
Cross-domain Transfer of Defect Features in Technical Domains
Based on Partial Target Data

Cross-domain Transfer of Defect Features in Technical Domains Based on Partial Target Data

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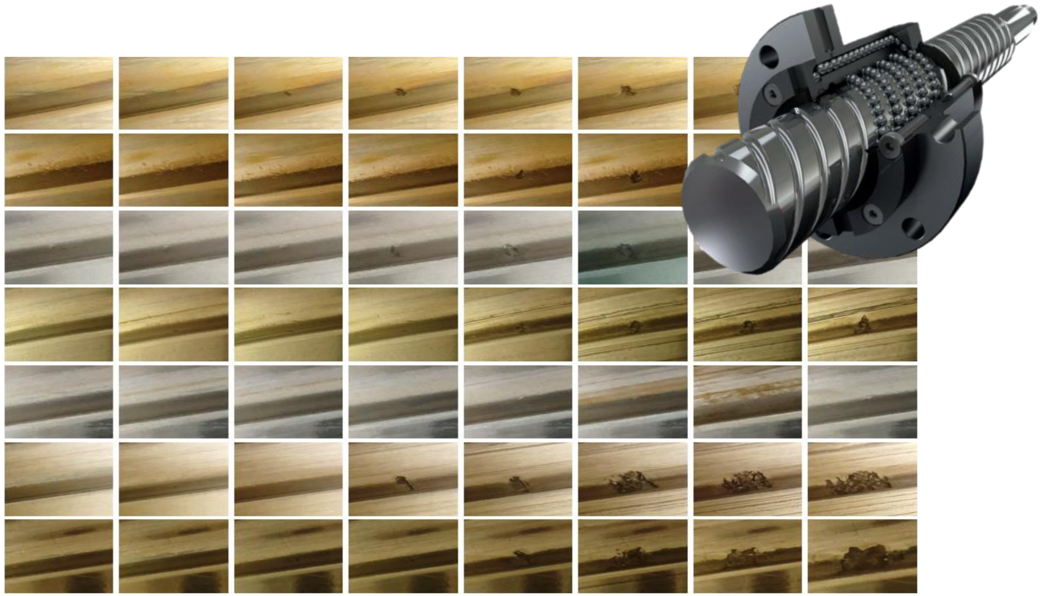
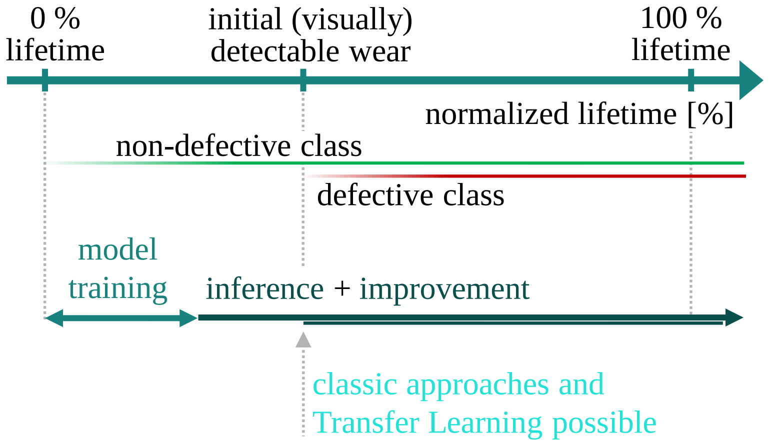
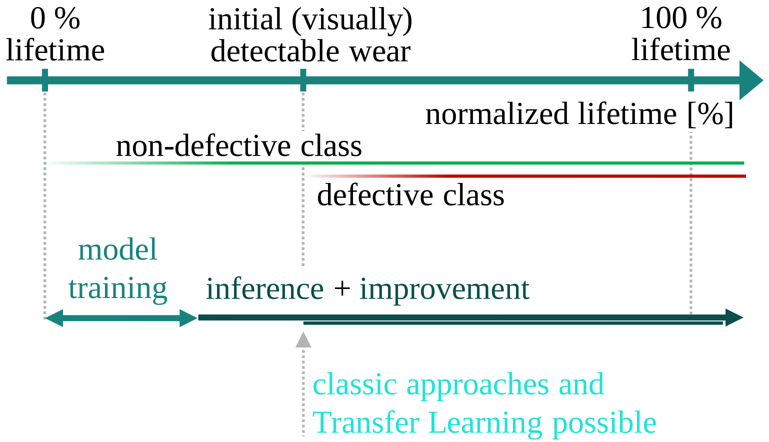
Background & Motivation





Classic Transfer-Learning **is possible** when defective data of the target class is available.

