선로전환기

AI-Based Railway PMD(Point Machine Device) Failure Prediction System

Team: **Daejeon X**
AI Bigdata Department

Our Team

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Kaung Mon Thant	Front-end and Back-end developer, documentation
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PARTICIPATING COMPANY

Sehwa Co., Ltd

CONTENTS

Problem Statement

Train Accidents

27% of all train accidents were caused due to the **PMD(선로전환기)**.

Proposed Solution

선로전환기

1 Classify PMD Event Pattern

- Identifying issues through the event classification

2 Detect PMD Abnormal Event

- Detecting abnormal event

3 Predict PMD Failure

- Predicting potential problem events

Our Solution

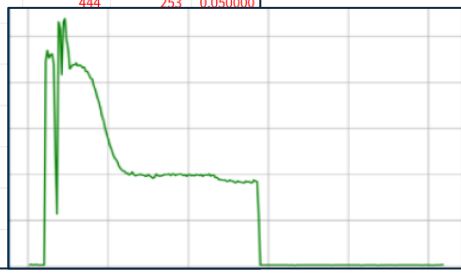
PMD (선로전환기)

Failure Prediction System

AI

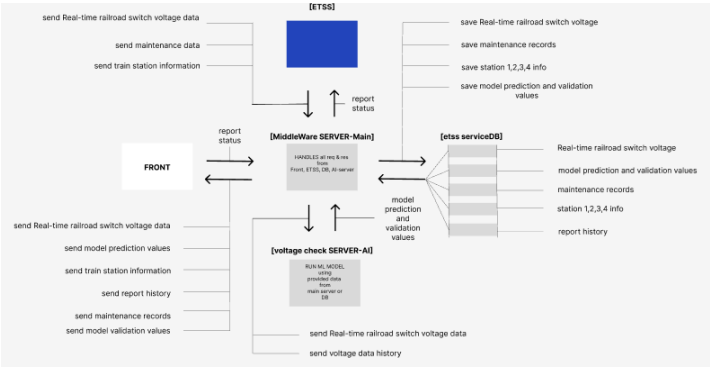
- Failure Prediction

	time_stamp	pmd_type	event_num	event_seq	ac_curr
113,252	20221103010059580	PMD011	444	250	0.060000
113,253	20221103010059580	PMD011	444	251	0.060000
113,254	20221103010059580	PMD011	444	252	0.050000
113,255	20221103010059580	PMD011	444	253	0.050000
113,256	20221103010059580	PMD011			
113,257	20221103010059580	PMD011			
113,258	20221103010059580	PMD011			
113,259	20221103010059580	PMD011			
113,260	20221103010059580	PMD011			
113,261	20221103010059580	PMD011			



