Domain Adaptation

Hung-yi Lee 李宏毅

You have learned a lot about ML. Training a classifier is not a big deal for you. ☺

Training Data

Testing Data

99.5%

57.5%

The results are from: http://proceedings.mlr.press/v37/ganin15.pdf

Domain shift: Training and testing data have different distributions.

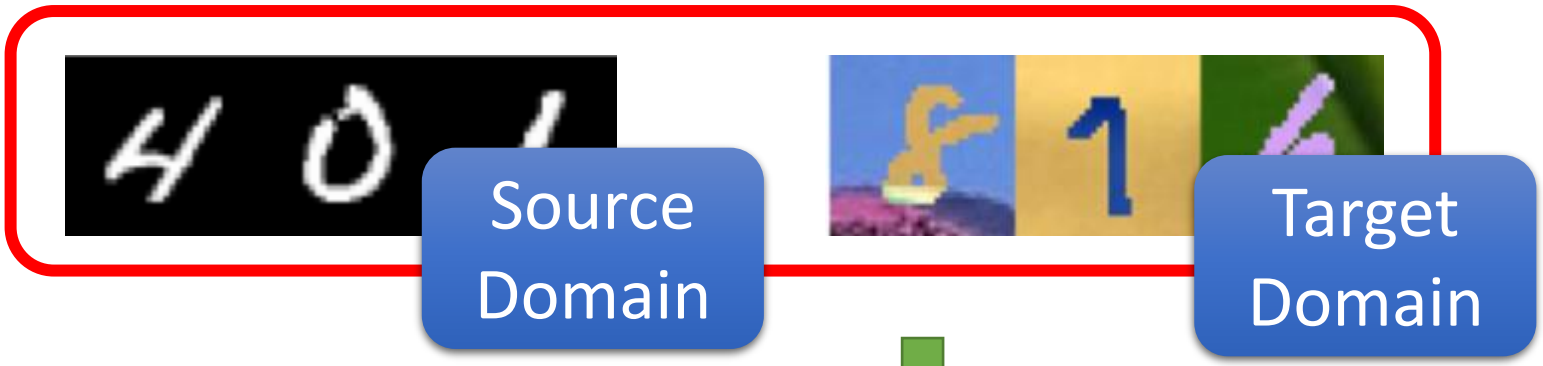
Domain adaptation

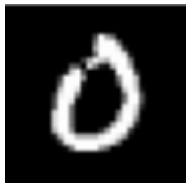
Transfer learning: https://youtu.be/qD6iD4TFsdQ

Domain Shift

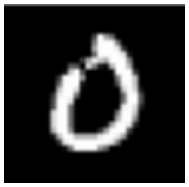
Training Data

Testing Data





This is “0”.



This is “1”.

Domain Adaptation

Source Domain
(with labeled data)

“4” “0” “1”