Background & Motivation

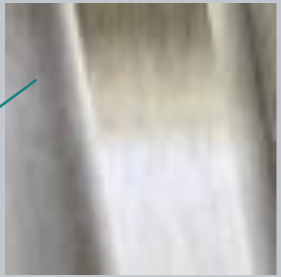


Classic Transfer-Learning **is not possible** when **no** defective data of the target class is available.
What to do?

Background & Motivation

Target Domain

Background



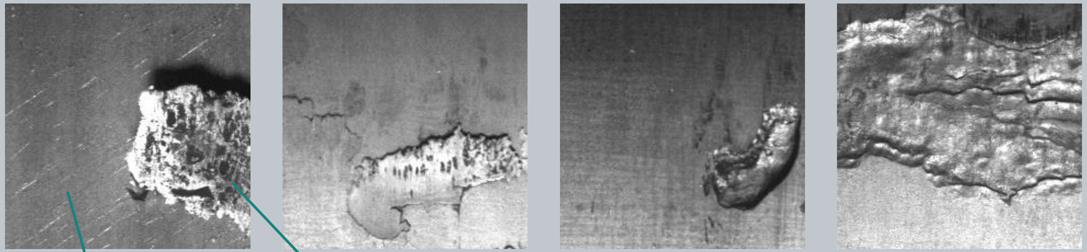
Defect

Features

We only have this

Defects on Ball Screw Drives

Source Domain



Background

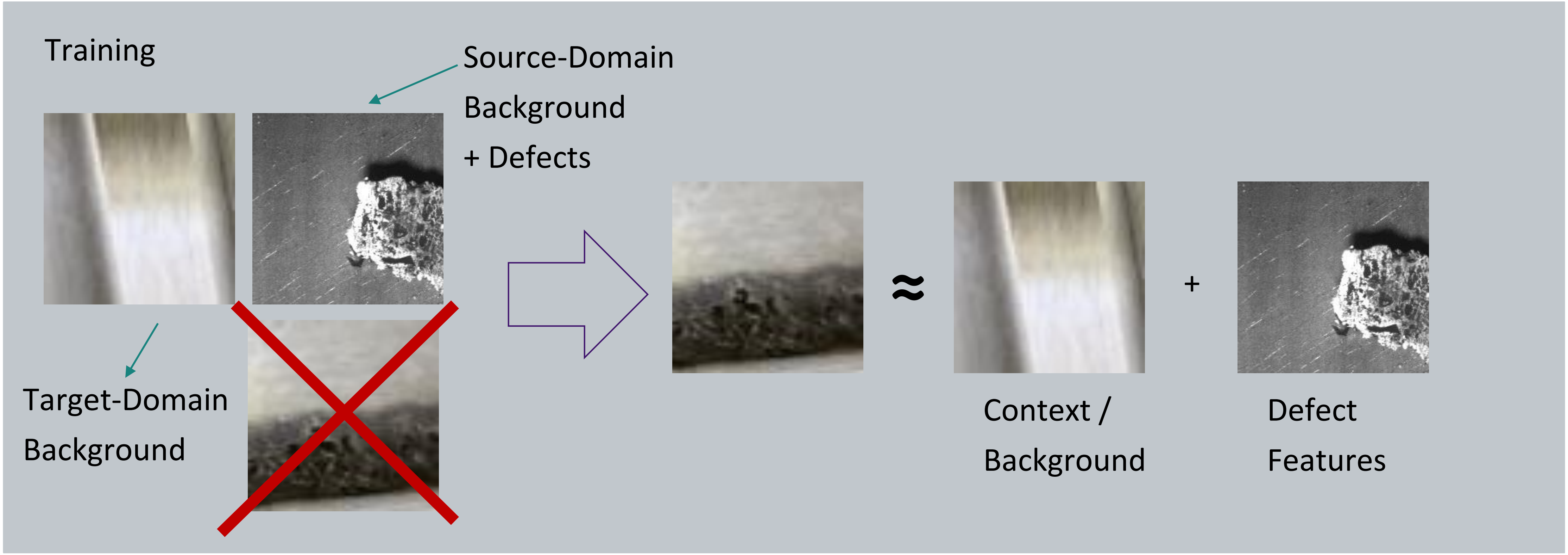
Defect

Features

Defects on metallic Surfaces

Defect features are similar. Though, background is different.

