

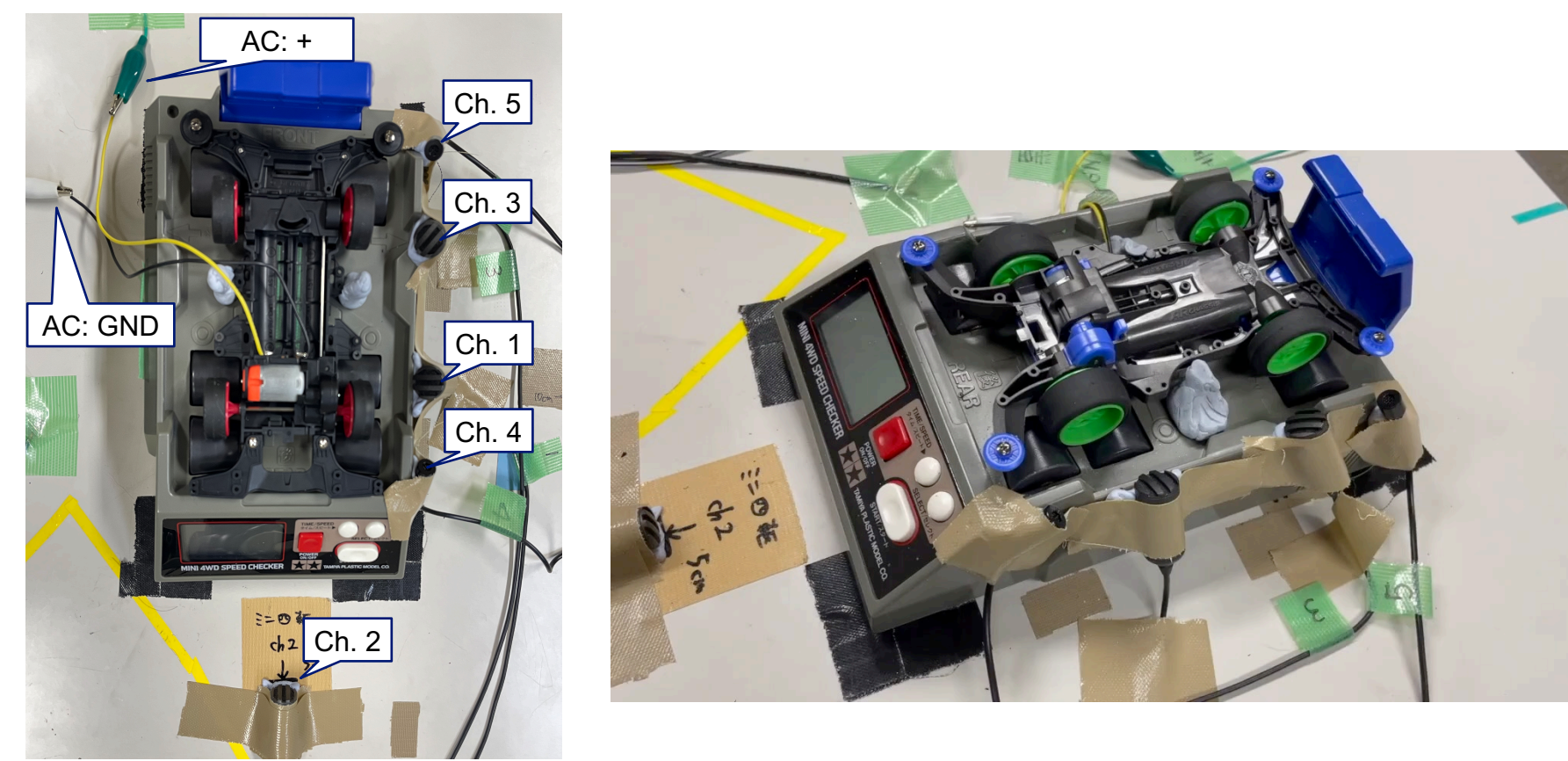


# ToyADMOS2: Another dataset of miniature-machine operating sounds for anomalous sound detection under domain shift conditions



Noboru Harada, Daisuke Niizumi, Daiki Takeuchi, Yasuhiro Ohishi, Masahiro Yasuda, and Shoichiro Saito  
NTT Corporation, Japan

