DG-MIX : Domain Generalization for Anomalous Sound Detection based on Self-Supervised Learning

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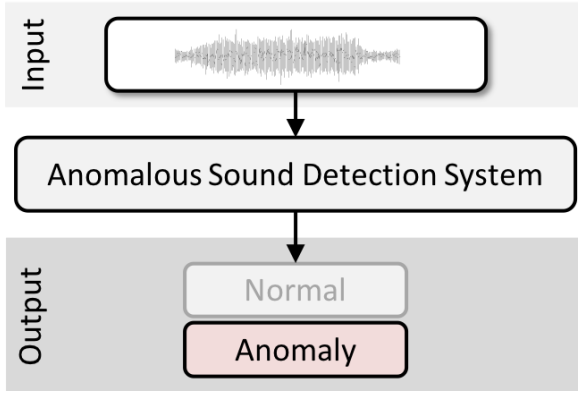
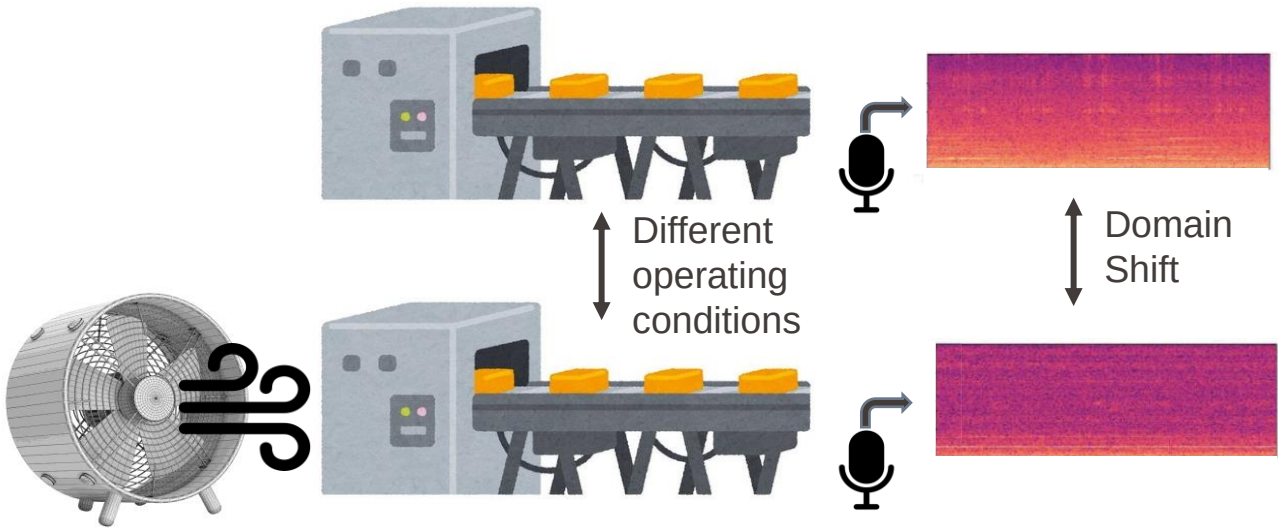
Anomalous sound detection (ASD)

- **ASD** aims to identify whether a machine sound is:
  - Normal
  - Anomalous
- Anomalous sounds:
  - Very diverse
  - Rarely occur
- Real-world environments are often **changing**.