Background & Motivation



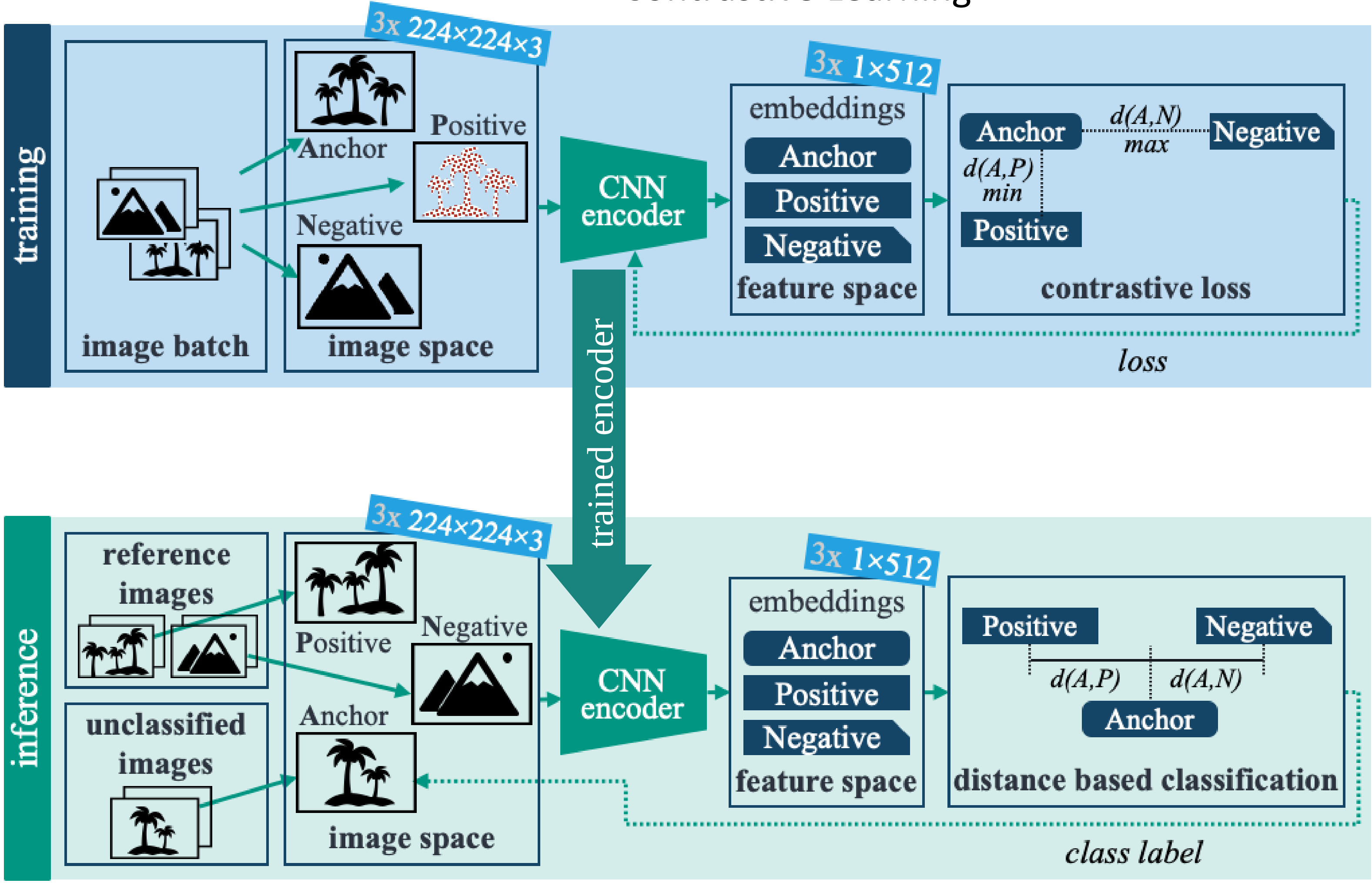
How to combine the Defect Features from the known Source Domain with the Background Features of the Target Domain?

Agenda

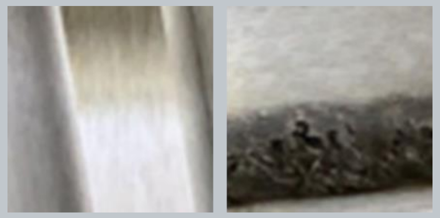
Background & Motivation	1	Data of interest is often underrepresented during training.
Approach	3	Data from different contexts with related features can be used to bridge the gap.
Results & Discussion	4	Helpful for different domains.