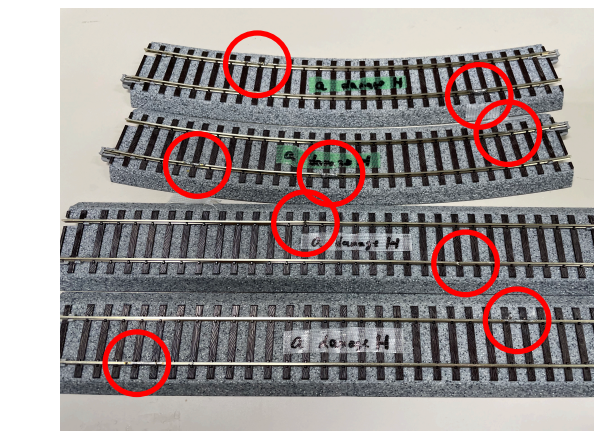
## Toy car: Microphone arrangement



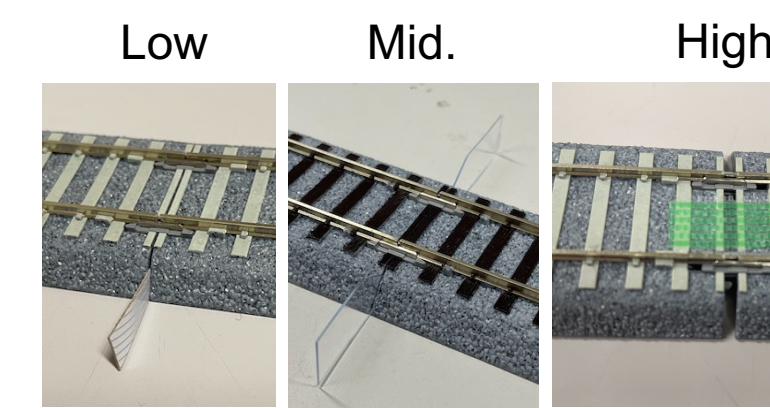
## Toy train: Anomaly conditions



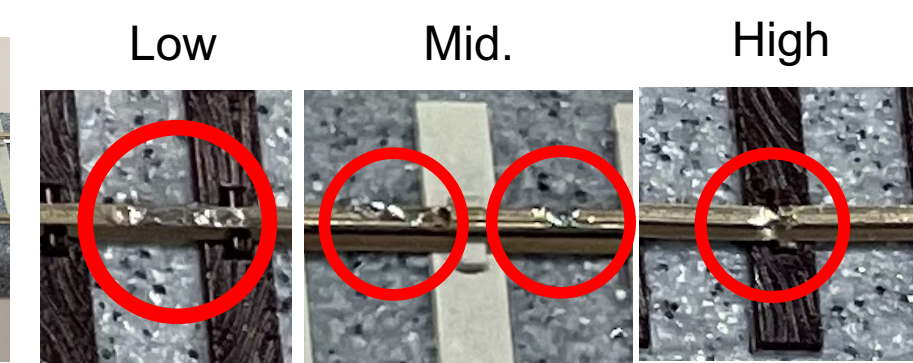
	Toy car	Toy train
a	Bent shaft	Obstructing stone
b	Deformed gears	Disjointed railway
c	Melted gears	Broken shaft
d	Damaged wheels	Flat tire



### Disjointed railway



### Obstructing stone



## Recipe (easy template for generating sub-dataset)

You can simply edit the recipe template and run mixer.py to generate a test dataset

No.	Folder	FileID	Model	CarID	Speed	Defect	D_Level	# of Rec.	r0_pat	r0_mics	r0_nz	r0_dly
1	ToyCar/normal	CN001-carA1-speed1	A	A1	1	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
2	ToyCar/normal	CN002-carA1-speed1	A	A1	1	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
3	ToyCar/normal	CN003-carA2-speed1	A	A2	1	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
4	ToyCar/normal	CN004-carA2-speed1	A	A2	1	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
5	ToyCar/normal	CN005-carA1-speed2	A	A1	2	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
6	ToyCar/normal	CN006-carA1-speed2	A	A1	2	-	-	260	ToyCar/train/section_00_source_train_normal_?????.wav	[1,2,3,4,5]	1	30
7	ToyCar/normal	CN121-carE1-speed1	A	E1	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
8	ToyCar/normal	CN122-carE1-speed1	A	E1	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
9	ToyCar/normal	CN123-carE2-speed1	A	E2	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
10	ToyCar/normal	CN124-carE2-speed1	A	E2	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
11	ToyCar/normal	CN125-carE1-speed1	A	E1	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
12	ToyCar/normal	CN126-carE2-speed1	A	E2	1	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
13	ToyCar/normal	CN127-carE1-speed2	A	E1	2	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
14	ToyCar/normal	CN128-carE2-speed2	A	E2	2	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
15	ToyCar/normal	CN129-carE1-speed2	A	E1	2	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30
16	ToyCar/normal	CN130-carE2-speed2	A	E2	2	-	-	260	ToyCar/train/section_01_target_test_normal_?????.wav	[1,2,3,4,5]	1	30