Knowledge of target domain

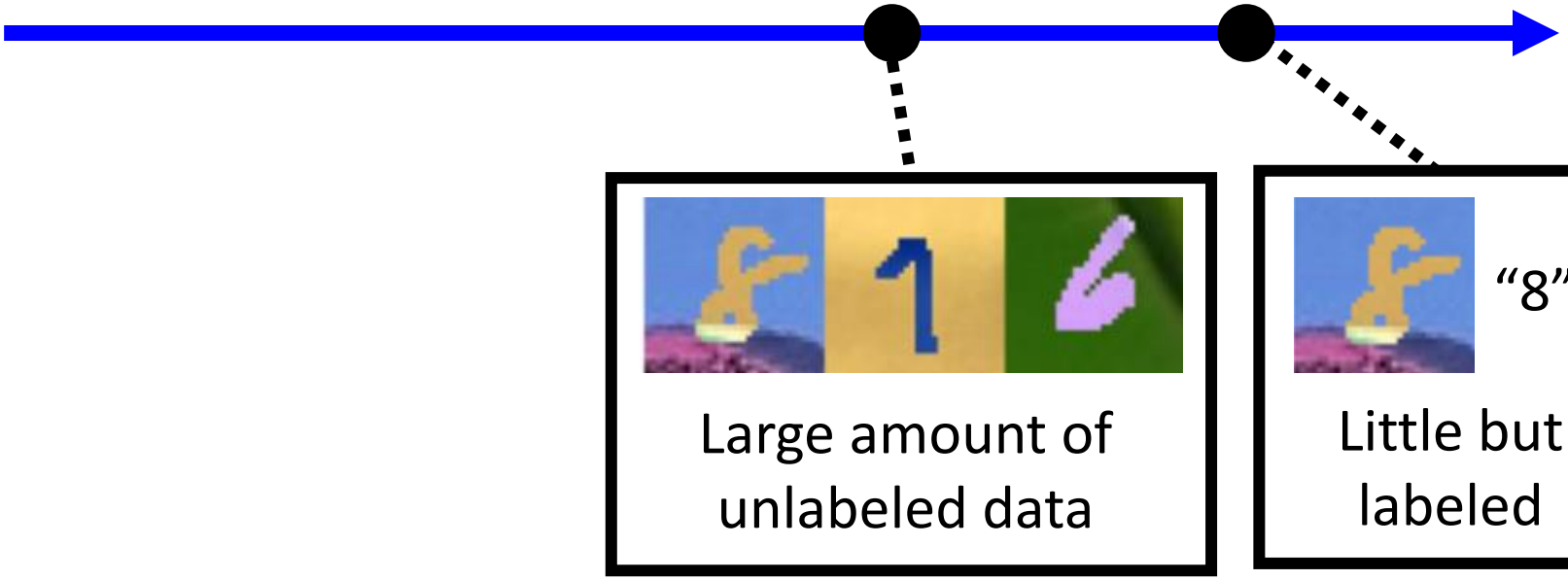
- Idea: training a model by source data, then fine-tune the model by target data
- Challenge: only limited target data, so be careful about overfitting