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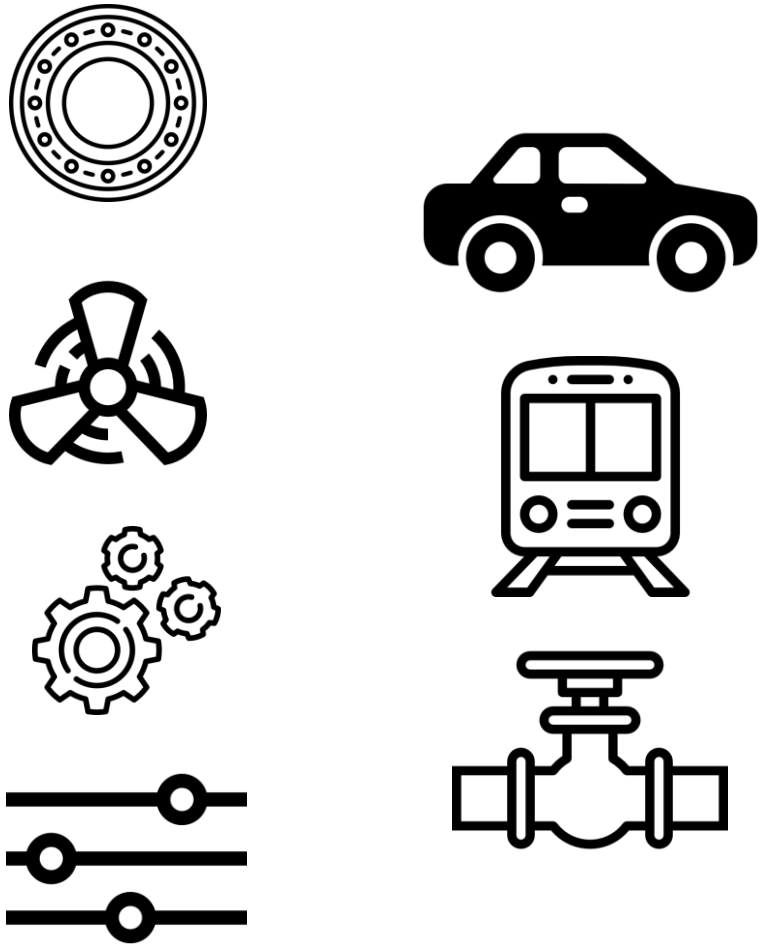
DCASE2022 Data Challenge Task 2

Description:

The dataset contains 7 machine types with 6 sections each:



Each section has

Source domain : **990** audio normal clips
Target domain : **10** audio normal clips

and is dedicated to a **specific** type of **domain shift**.