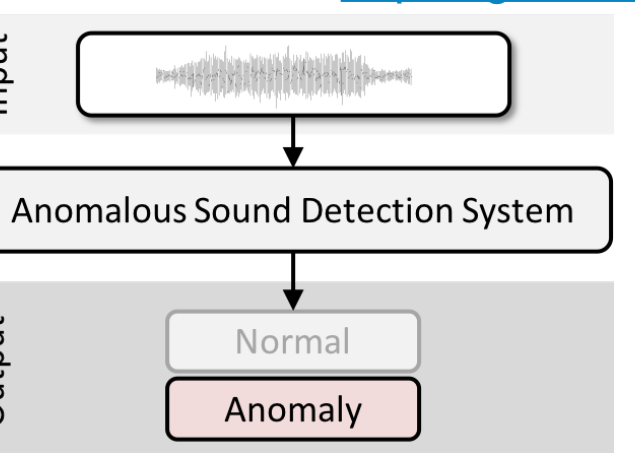
```
$ python mixer.py ToyADMOS2 car_shift recipe_example_car_shift.xlsx -6
```

## What is ToyADMOS2?



- “ToyADMOS2” is a new large-scale dataset for anomaly detection in machine operating sound
- Designed for evaluating anomaly detection systems under Domain-shift conditions

The dataset is freely available at <https://github.com/nttclab/ToyADMOS2-dataset>

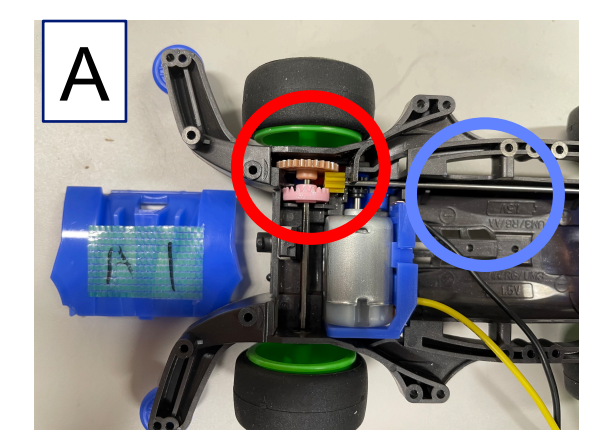


A subset of this dataset is used in the DCASE2021 Challenge Task2: **Unsupervised Anomalous Sound Detection for Machine Condition Monitoring under Domain Shifted Conditions**