Backend

- Managing data

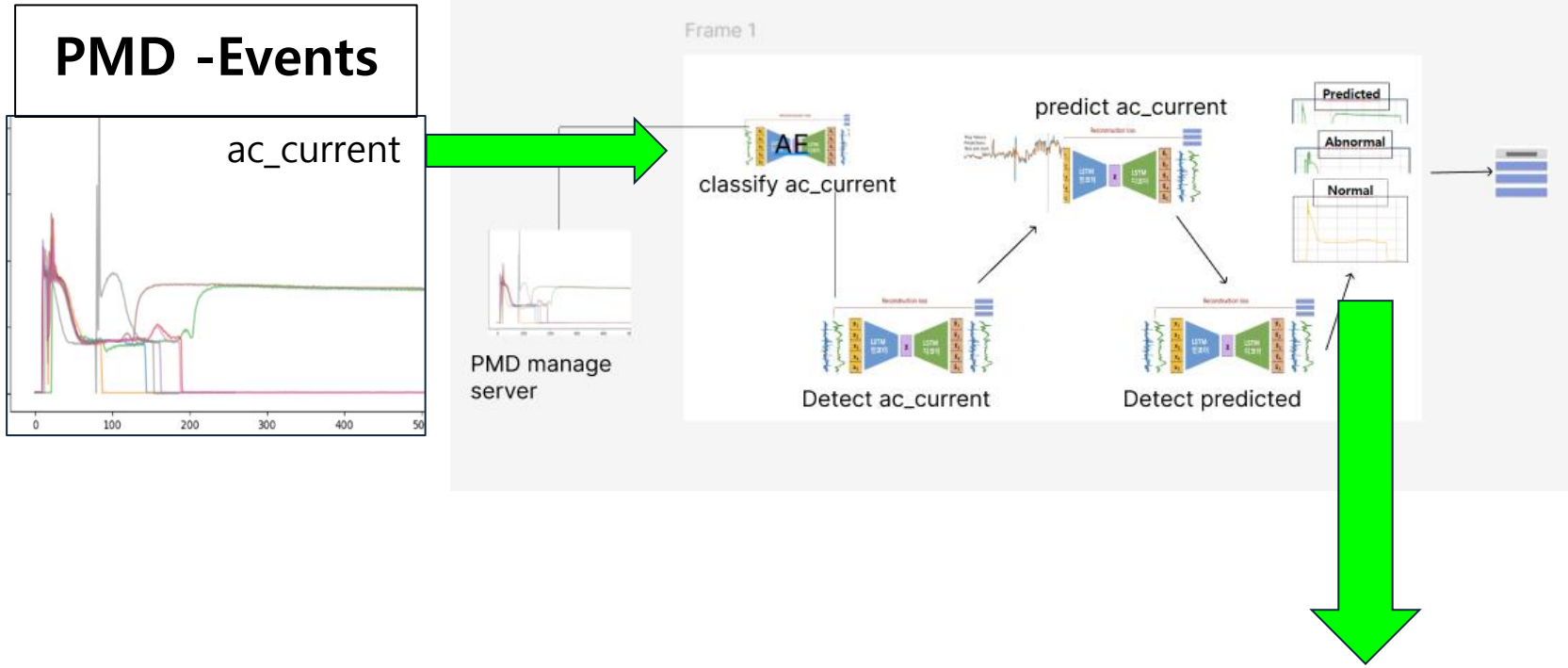


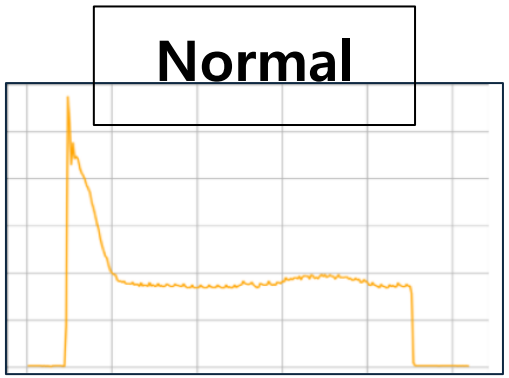
Frontend

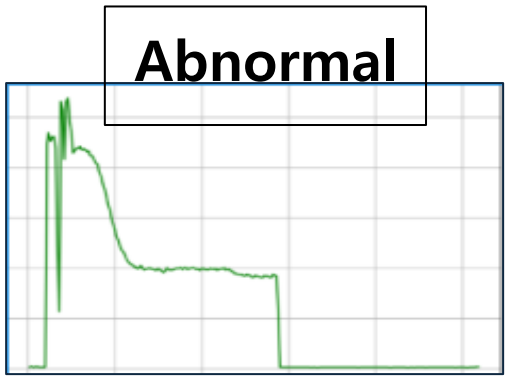
- Event display

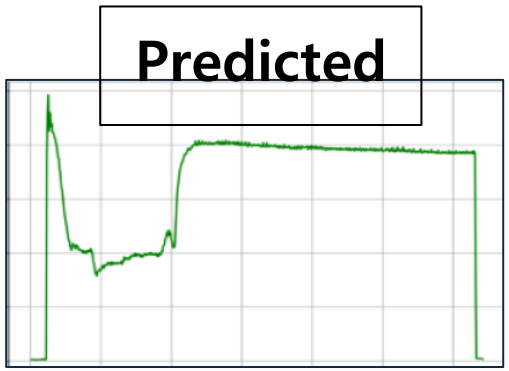
AI

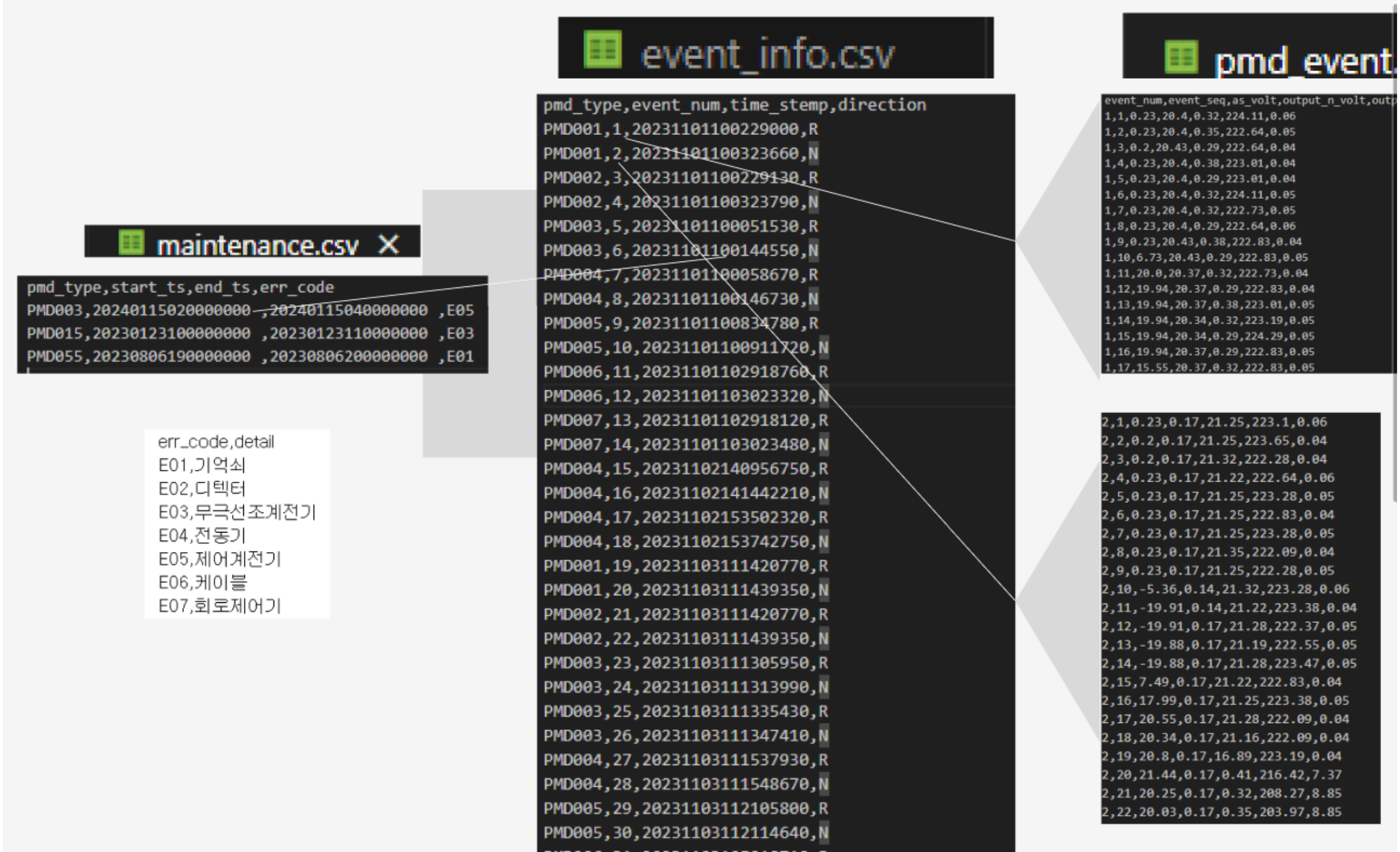
- Receive Event data.
- classify Event to categorize its type.
- Determine event
  - ○ normal or abnormal.
- Predict Event
- Determine Predicted Event
  - ○ Normal or abnormal
- Save results in the Backend