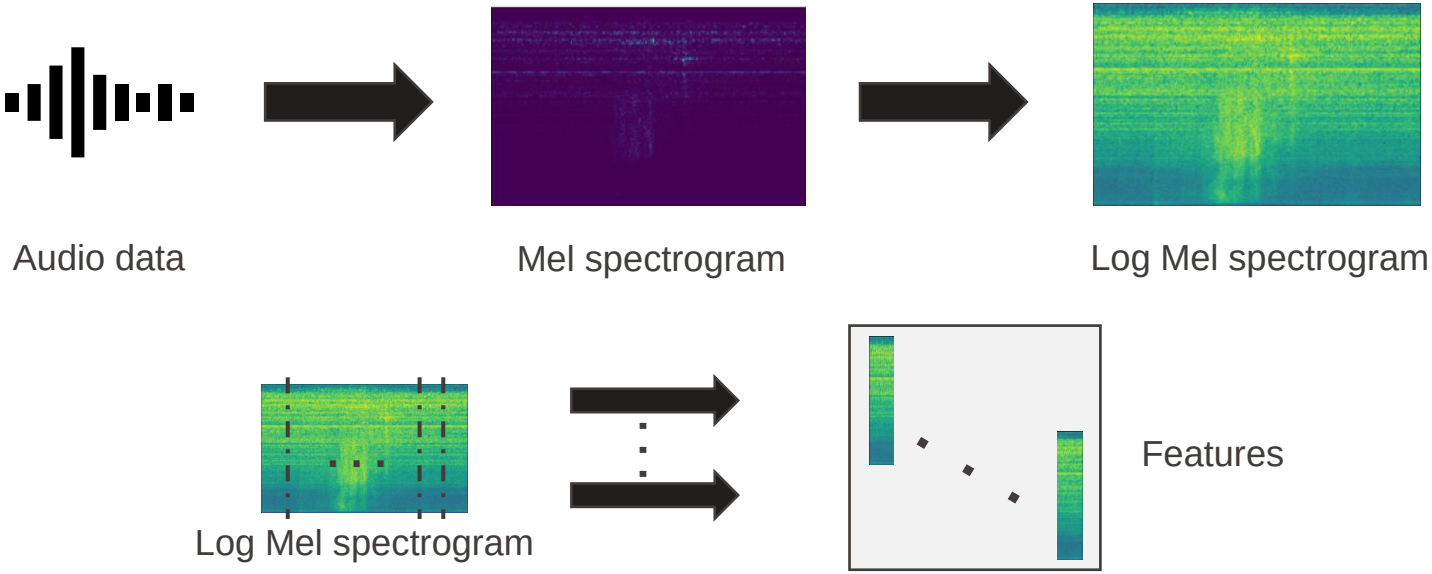
DG

operating conditions vary
(voltage, velocity, factory noise, etc …)

Method

- We propose a new consistency term with:
  - Virtual domains generated by linearly interpolated feature vectors