Domain Adaptation

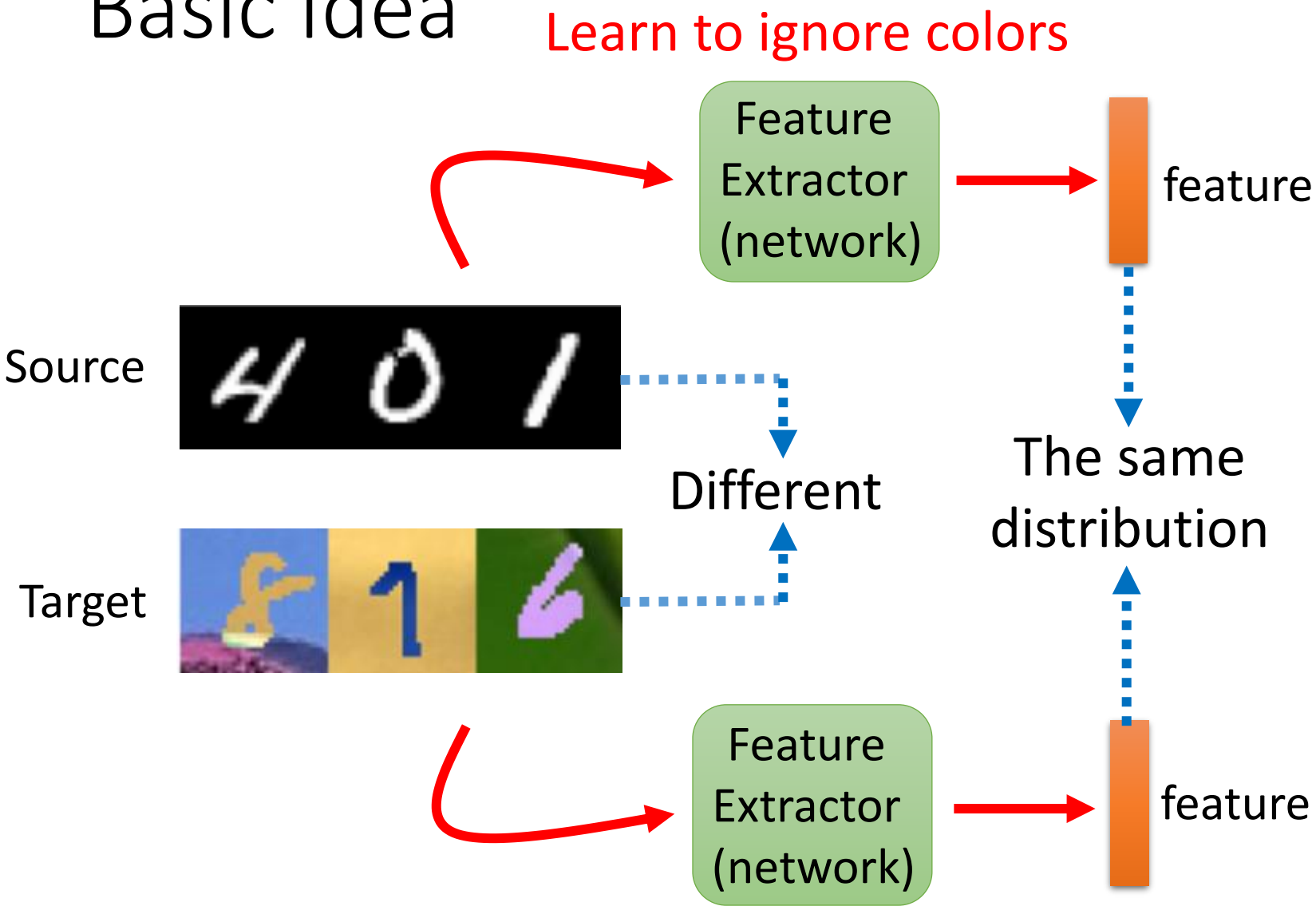
Source Domain
(with labeled data)

“4” “0” “1”