## Toy car: Anomaly conditions



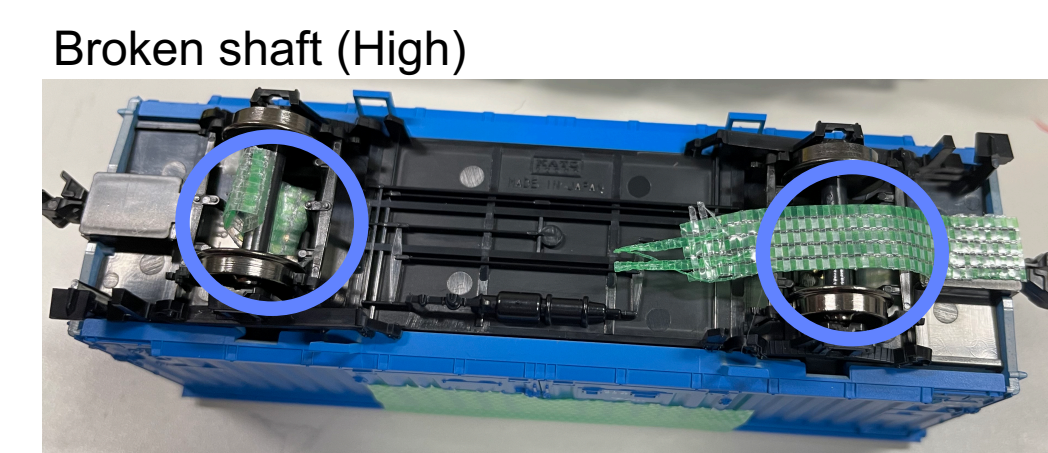
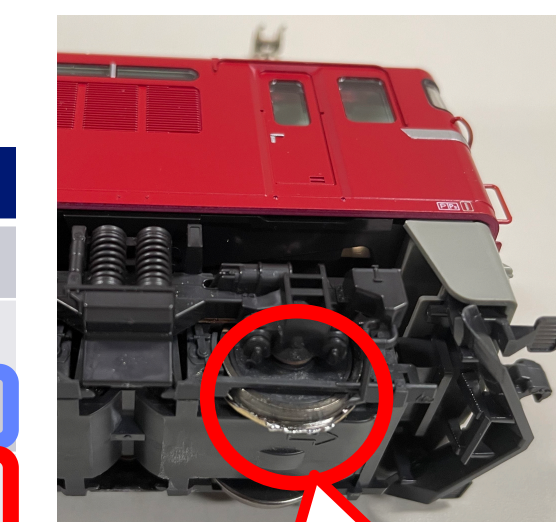
	Toy car	Toy train
a	Bent shaft	Obstructing stone
b	Deformed gears	Disjointed railway
c	Melted gears	Broken shaft
d	Damaged wheels	Flat tire



## Toy train: Anomaly conditions



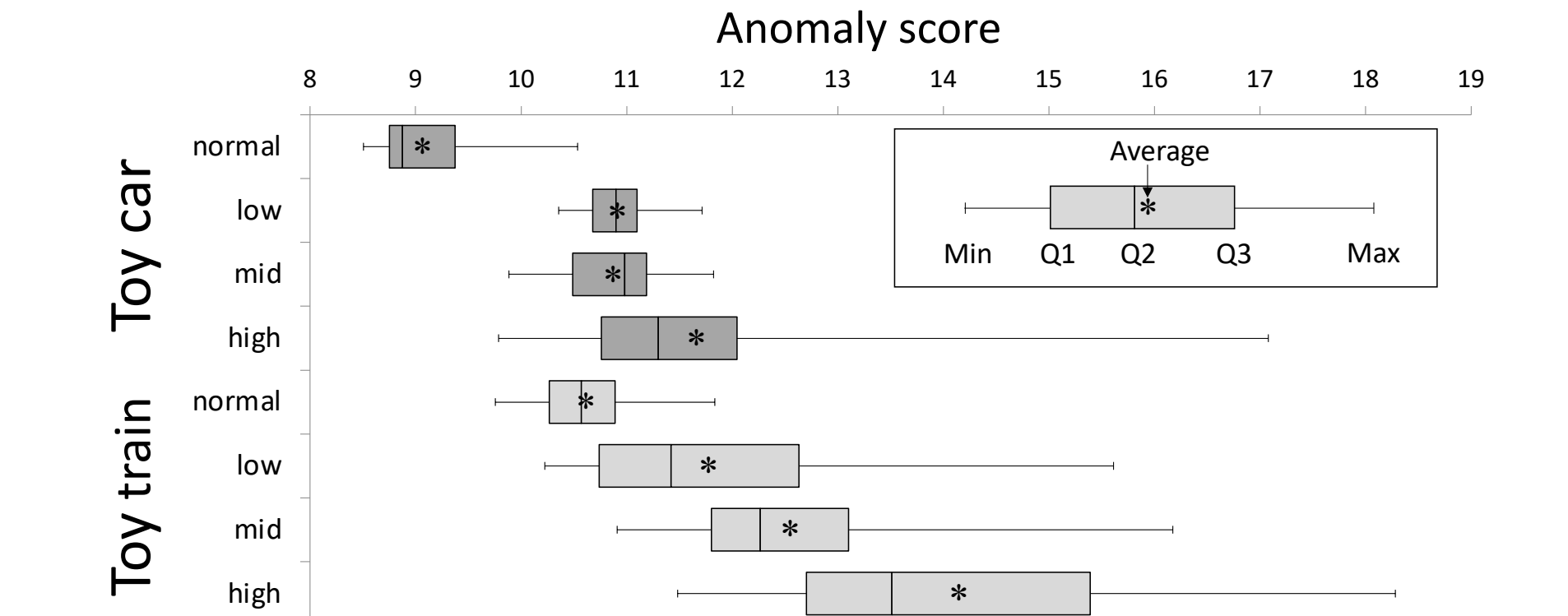
	Toy car	Toy train
a	Bent shaft	Obstructing stone
b	Deformed gears	Disjointed railway
c	Melted gears	Broken shaft
d	Damaged wheels	Flat tire