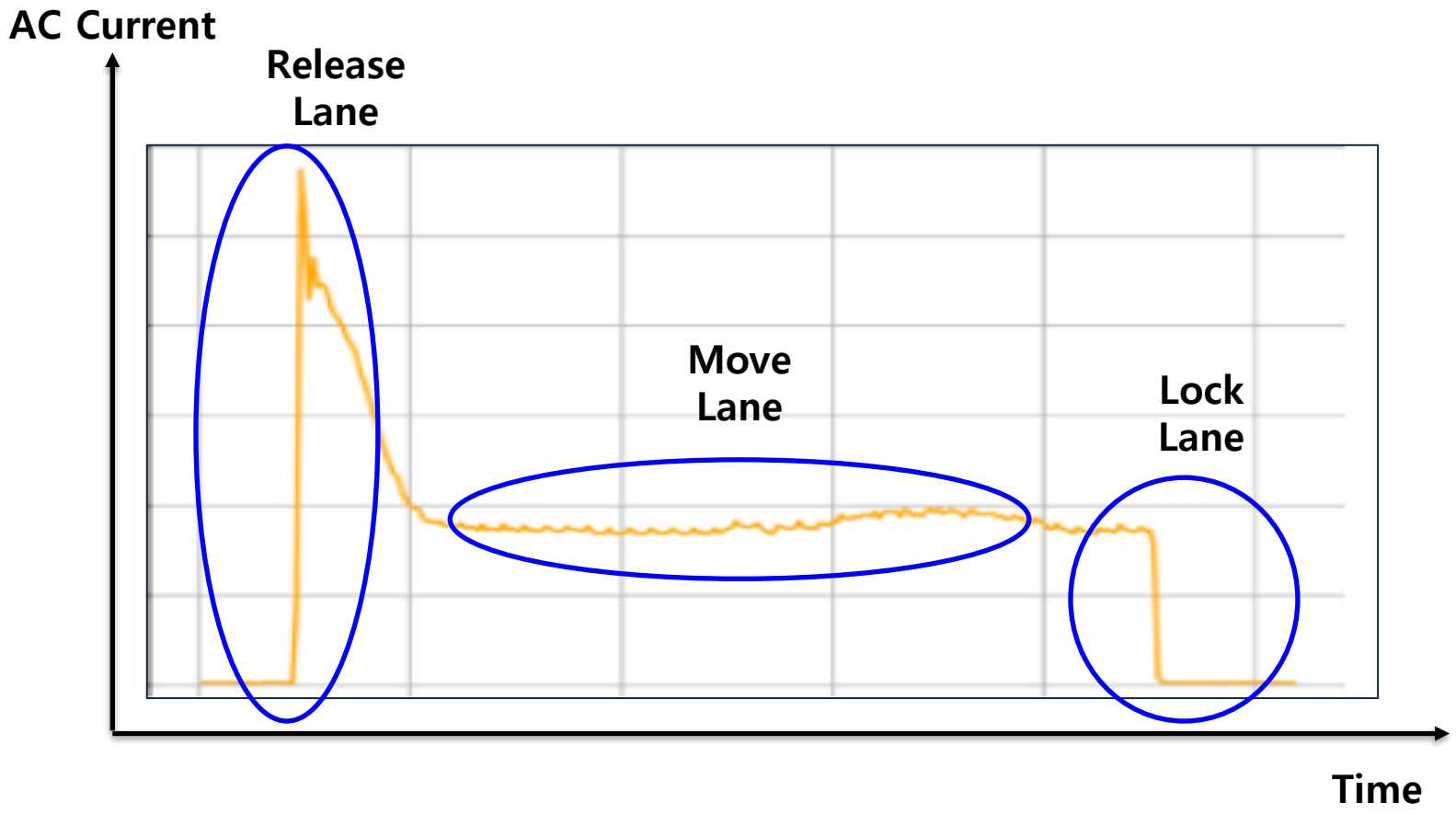



event_info.csv
pmd_event.
maintenance.csv
pmd_type,start_ts,end_ts,err_code
PMD003,20240115020000000 ,20240115040000000 ,E05
PMD015,20230123100000000 ,20230123110000000 ,E03
PMD055,20230806190000000 ,20230806200000000 ,E01
err_code,detail
E01,기억쇠
E02,디텍터
E03,무극선조계전기
E04,전동기
E05,제어계전기
E06,케이블
E07,회로제어기
pmd_type,event_num,time_stemp,direction
PMD001,1,20231101100229000,R
PMD001,2,20231101100323660,N
PMD002,3,20231101100229130,R
PMD002,4,20231101100323790,N
PMD003,5,20231101100051530,R
PMD003,6,20231101100144550,N
PMD004,7,20231101100058670,R
PMD004,8,20231101100146730,N
PMD005,9,20231101100834780,R
PMD005,10,20231101100911720,N
PMD006,11,20231101102918760,R
PMD006,12,20231101103023320,N
PMD007,13,20231101102918120,R
PMD007,14,20231101103023480,N
PMD004,15,20231102140956750,R
PMD004,16,20231102141442210,N
PMD004,17,20231102153502320,R
PMD004,18,20231102153742750,N
PMD001,19,20231103111420770,R
PMD001,20,20231103111439350,N
PMD002,21,20231103111420770,R
PMD002,22,20231103111439350,N
PMD003,23,20231103111305950,R
PMD003,24,20231103111313990,N
PMD003,25,20231103111335430,R
PMD003,26,20231103111347410,N
PMD004,27,20231103111537930,R
PMD004,28,20231103111548670,N
PMD005,29,20231103112105800,R
PMD005,30,20231103112114640,N
event_num,event_seq,as_volt,output_n_volt,outp
1,1,0.23,20.4,0.32,224.11,0.06
1,2,0.23,20.4,0.35,222.64,0.05
1,3,0.2,20.43,0.29,222.64,0.04
1,4,0.23,20.4,0.38,223.01,0.04
1,5,0.23,20.4,0.29,223.01,0.04
1,6,0.23,20.4,0.32,224.11,0.05
1,7,0.23,20.4,0.32,222.73,0.05
1,8,0.23,20.4,0.29,222.64,0.06
1,9,0.23,20.43,0.38,222.83,0.04
1,10,6.73,20.43,0.29,222.83,0.05
1,11,20.0,20.37,0.32,222.73,0.04
1,12,19.94,20.37,0.29,222.83,0.04
1,13,19.94,20.37,0.38,223.01,0.05
1,14,19.94,20.34,0.32,223.19,0.05
1,15,19.94,20.34,0.29,224.29,0.05
1,16,19.94,20.37,0.29,222.83,0.05
1,17,15.55,20.37,0.32,222.83,0.05
2,1,0.23,0.17,21.25,223.1,0.06
2,2,0.2,0.17,21.25,223.65,0.04
2,3,0.2,0.17,21.32,222.28,0.04
2,4,0.23,0.17,21.22,222.64,0.06
2,5,0.23,0.17,21.25,223.28,0.05
2,6,0.23,0.17,21.25,222.83,0.04
2,7,0.23,0.17,21.25,223.28,0.05
2,8,0.23,0.17,21.35,222.09,0.04
2,9,0.23,0.17,21.25,222.28,0.05
2,10,-5.36,0.14,21.32,223.28,0.06
2,11,-19.91,0.14,21.22,223.38,0.04
2,12,-19.91,0.17,21.28,222.37,0.05
2,13,-19.88,0.17,21.19,222.55,0.05
2,14,-19.88,0.17,21.28,223.47,0.05
2,15,7.49,0.17,21.22,222.83,0.04
2,16,17.99,0.17,21.25,223.38,0.05
2,17,20.55,0.17,21.28,222.09,0.04
2,18,20.34,0.17,21.16,222.09,0.04
2,19,20.8,0.17,16.89,223.19,0.04
2,20,21.44,0.17,0.41,216.42,7.37
2,21,20.25,0.17,0.32,208.27,8.85
2,22,20.03,0.17,0.35,203.97,8.85