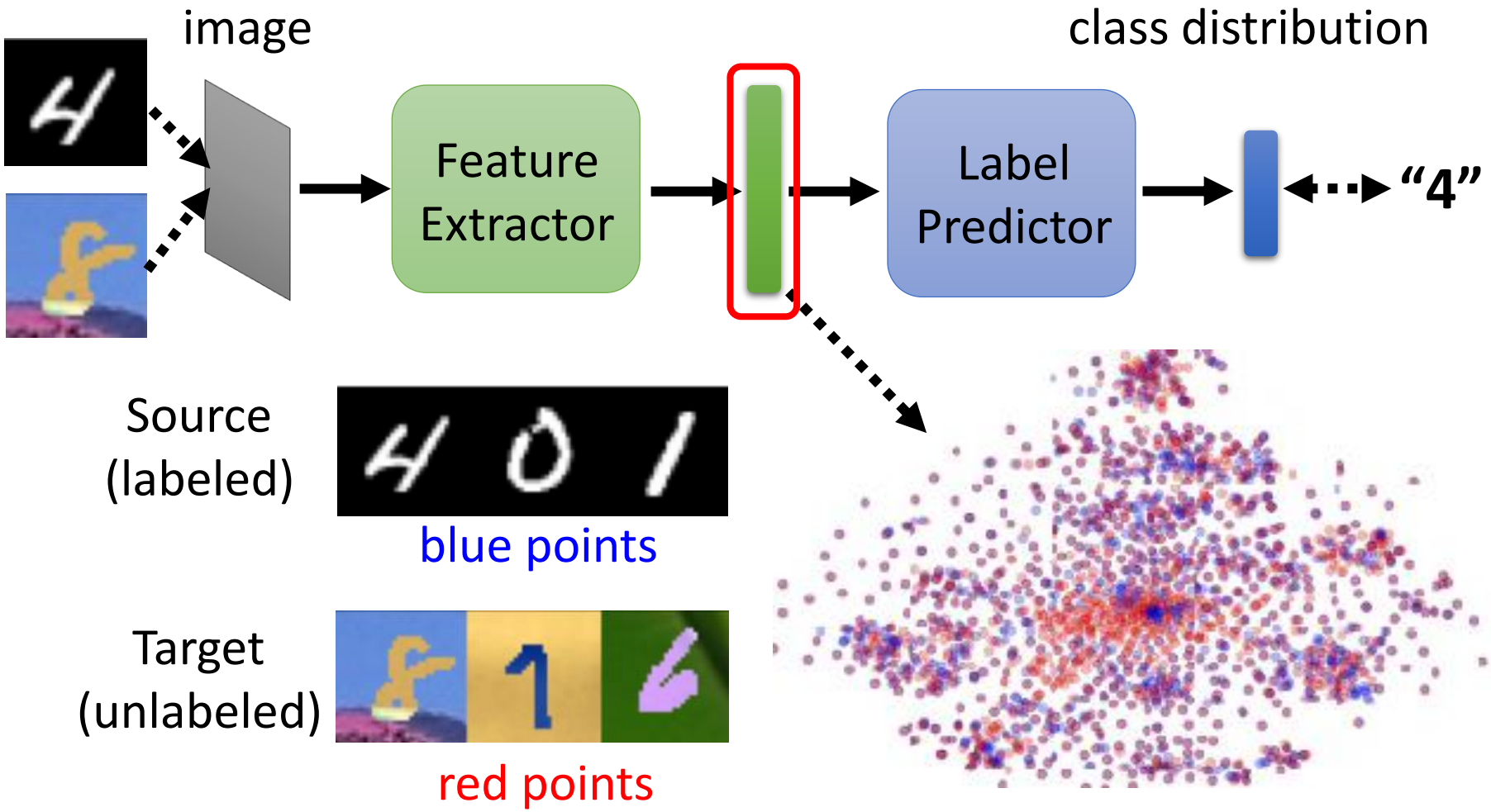
Knowledge of target domain



Basic Idea


Learn to ignore colors
Feature Extractor (network)
feature
Source
Different
The same distribution
Target
Feature Extractor (network)
feature

Domain Adversarial Training



Domain Adversarial Training

若讓Ld越小越好，則意味著希望把source domain的圖片分成target domain
把target domain分成source domain。但這樣還是把兩個domain的圖分開了

$\theta_f^* = \min_{\theta_f} L - L_d$?

always zero?

θ_f Feature Extractor

θ_p Label Predictor

"4"

L

Generator

$\theta_p^* = \min_{\theta_p} L$

$\theta_d^* = \min_{\theta_d} L_d$

θ_d Domain Classifier

L_d

Source?
Target?

Discriminator

- Feature extractor: Learn to "fool" domain classifier
- Also need to support label predictor

Domain Adversarial Training

Yaroslav Ganin, Victor Lempitsky, Unsupervised Domain Adaptation by Backpropagation, ICML, 2015

Hana Ajakan, Pascal Germain, Hugo Larochelle, François Laviolette, Mario Marchand, Domain-Adversarial Training of Neural Networks, JMLR, 2016

METHOD	SOURCE	MNIST	SYN NUMBERS	SVHN	SYN SIGNS
	TARGET	MNIST-M	SVHN	MNIST	GTSRB
SOURCE ONLY		.5749	.8665	.5919	.7400
proposed approach		.8149	.9048		
TRAIN ON TARGET		.9891	.9244	.9951	.9987