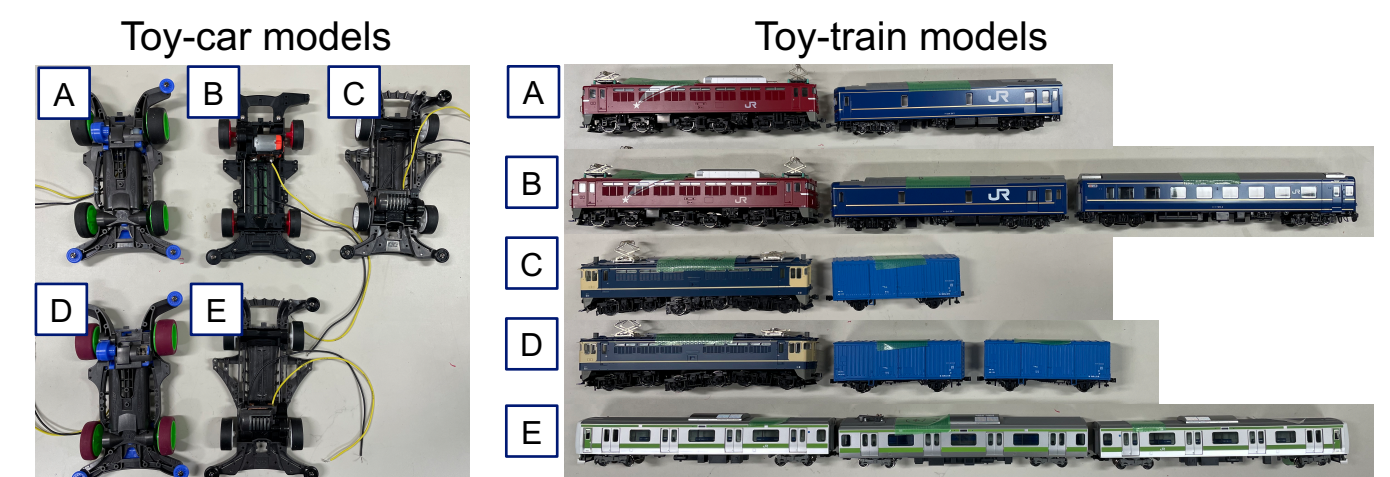
## Dataset analysis



Anomaly score for the dataset under clean condition (no background noise) calculated by the DCASE2020 baseline AE



