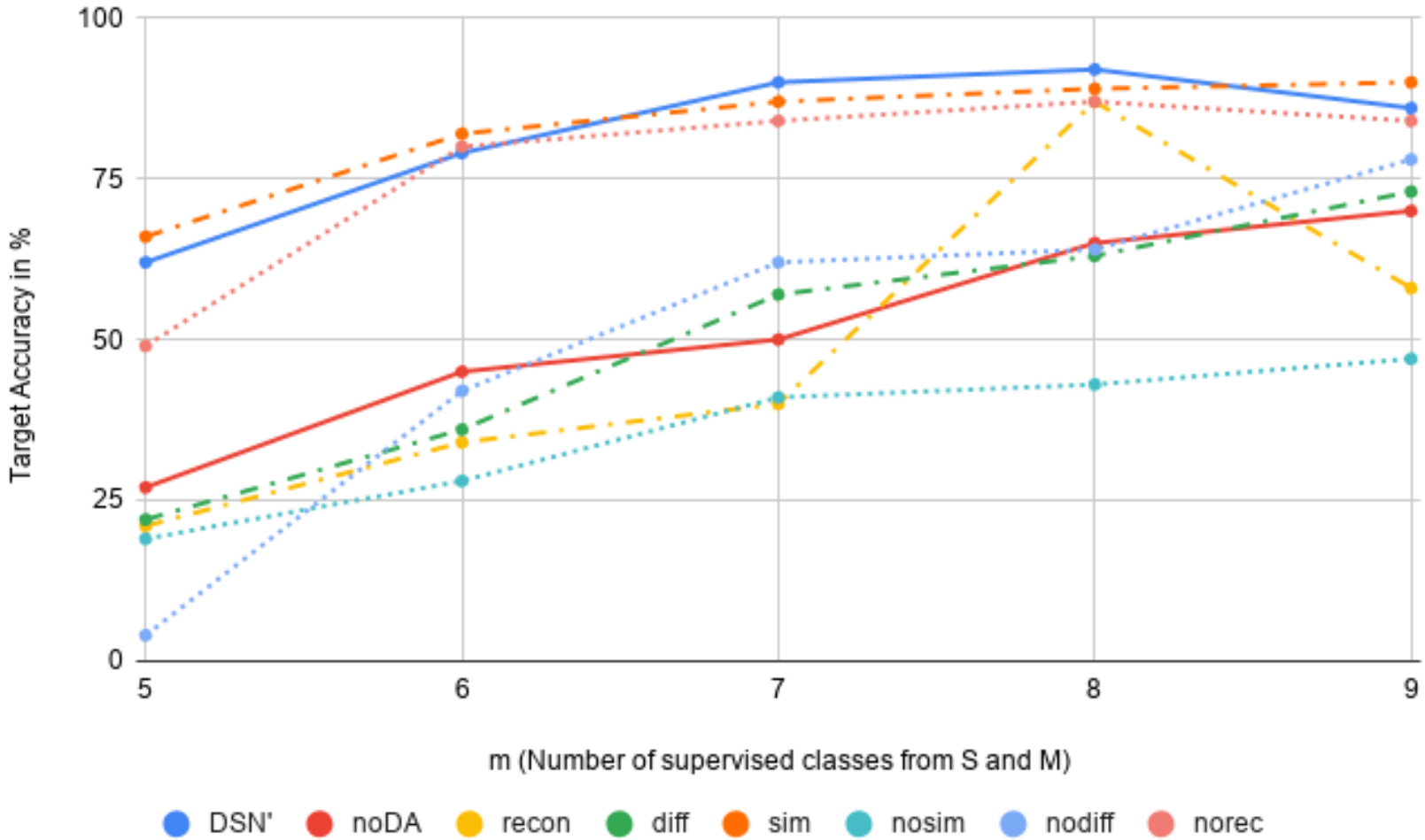
- ...

Results


100
75
50
25
0
Target Accuracy in %
5
6
7
8
9
m (Number of supervised classes from S and M)
DSN'
noDA
recon
diff
sim
nosim
nodiff
norec

Open Questions

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- Relatively big performance gap between $m = 5$ and $m = 6$