PMD AC Current Pattern Graph

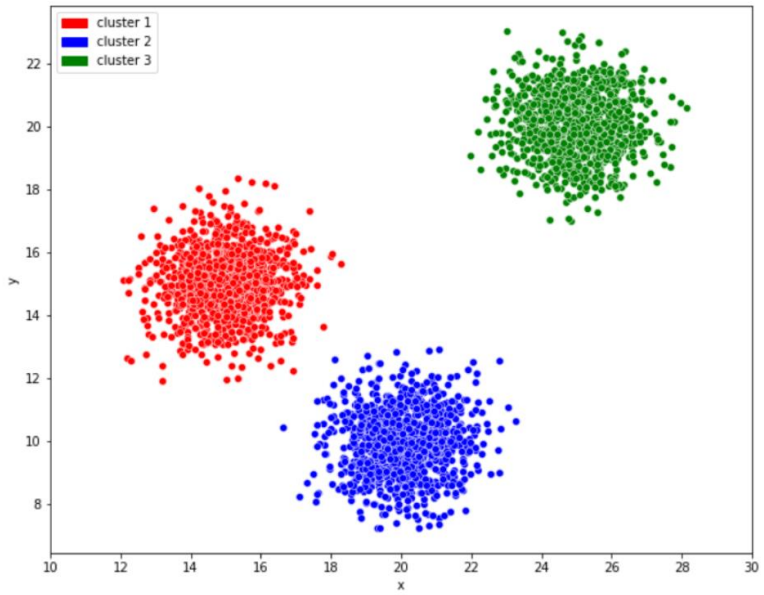
선로전환기

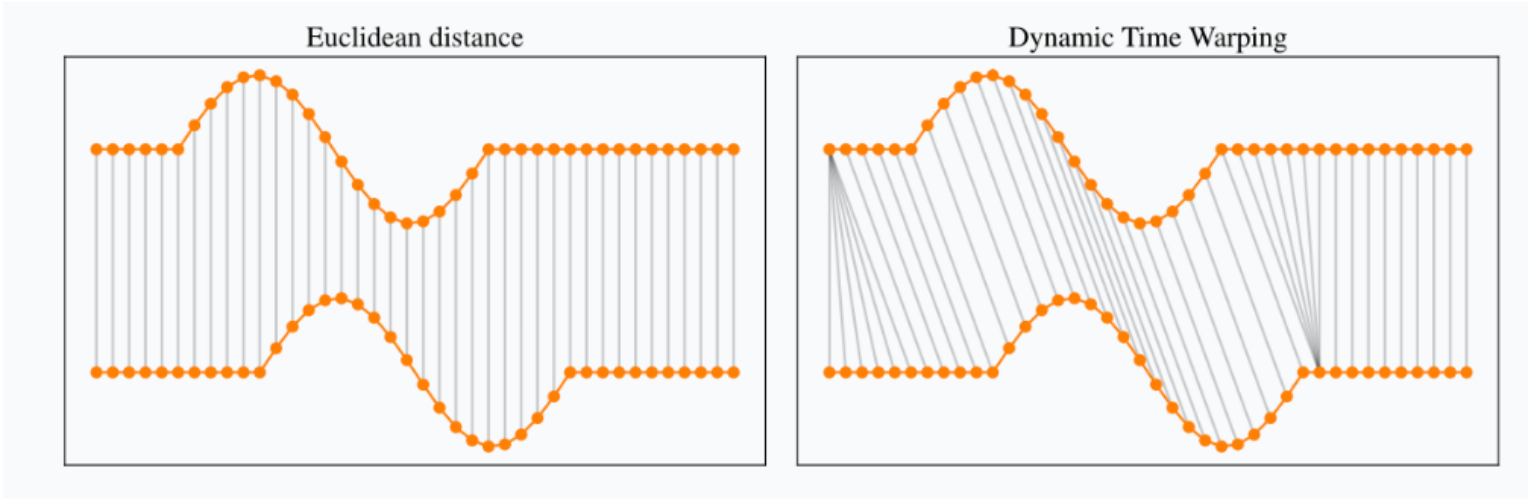
as_volt, output_n_volt, output_r_volt, ac_volt, **ac_curr**