Approach

Contrastive Learning



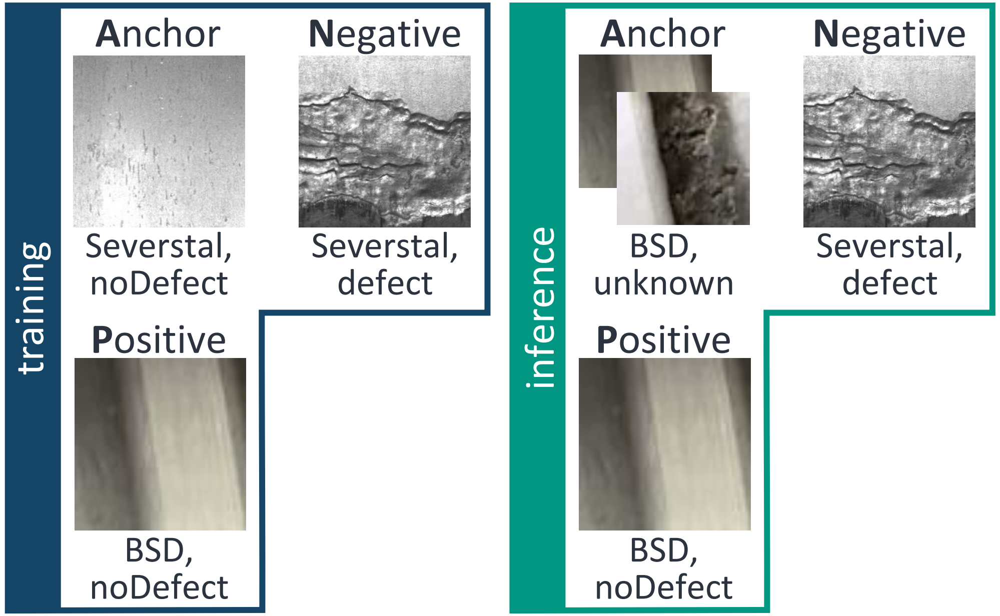
What we should have



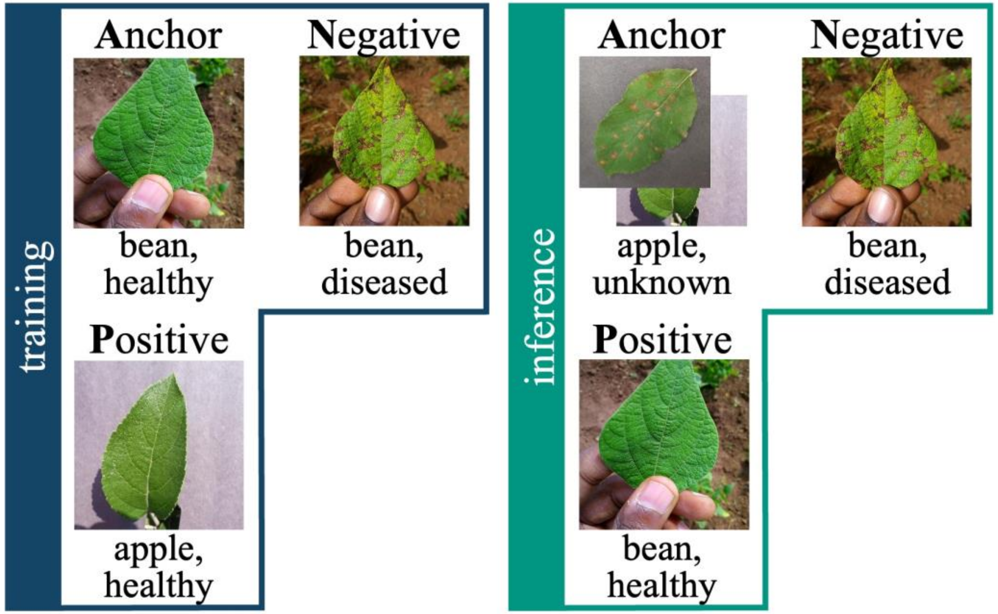
What we have

Approach

Transfer for Defects on **Steel Surfaces**



Transfer for Defects on **Leafes**

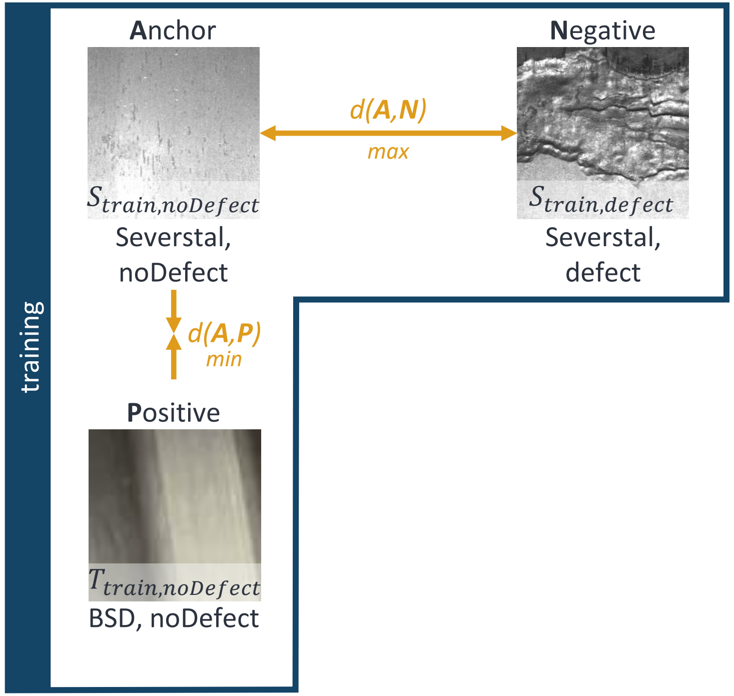


How to combine the Defect Features from the known Source Domain with the Background Features of the Target Domain?