  - Operating condition-invariant heath-state representation

Preprocessing step:



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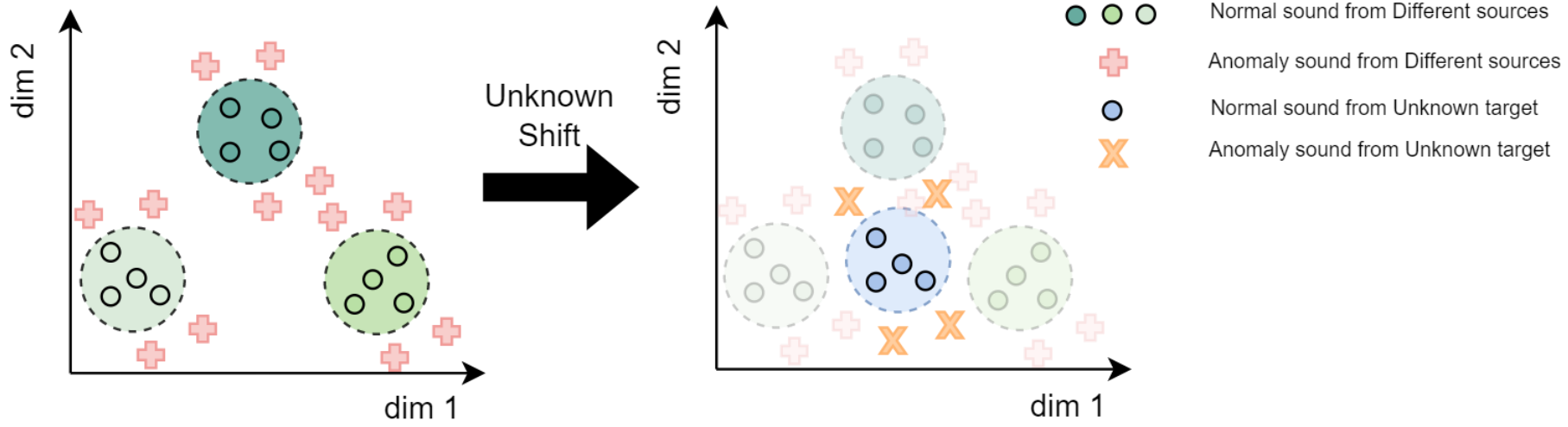
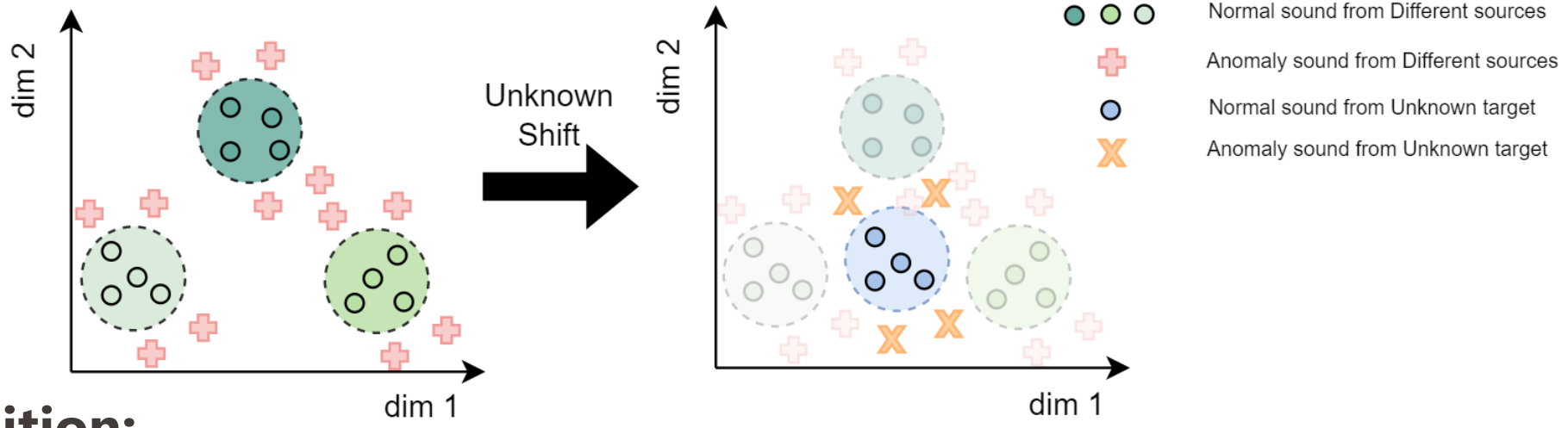
Proposed Framework : DG-Mix - Intuition

