DCASE2021 CHALLENGE

Monitoring Task 2

Description and Discussion on DCASE 2021 Challenge Task 2: Unsupervised Anomalous Detection for Machine Condition Monitoring Under Domain Shifted Conditions


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Task scope & applications

Monitoring Task 2

Machine condition monitoring

Determine if a machine is **normal** or **anomalous** from sound

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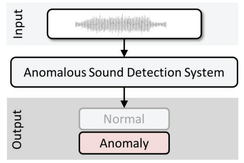

Challenges

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1. How can we detect anomalies without anomalous training data?

Normal samples

Easy to collect

Anomaly samples

Anomalies are rare.

All variations cannot be collected and trained.

2. How can we avoid being affected by training-test gaps (= domain shifts)?

Winter (training)

Summer (test)

Sound changes b/w training and test regardless of normal or anomalous.

Difficult to distinguish b/w domain shifts and anomalies

Challenges & positioning

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1. How can we detect anomalies without anomalous training data?
2. How can we avoid being affected by training-test gaps (= domain shifts)?

Fewer training samples of events to be detected

	Detecting "DEFINED" sounds	Detecting "UNKNOWN" sounds
Small domain shifts	Regular task of scene classification or event detection Rare-sound/few-shot event detection <DCASE2017 Task2> <DCASE2021 Task5> Animal, gunshot, etc.	Unsupervised anomalous sound detection <DCASE2020 Task2>
Large domain shifts	Scene classification with mismatched devices <DCASE2018-21 Task1>	Unsupervised anomalous sound detection under domain shifts <DCASE2021 Task2> **We are here!**

Larger gaps b/w training and test

Taxonomy in 2021

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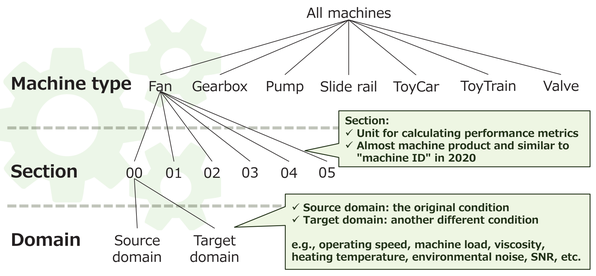

Section:
- ✓ Unit for calculating performance metrics
- ✓ Almost machine product and similar to "machine ID" in 2020

- ✓ Source domain: the original condition
- ✓ Target domain: another different condition

e.g., operating speed, machine load, viscosity, heating temperature, environmental noise, SNR, etc.

Dataset in 2021

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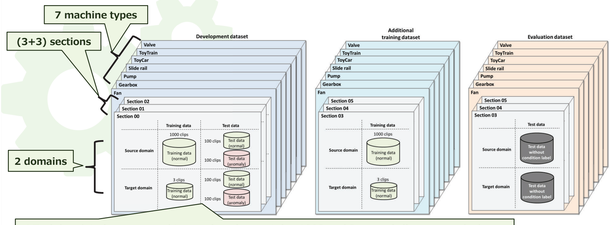
ToyADMOS2 [Harada+, 2021] & MIMII DUE [Tanabe+, 2021]



- ✓ Training data in source and target domains contains 1000 and 3 normal clips, respectively.
- ✓ Each clip is a 10-second monaural wave file.

Task setup in 2021

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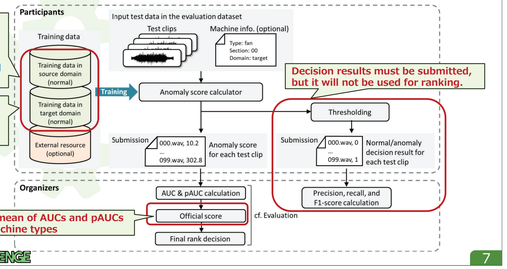
Similar to 2020, but with some differences

- ✓ Training data contain only normal data.
- ✓ Each clip is a 10-second monaural wave file.