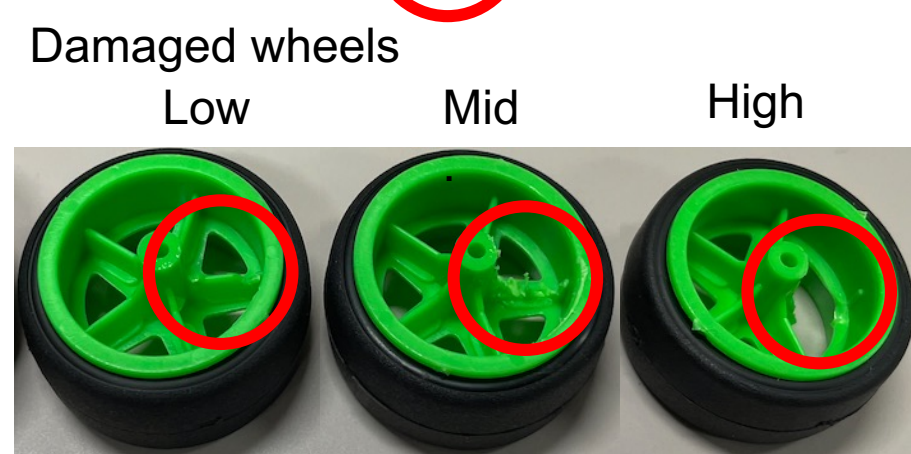
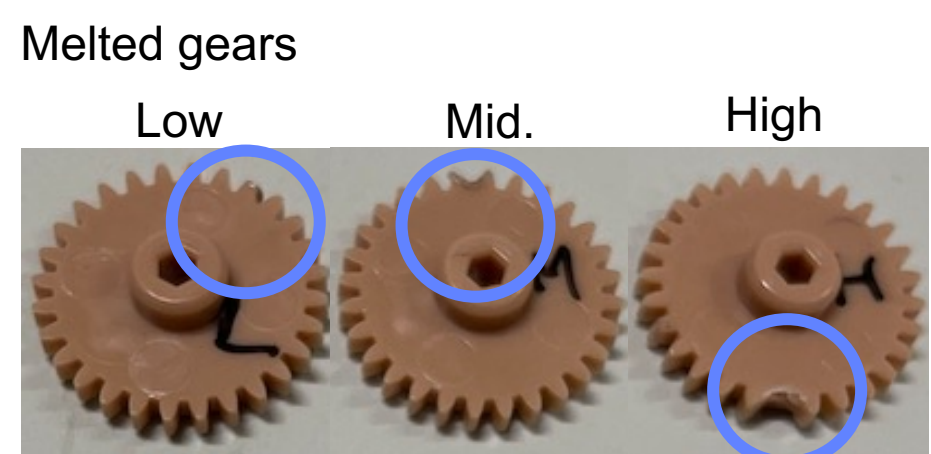
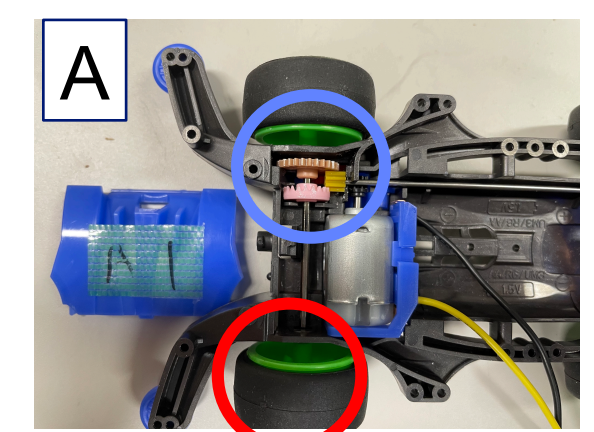
## What is ToyADMOS2?



## Toy car: Anomaly conditions



	Toy car	Toy train
a	Bent shaft	Obstructing stone
b	Deformed gears	Disjointed railway
c	Melted gears	Broken shaft
d	Damaged wheels	Flat tire



## Recipe (easy template for generating test conditions)



<https://github.com/nttclab/ToyADMOS2-dataset>

```
python mixer.py /path/to/ToyADMOS2 your_new_dataset recipe_benchmark.xlsx clean
python mixer.py /path/to/ToyADMOS2 your_new_dataset recipe_benchmark.xlsx 6
```

- recipe\_example\_car\_shift.xlsx is also another example.
- recipe\_template is a template, as well as one more example.

## DCASE2021 Challenge T2 results on ToyADMOS2



Rank	System	ToyCar		ToyTrain		ToyCar		ToyTrain	
		AUC	pAUC	AUC	pAUC	AUC	pAUC	AUC	pAUC
1	Lopez_IL_task2_4	81.44%	59.05%	77.56%	62.21%	69.97%	60.39%	62.38%	57.78%
2	Morita_SECOM_task2_3	56.47%	53.08%	52.23%	49.60%	66.04%	64.47%	40.47%	49.67%
3	Wilkinghoff_FKIE_task2_3	67.07%	63.05%	70.87%	56.19%	72.83%	63.77%	48.38%	52.39%
4	Kuroyanagi_NU-HDL_task2_3	62.02%	59.69%	71.49%	58.98%	61.38%	52.00%	54.42%	55.27%
5	Sakamoto_Fixstars_task2_1	81.76%	71.53%	66.24%	53.74%	66.46%	63.06%	57.75%	55.29%
21	DCASE2021 baseline task2 AE	76.33%	51.26%	69.89%	55.49%	58.02%	53.42%	67.18%	59.78%

Domain shift (indicated by arrows between ToyCar and ToyTrain columns)