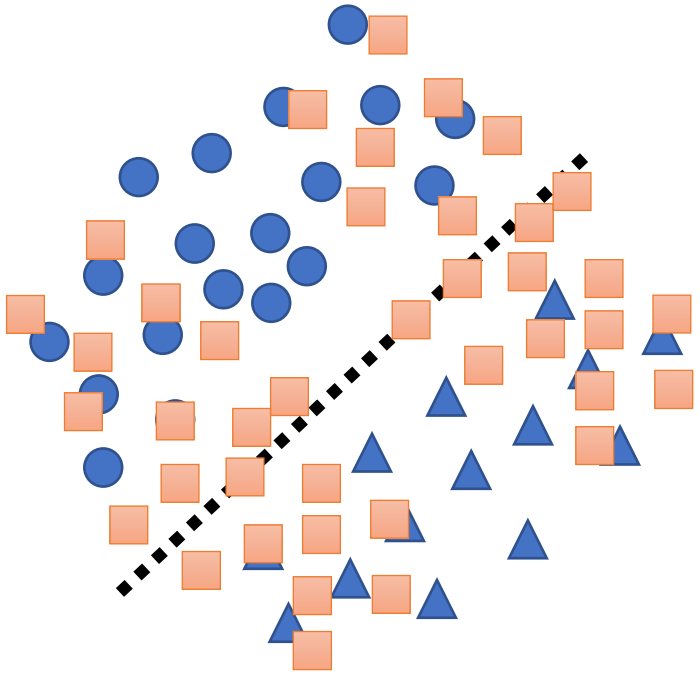
Limitation

class 1 (source)

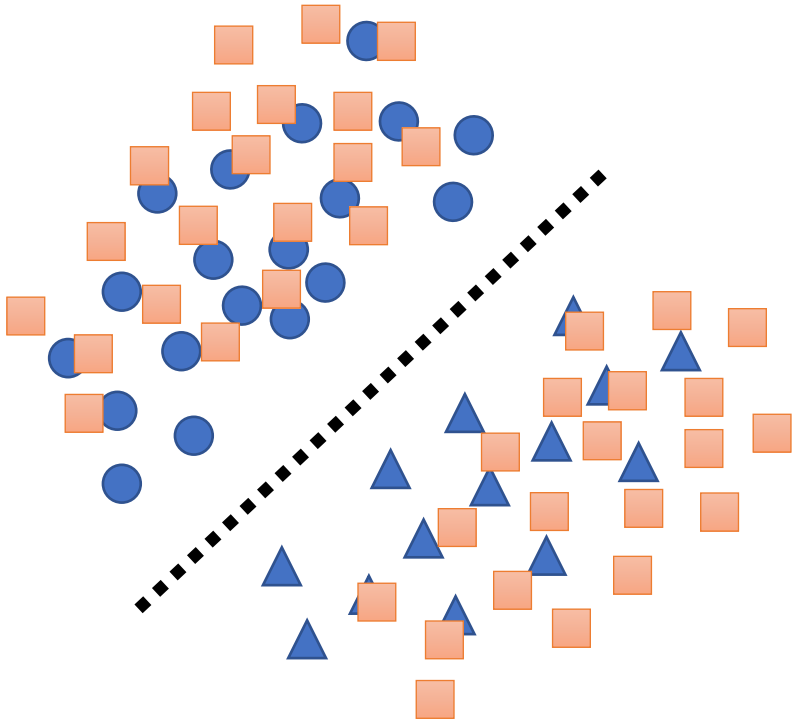
class 2 (source)

Target data (class unknown)