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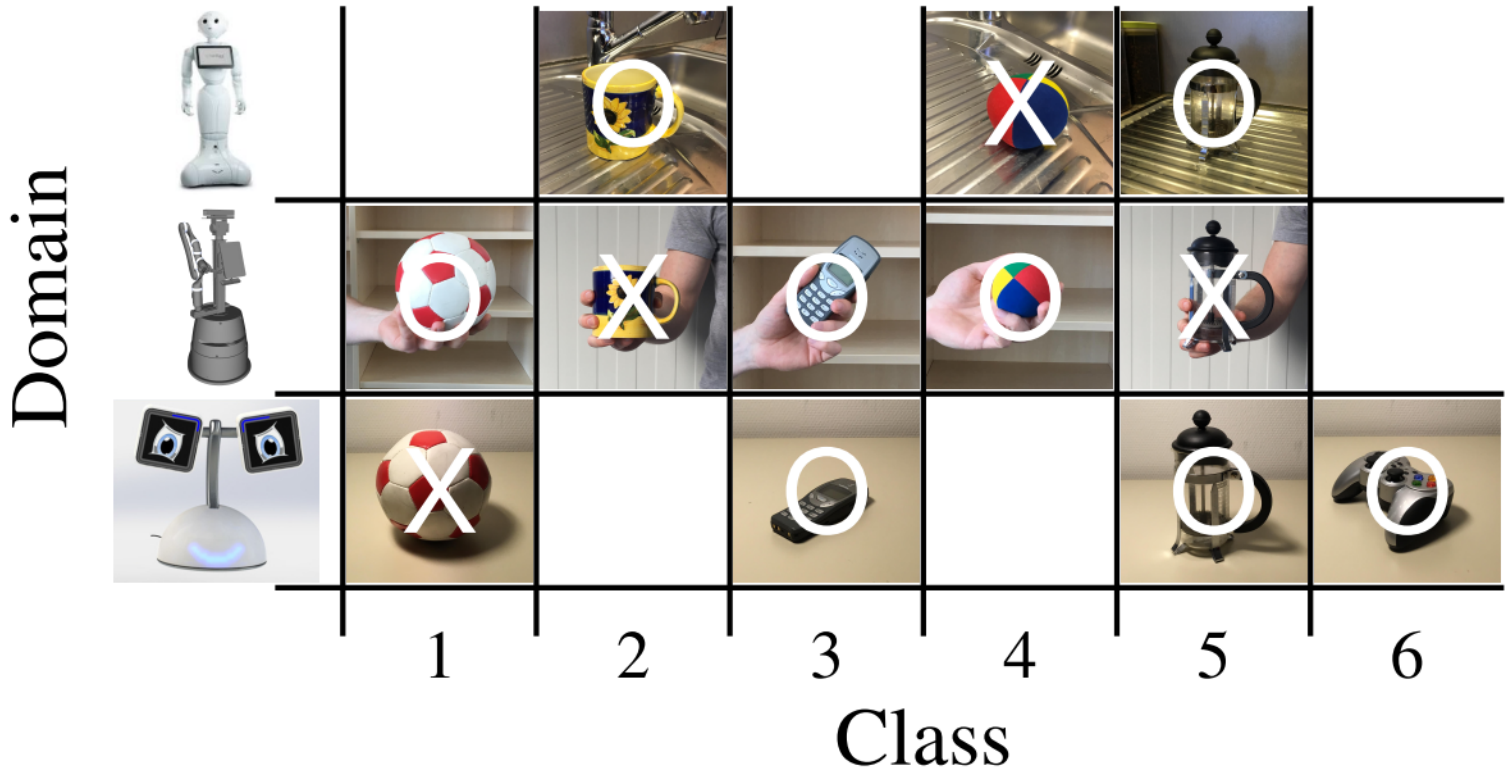
- Relatively big performance gap between $m = 5$ and $m = 6$
- Radical bad results in some runs within the same setup

Conclusion



[1]

Sources

[1] Schrom, Sebastian ; Hasler, Stephan: Domain Mixture: An Overlooked Scenario in Domain Adaptation, 2019

[2] Bousmalis, Konstantinos ; Trigeorgis, George ; Silberman, Nathan ; Krishnan, Dilip ; Erhan, Dumitru: Domain Separation Networks. In: CoRR abs/1608.06019 (2016). http://arxiv.org/abs/1608.06019

[3] Ganin, Yaroslav ; Ustinova, Evgeniya ; Ajakan, Hana ; Germain, Pascal ; Larochelle, Hugo; Laviolette, François ; Marchand, Mario ; Lempitsky, Victor S.: Domain-Adversarial Training of Neural Networks. In: J. Mach. Learn. Res. 17 (2015), S. 59:1–59:35

[4] Ding, Z. ; Shao, M. ; Fu, Y.: Incomplete Multisource Transfer Learning. In: IEEE Transactions on Neural Networks and Learning Systems 29 (2018), Feb, Nr. 2, S. 310–323. http://dx.doi.org/10.1109/TNNLS.2016.2618765. – DOI 10.1109/TNNLS.2016.2618765. – ISSN 2162–2388