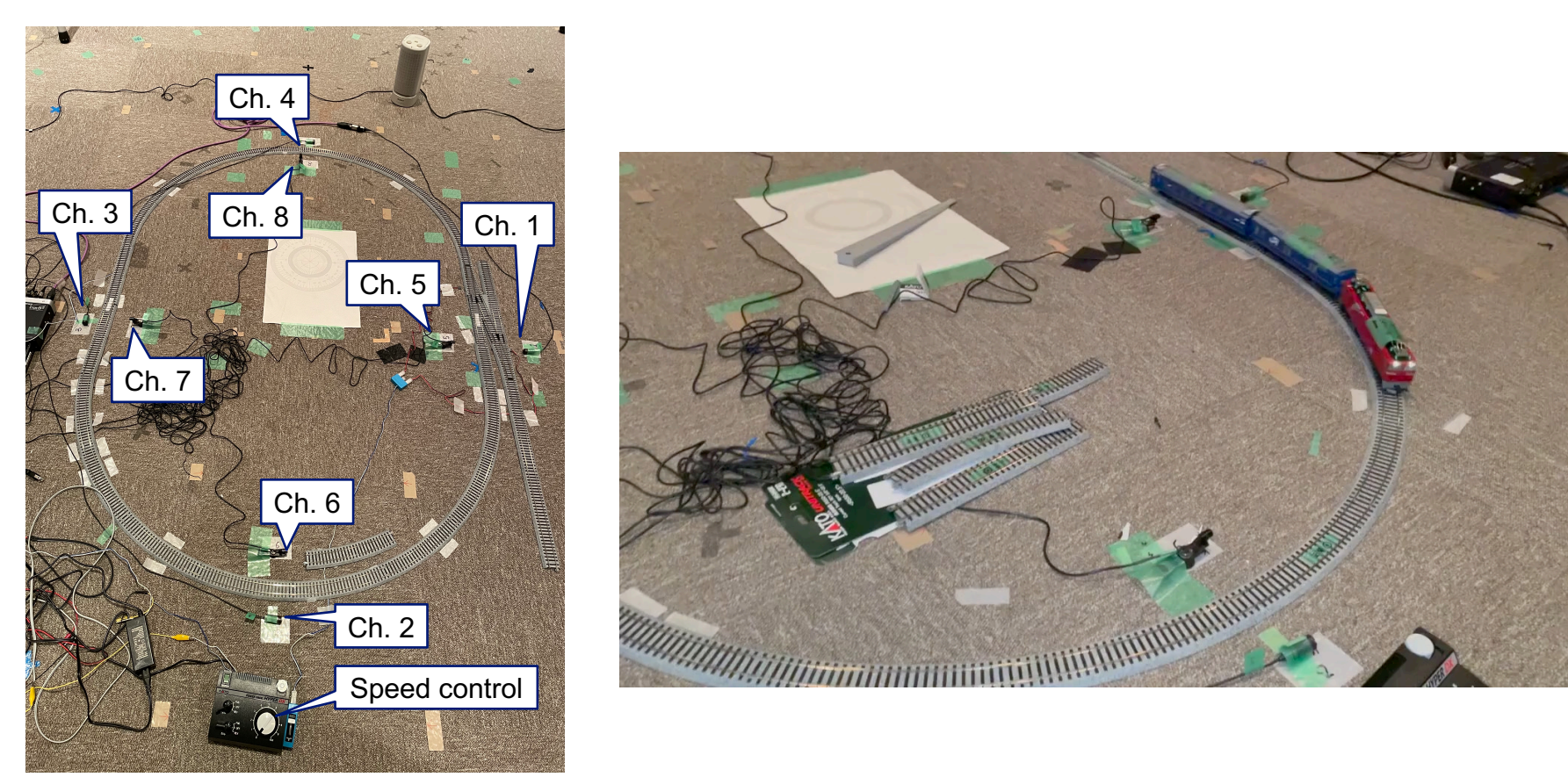
## Design choice for domain-shift conditions