Decision boundaries learned from source domain

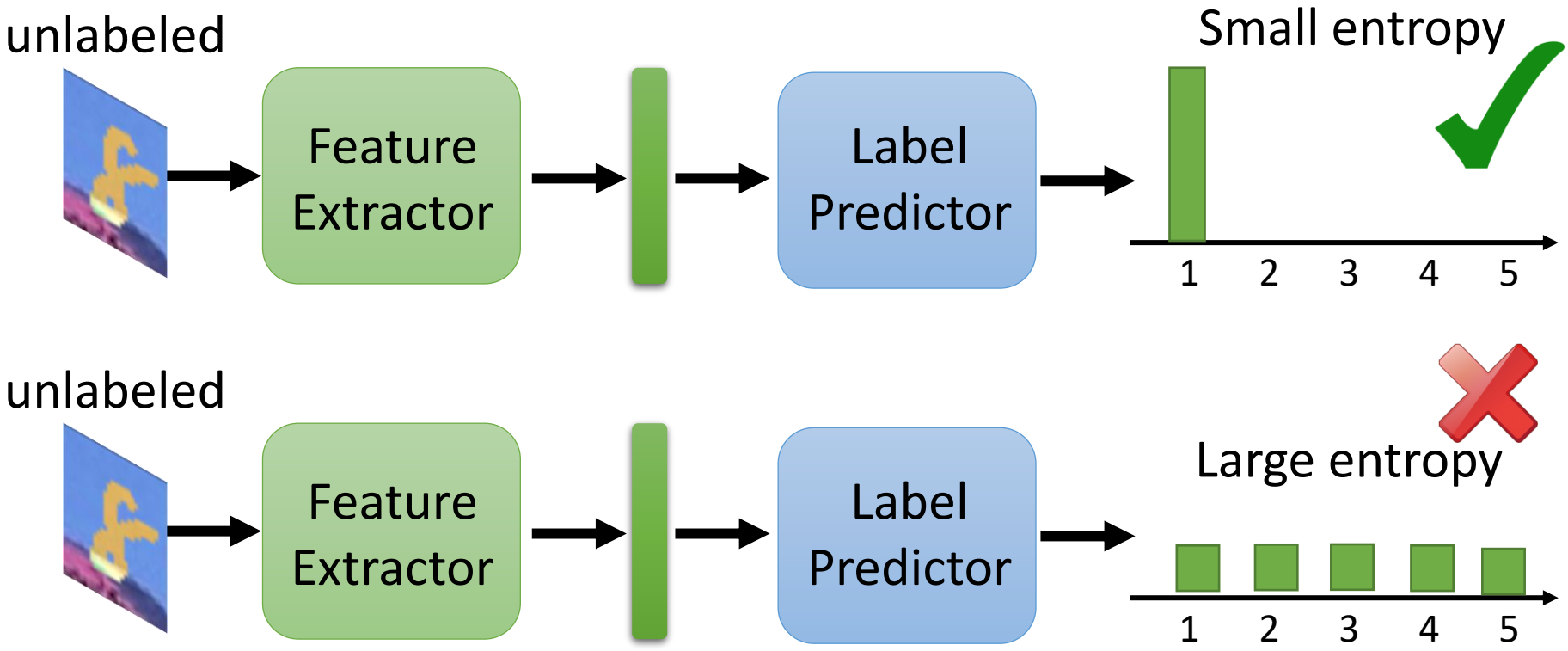


Source and target data are aligned, but ……



Target data (unlabeled far from boundary)