Domain Generalization:

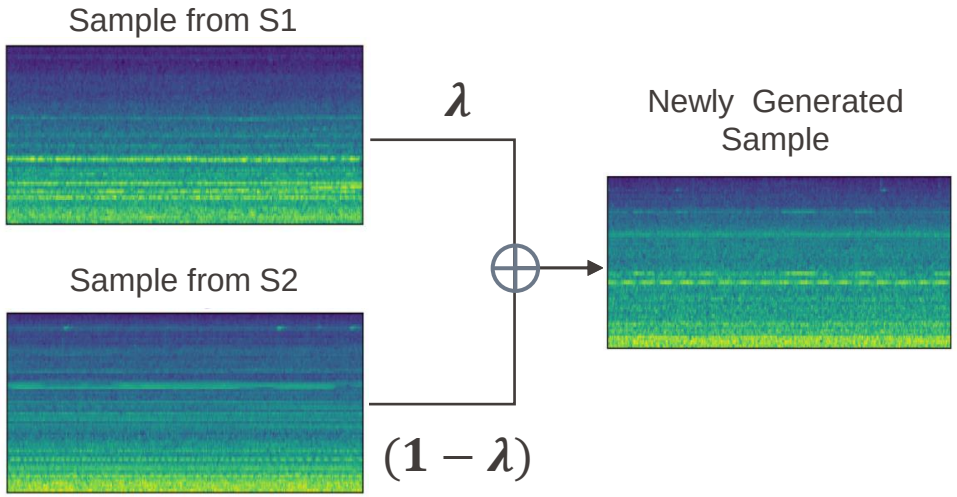


Proposed Framework : DG-Mix - Intuition

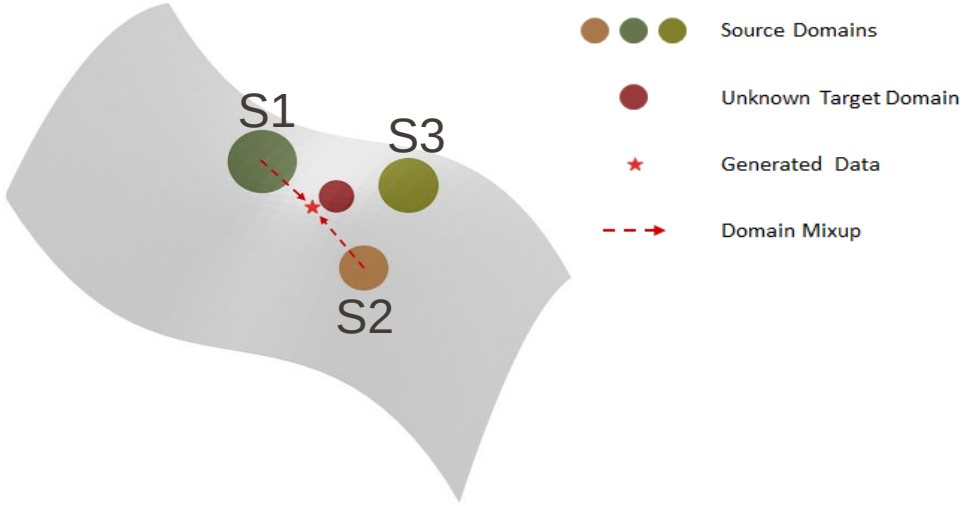
Domain Generalization:



Intuition:



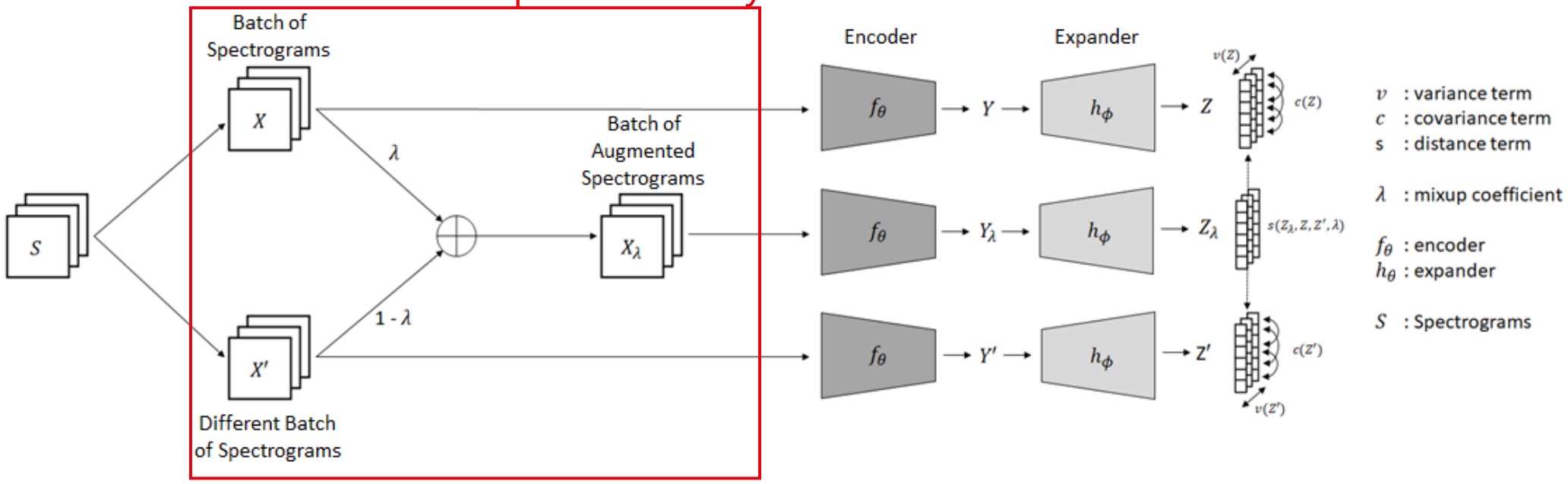
Input Space



Latent Domain Manifold

Proposed Framework : DG-Mix

Proposed novelty

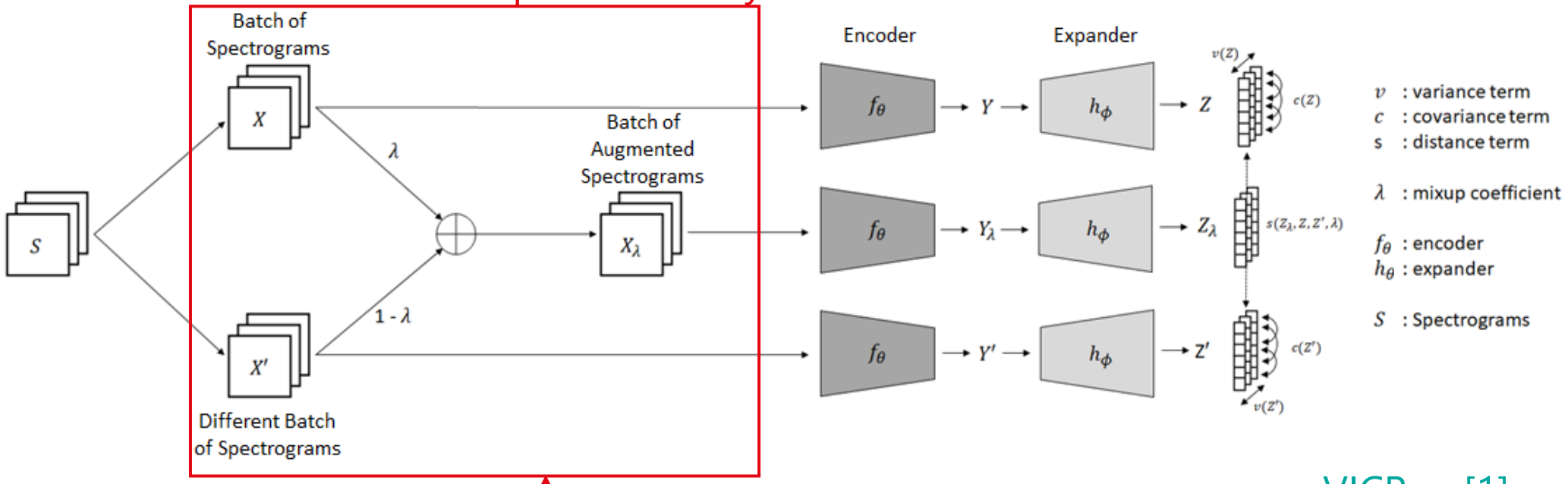


DG-Mix learns **condition-invariant** representations in an **unsupervised** manner by:

- Revealing the impact of attributes on the data.
- Obtaining uncorrelated embedding features containing specific information.
- Respecting defined **geometrical constraints** between different domains.

Proposed Framework : DG-Mix - Losses

Proposed novelty



VICReg [1]