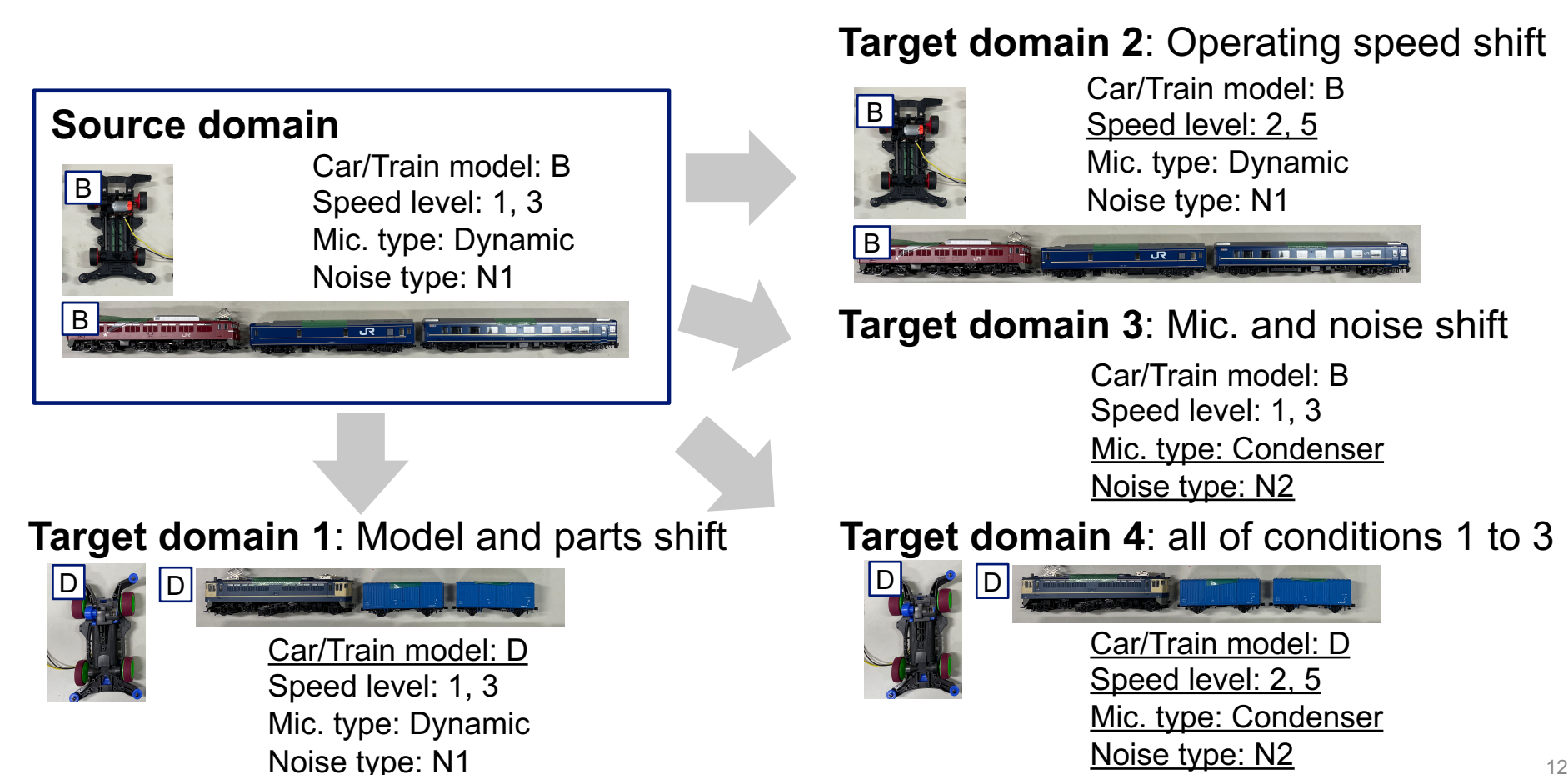
Variation settings of sub-datasets

	Toy car	Toy train
Model variations	Five (A, B, C, D, E)	Five (A, B, C, D, E)
Speed levels	Five (1, 2, 3, 4, 5)	Five (1, 2, 3, 4, 5)
Anomaly conditions	Four (a, b, c, d) x 3 damage levels	
Mic. type and channel config.	Dynamic Ch. 1-3	Ch. 1-4
	Condenser Ch. 4, 5	Ch. 5-8
Noise type	Four recordings	
Normal samples	1,094 samples x 5 models x 5 speed levels	91 hours x 2 ch-sets
Anomaly samples	324 samples x 5 models x 5 speed levels	27 hours x 2 ch-sets
Noise samples	Four types (24 hours) per a channel	

## Toy train: Microphone arrangement



## Example domain-shift condition



## Conclusion



- A new dataset for anomaly sound detection “ToyADMOS2” is proposed.
- Consists of two sub-datasets (Toy car and Toy train) for machine condition inspection.
- Domain shifts are represented by introducing several differences in operating conditions, such as different machine models and parts configurations, operating speeds, microphone arrangements and background noise types.
- The dataset can be used to assess anomaly detection systems. It is desired to develop anomaly detection systems working well even under domain-shift conditions.