Considering Decision Boundary



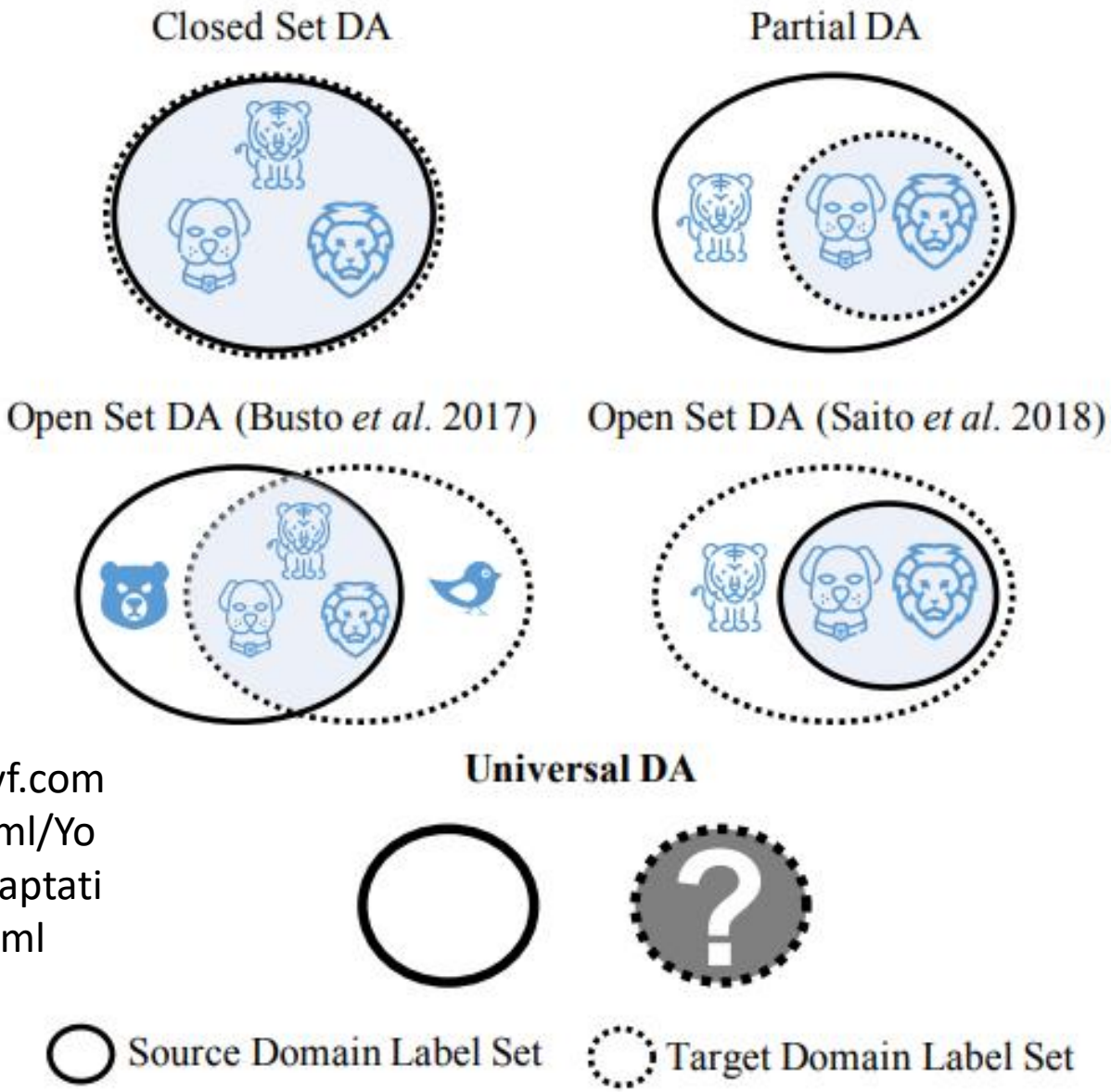
Used in Decision-boundary Iterative Refinement Training with a Teacher (DIRT-T)