CR/APT4 | 13.09.2023

Approach

Adapted Contrastive Learning



Adaption of Loss Function

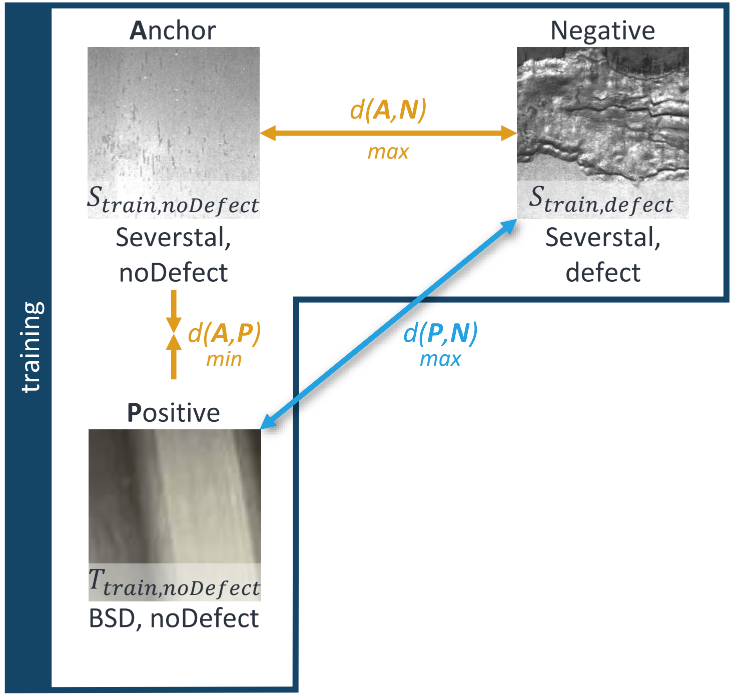
Original Loss Function

$$Loss = max(d(A, P) - d(A, N) + m_1, 0)$$

How to combine the Defect Features from the known Source Domain with the Background Features of the Target Domain?