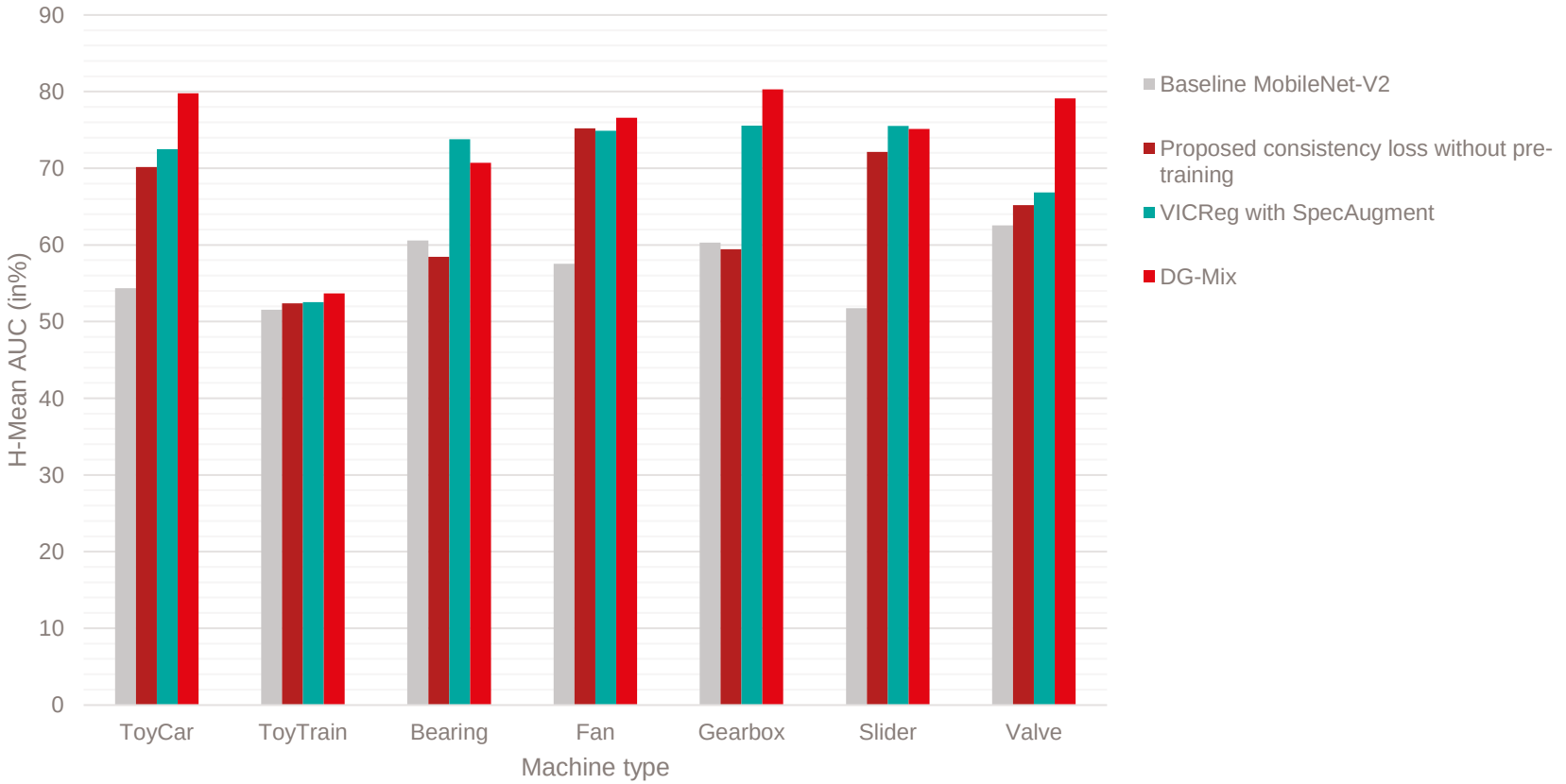
$$L_{total} = \frac{1}{N}\sum_{i=1}^{N}\|z_{\lambda,i} - (\lambda z_i + (1-\lambda)z'_i)\|_2^2 + \frac{1}{D}\sum_{i=1}^{D} max(0, 1-\sqrt{Var(z_i)}) + \frac{1}{d}\sum_{i\neq j}[C(Z)]_{i,j}^2$$

[1] Adrien Bardes, Jean Ponce, Yann LeCun (2021). VICReg: Variance-Invariance-Covariance Regularization for Self-Supervised Learning

Experiments:

Results

Methods	Baseline MobileNet-V2	Proposed consistency loss without pre-training	VICReg with SpecAugment	**DG-Mix**
Overall Harmonic Mean (in %)	56.65	68.32	69.18	**72.34**



Conclusion

- A novel **ADS** framework for **Domain Generalization** was proposed
- **Pre-training** improves generalization of a model.
- Superior performance on evaluation dataset.
- **Mixup** :
  - Better than standard data augmentations
  - No prior knowledge of fault characteristics assumed