https://arxiv.org/abs/1802.08735

Maximum Classifier Discrepancy

https://arxiv.org/abs/1712.02560

Outlook



Universal domain adaptation

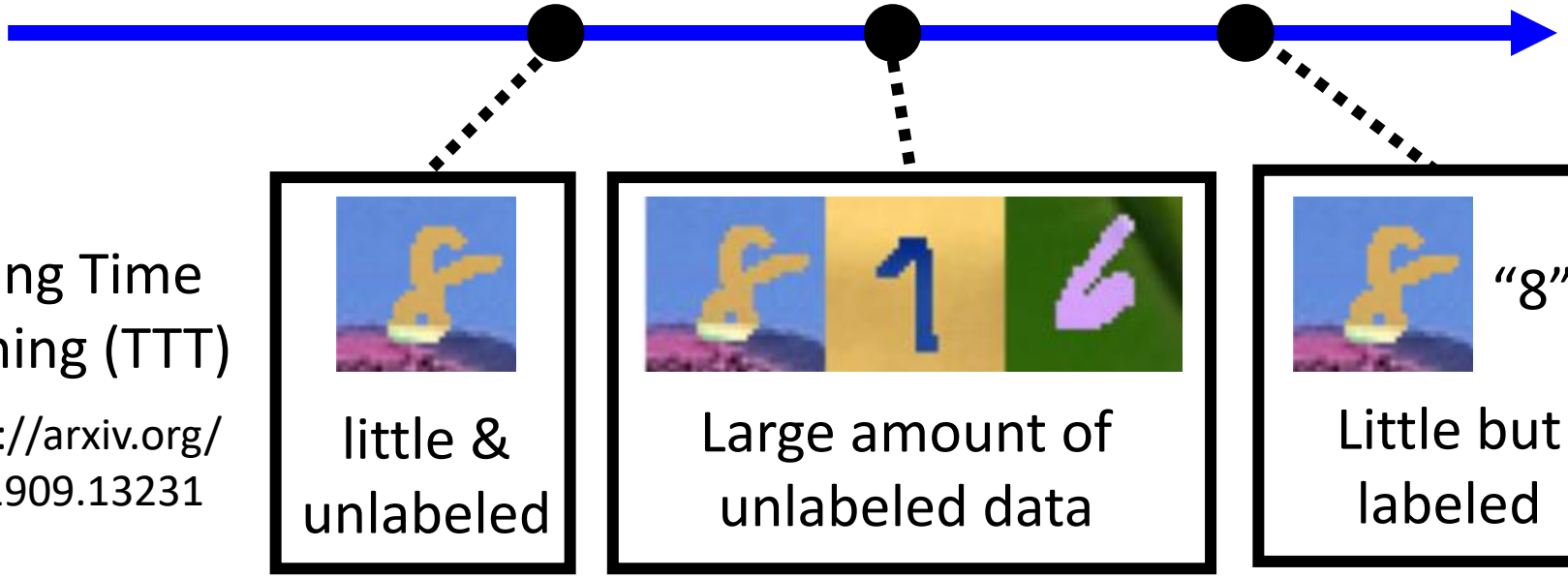
https://openaccess.thecvf.com/content_CVPR_2019/html/You_Universal_Domain_Adaptation_CVPR_2019_paper.html

Domain Adaptation

Source Domain
(with labeled data)

“4” “0” “1”

Knowledge of target domain



Domain Adaptation

Source Domain
(with labeled data)

“4” “0” “1”

Knowledge of target domain

little &
unlabeled

Large amount of
unlabeled data

“8”

Little but
labeled

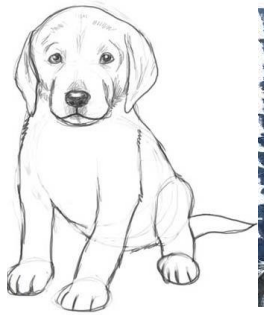
Domain Generalization

https://ieeexplore.ieee.org/document/8578664


cat


dog


cat


dog


cat


dog

Training


cat


dog

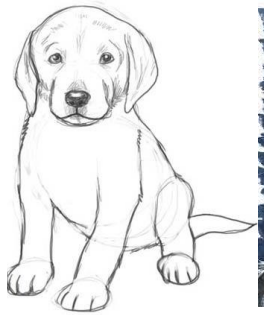
Testing


cat


dog

Training


cat


dog


cat


dog


cat


dog

Testing

https://arxiv.org/abs/2003.13216

Concluding Remarks

Source Domain
(with labeled data)

“4” “0” “1”

Knowledge of target domain

little &
unlabeled

Large amount of
unlabeled data

“8”

Little but
labeled