Approach

Adapted Contrastive Learning



Adaption of Loss Function

Original Loss Function

$$Loss = max(d(A,P) - d(A,N) + m_1, 0)$$

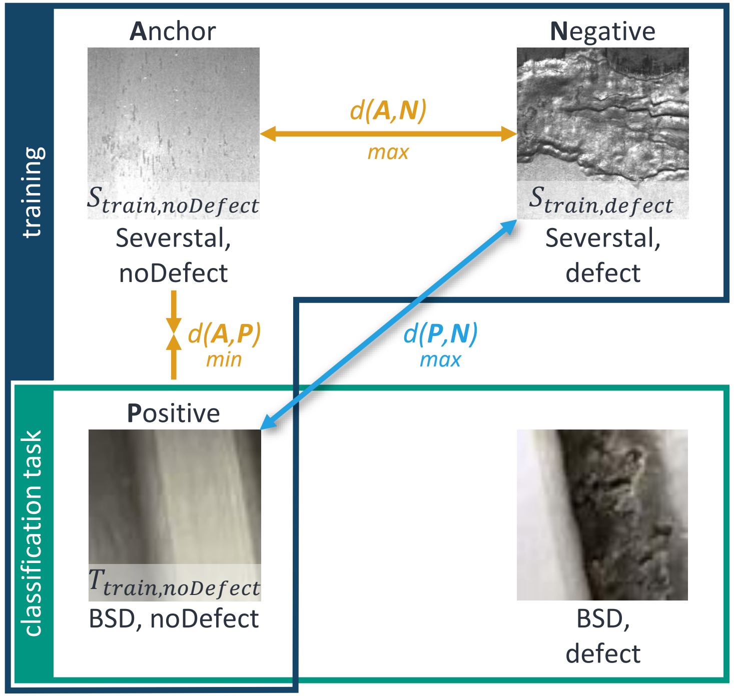
Adapted Loss Function

$$Loss = max(d(A,P) - d(A,N) + m_1, 0) + max(d(A,P) - d(P,N) + m_2, 0)$$

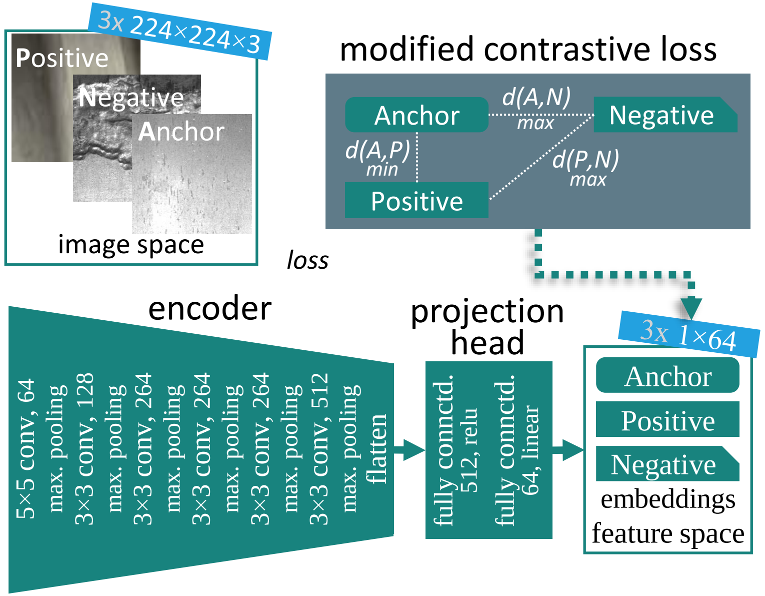
Adapting the loss function bridges the gap between domains.

Approach

Adapted Contrastive Learning



Feature Extractor Trained with Adapted Loss Function



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Agenda

Background & Motivation

1 Data of interest is often underrepresented during training.

Approach

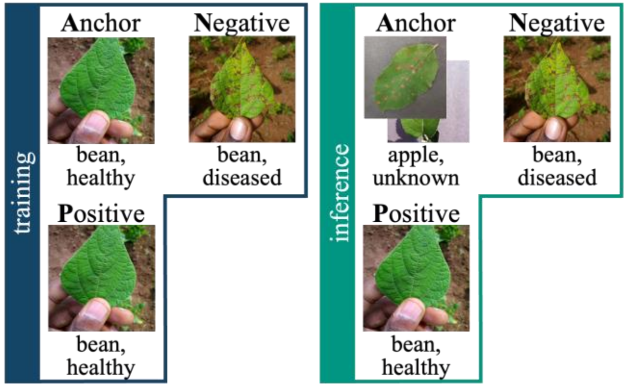
3 Data from different contexts with related features can be used to bridge the gap.