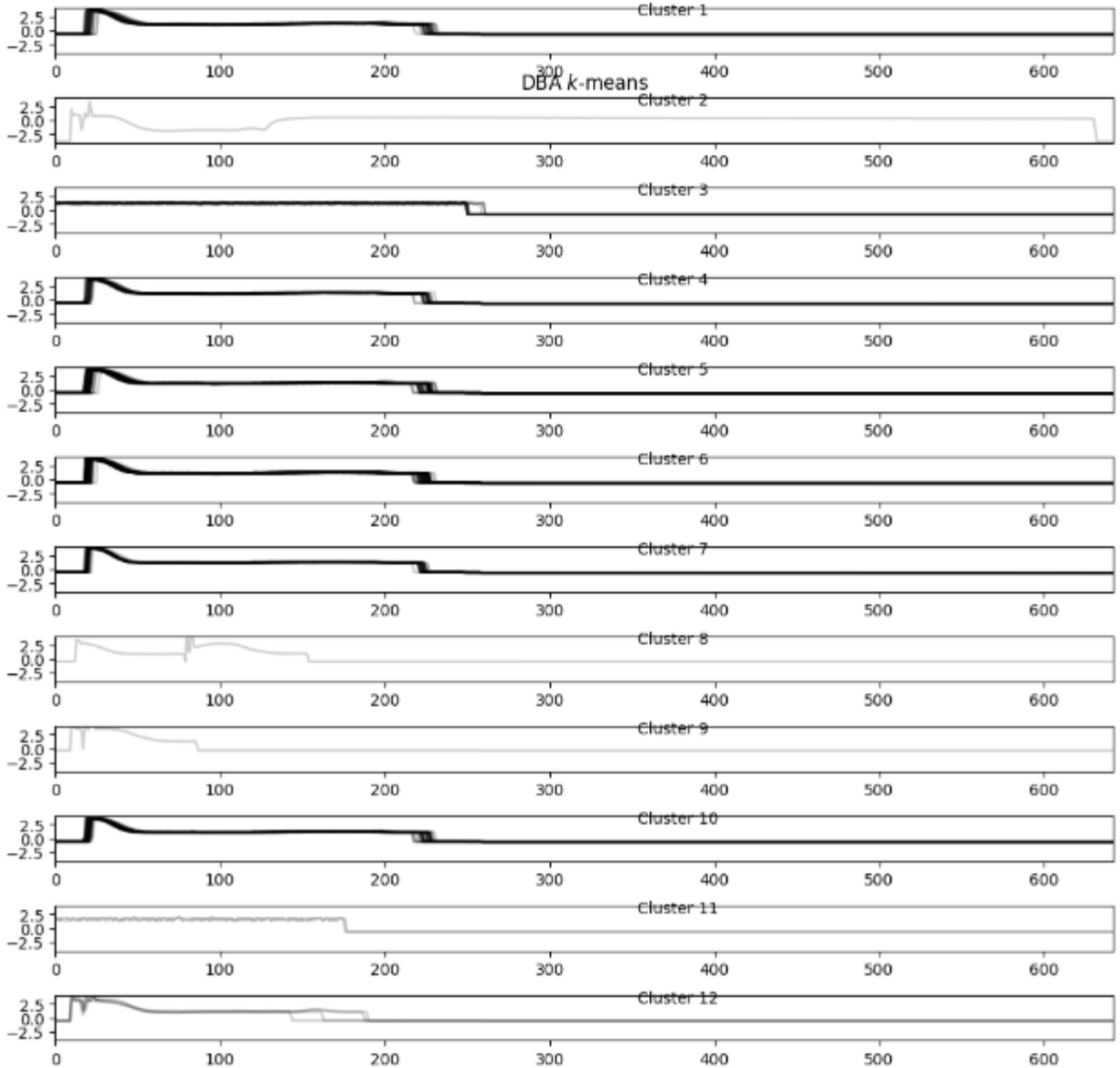


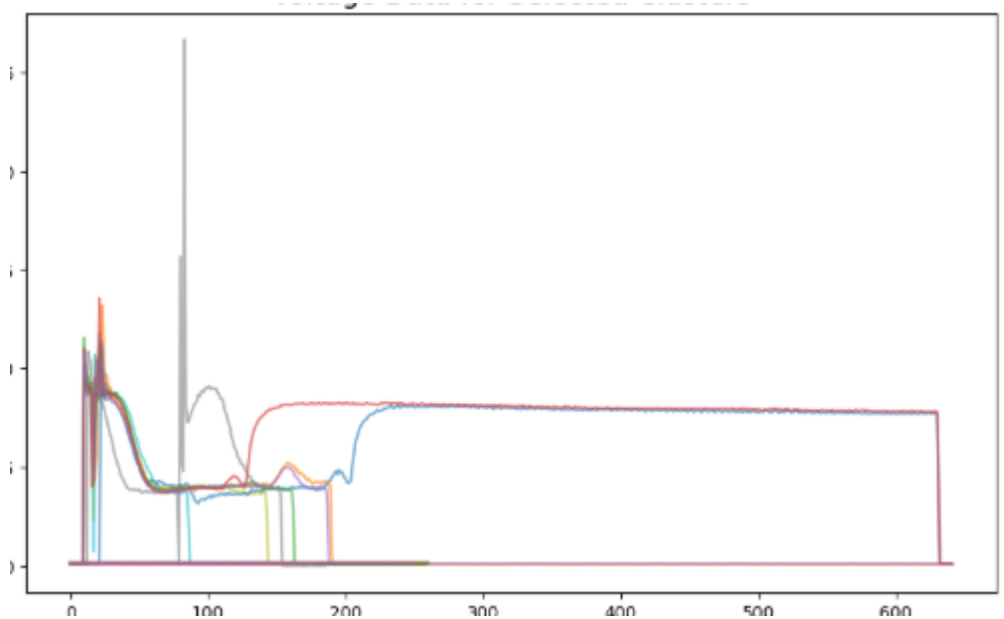
군집 모델

K-mean


cluster 1
cluster 2
cluster 3
x
y

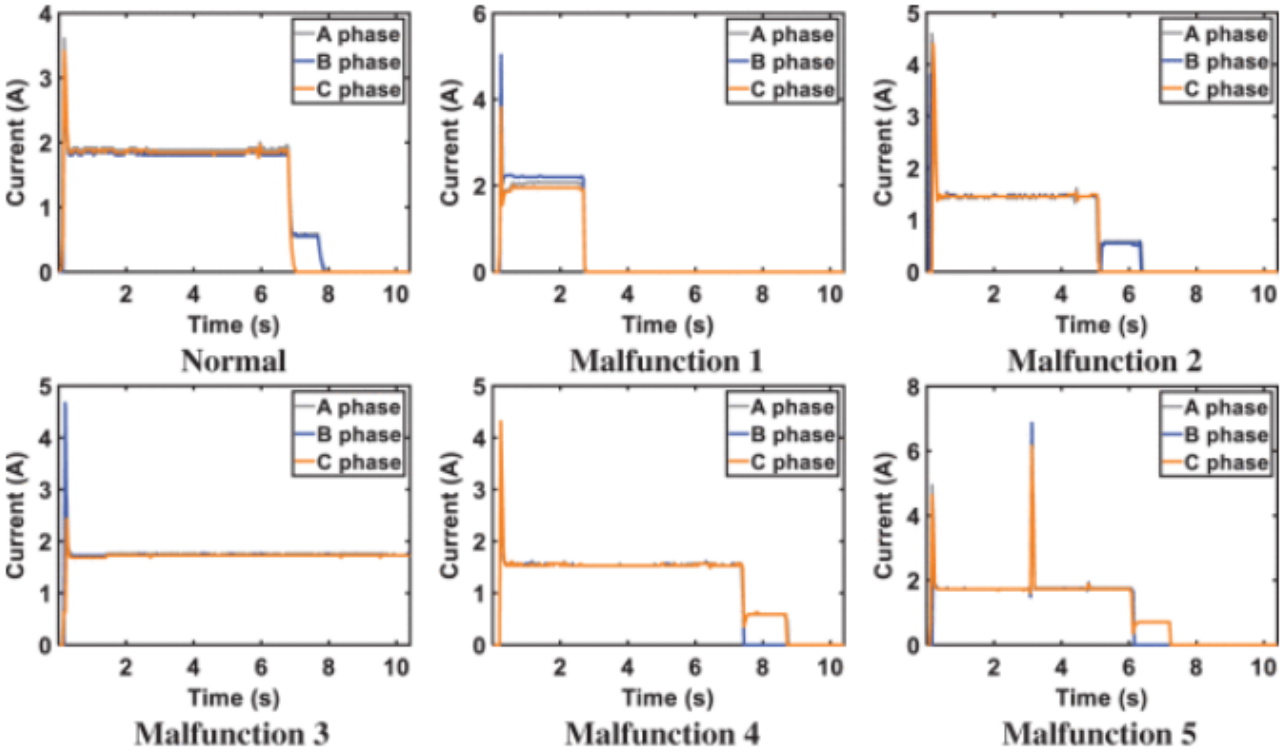

Euclidean distance
Dynamic Time Warping





Selected Clusters: [1, 2, 7, 8, 10, 11, 12, 14]
Indices of Selected Clusters: [428 429 430 431 432 433 434 435 443 445 447 448 458 499 500 512 513 514
515 516 517 530 531 532 538 538 539 540 541 542 543 544 545 546 547 548
549 554 555 556 557 558 559 560 561 573 598 599]

	event_num	voltage_as
428	429	[0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