- ✓ 1000 clips from source domain
- ✓ 3 clips from target domain



Baseline systems

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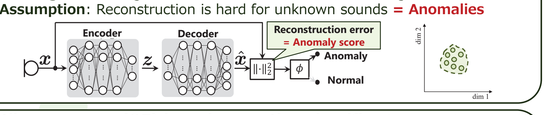
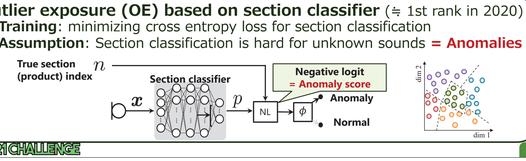
1. Autoencoder (AE)-based outlier detector (same baseline as 2020)
- **Training**: minimizing reconstruction error of normal training data
- **Assumption**: Reconstruction is hard for unknown sounds **= Anomalies**



2. Outlier exposure (OE) based on section classifier (≒ 1st rank in 2020)
- **Training**: minimizing cross entropy loss for section classification
- **Assumption**: Section classification is hard for unknown sounds **= Anomalies**



Results

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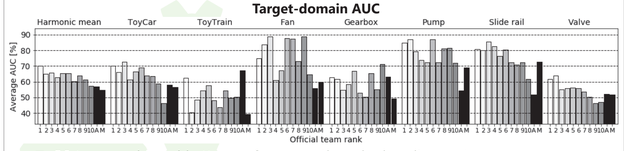
76 submissions from 27 teams



- 20 teams achieved better performance than the baseline systems.
- Each team had its own strength/weakness for a particular machine type, but the target-domain AUC roughly correlates to official ranking.

What is the remarkable approach of the top rankers? What are new findings in this task?

Remarkable approaches (1/2)

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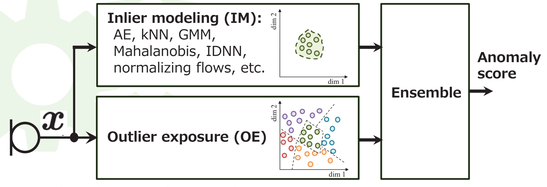
1. Parallel-type hybrid:
- ✓ Ensemble of "inlier modeling" (IM)-based outlier detection and OE
- ✓ Developed by the 1st, 4th, and 5th ranked teams



Pros: High performance for generalization

Cons: Overall model tends to be large due to ensemble (but 5th team's was small.)

Remarkable approaches (2/2)

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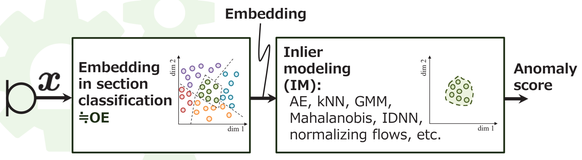
2. Serial-type hybrid:
- ✓ IM-based outlier detection for the embeddings learned in section classification
- ✓ Developed by the 2nd and 3rd ranked teams



Pros: Model size can be limited.
Domain adaptation by updating IM with a few data of the target domain

Cons: Section classification does not always provide good embeddings.

Task2 related 7 papers will be presented in Workshop

Enjoy Workshop!

- ✓ X. Cai+, "A Contrastive Semi-Supervised Learning Framework For Anomaly Sound Detection"
- ✓ A. Fernandez+, "Using UMAP to Inspect Audio Data for Unsupervised Anomaly Detection Under Domain-Shift Conditions"
- ✓ N. Harada+, "ToyADMOS2: Another Dataset of Miniature-Machine Operating Sounds for Anomalous Sound Detection under Domain Shift Conditions"
- ✓ Y. Kawaguchi+, "Description and Discussion on DCASE 2021 Challenge Task 2: Unsupervised Anomalous Detection for Machine Condition Monitoring Under Domain Shifted Conditions"
- ✓ I. Kuroyanagi+, "An Ensemble Approach to Anomalous Sound Detection Based on Conformer-Based Autoencoder and Binary Classifier Incorporated with Metric Learning"
- ✓ J. A. Lopez+, "Ensemble Of Complementary Anomaly Detectors Under Domain Shifted Conditions"
- ✓ K. Wilkinghoff, "Combining Multiple Distributions based on Sub-Cluster AdaCos for Anomalous Sound Detection under Domain Shifted Conditions"