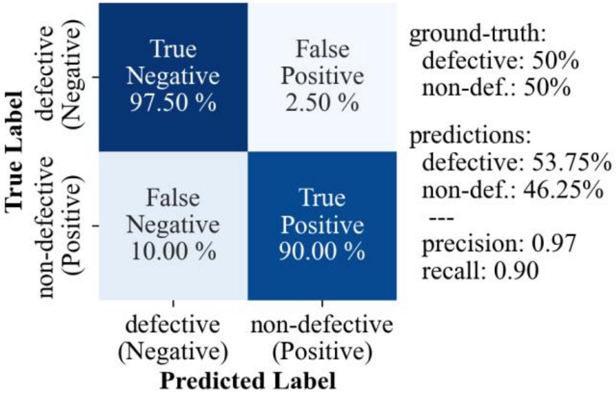
Results & Discussion

4 Helpful for different domains.

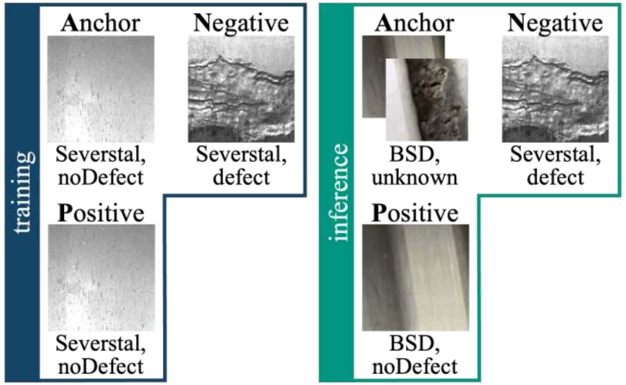
Results – Baseline: Domain Transfer

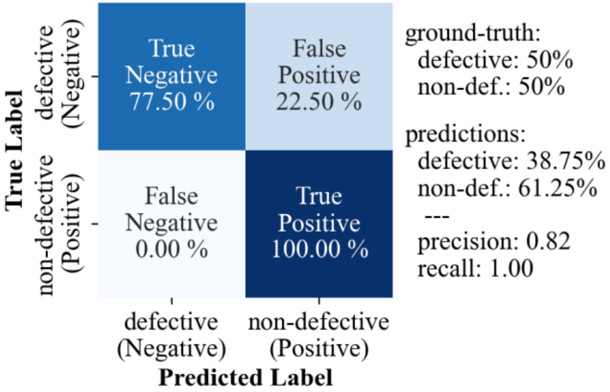
Domain Transfer from Bean to Apple





Domain Transfer from Severstal to BSD

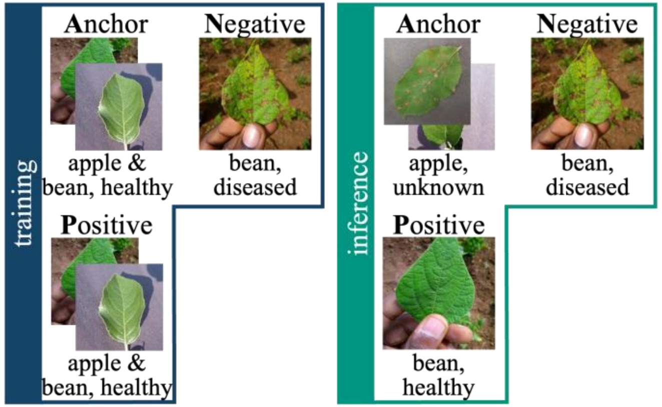


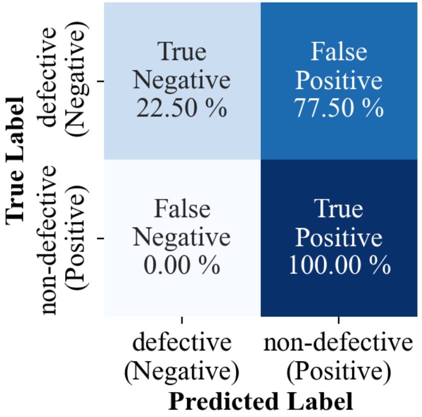


Domain Transfer works, when the domains are closely related.