429	430	[0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
430	431	[0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
431	432	[0.17, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
432	433	[0.13, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
433	434	[0.13, 0.13, 0.13, 0.13, 0.15, 0.13, 0.15, 0.1...
434	435	[0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
435	436	[0.15, 0.15, 0.17, 0.15, 0.15, 0.15, 0.15, 0.1...
443	444	[0.06, 0.09, 0.06, 0.06, 0.09, 0.06, 0.06, 0.0...
445	446	[0.06, 0.05, 0.06, 0.09, 0.06, 0.06, 0.06, 0.0...
447	448	[0.06, 0.06, 0.06, 0.07, 0.06, 0.05, 0.06, 0.0...
448	449	[0.06, 0.06, 0.09, 0.07, 0.06, 0.06, 0.06, 0.0...
458	459	[0.06, 0.09, 0.06, 0.06, 0.06, 0.06, 0.06, 0.0...
499	500	[0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.09, 0.1,...
500	501	[0.1, 0.1, 0.1, 0.1, 0.11, 0.1, 0.1, 0.1, 0.1,...
512	513	[0.13, 0.13, 0.13, 0.15, 0.13, 0.13, 0.13, 0.1...
513	514	[0.12, 0.13, 0.13, 0.13, 0.13, 0.13, 0.13, 0.1...



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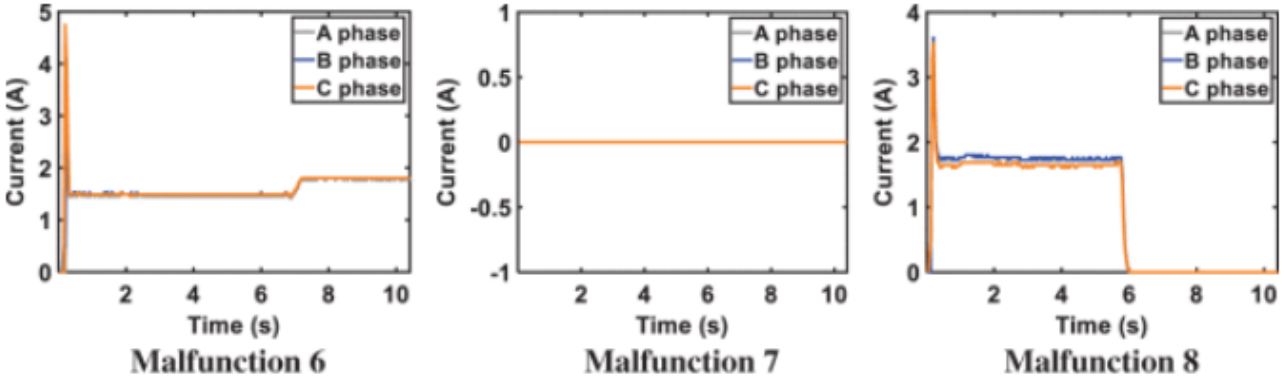
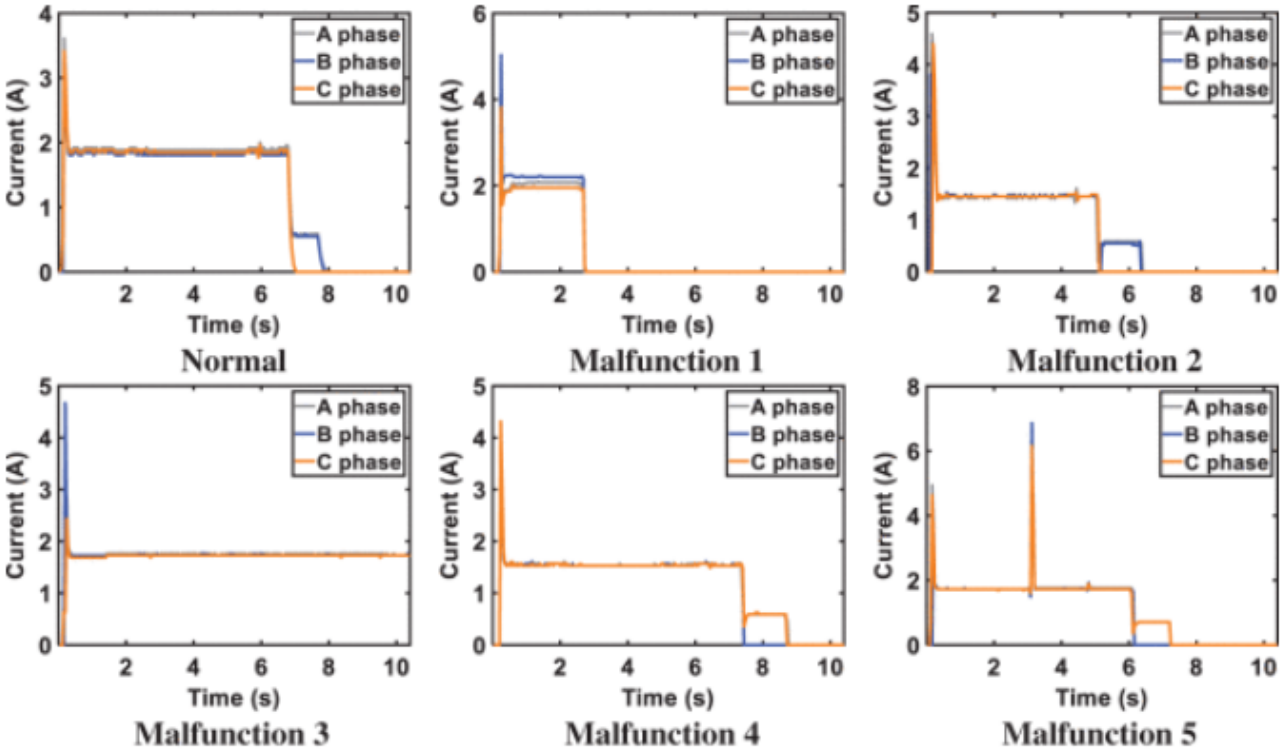