Results – Baseline: Mixed Datasets

Mixed Datasets Healthy Bean and Apple

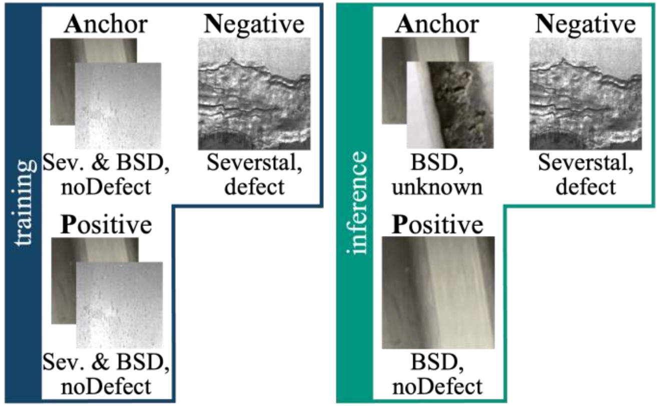


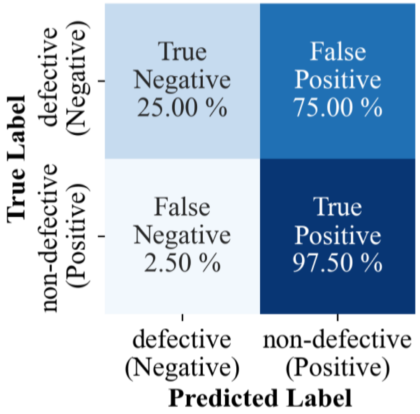


ground-truth:
defective: 50%
non-def.: 50%

predictions:
defective: 11.25%
non-def.: 88.75%
---
precision: 0.56
recall: 1.00

Mixed Datasets Healthy Severstal and BSD





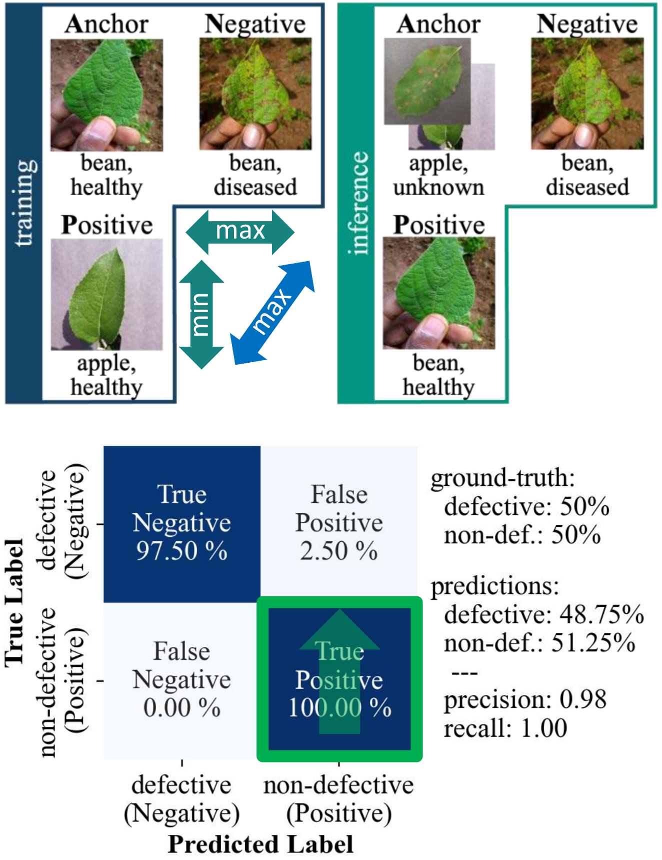
ground-truth:
defective: 50%
non-def.: 50%

predictions:
defective: 13.75%
non-def.: 86.25%
---
precision: 0.57
recall: 0.97

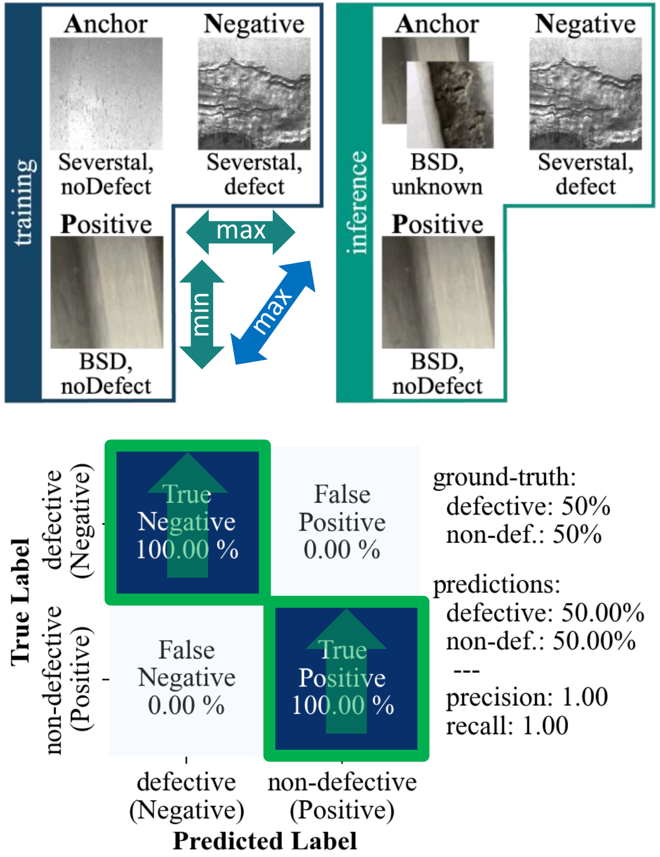
Mixed datasets confuse the model and do not lead to a domain transfer.

Results – New Loss

Cross domain transfer Bean, Apple



Cross domain transfer Severstal, BSD



Domain Adaption is possible: Defective Data is successfully classified during inference.

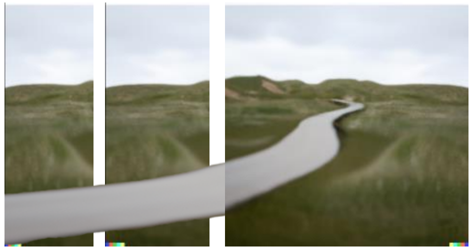
Summary and Outlook

Key Findings

- Loss function seems to be the key.
- We can identify defective instances without defective data during training by transfer of features across domains.
- Especially useful if features of interest are similar while background is different.

Outlook

- How to use this approach in the context of object detection?
- Can this be used for e.g. federated learning to combine feature spaces?
- Can this be applied on time series data as well?



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