Category	Curve shape	Condition reason
Normal	Normal.	Normal.
Malfunction 1	The current abruptly falls to zero.	Inadequate contact or not properly locked.
Malfunction 2	Interruption of current flow while releasing.	Irregular switch connection.
Malfunction 3	Current remains steady throughout the release process.	Opposition to mechanical stress.
Malfunction 4	The release time of the current is prolonged.	Irregular state of the motor.
Malfunction 5	A pulse arises amidst the switching process.	Inadequate connection of the automatic switch.
Malfunction 6	During the release process, the current escalates.	Internal obstruction and heightened friction.
Malfunction 7	The current consistently stays at zero.	Dysfunction in the action circuit.
Malfunction 8	Discharge without incremental phases.	Irregularity in the signaling circuit.



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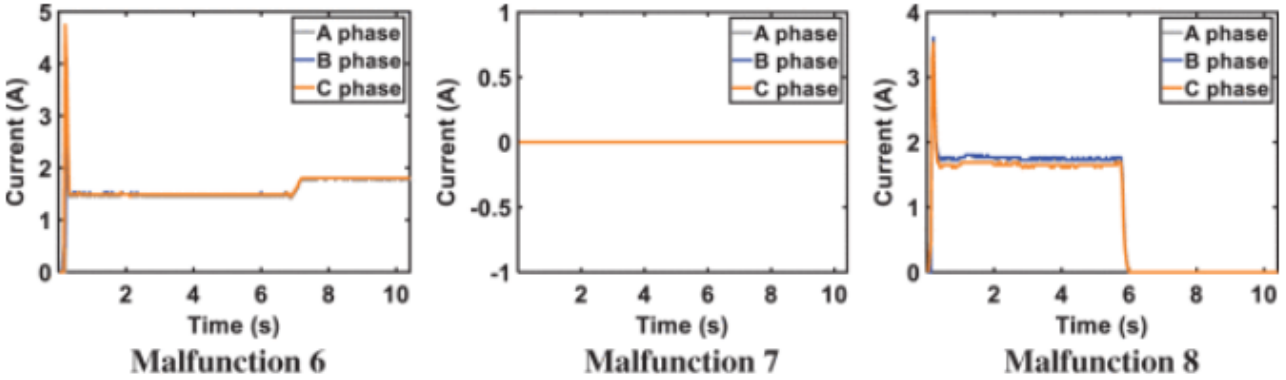
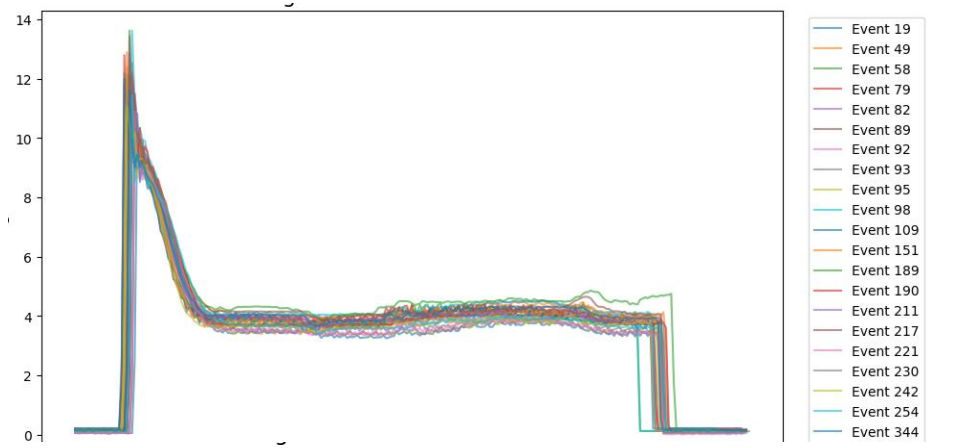
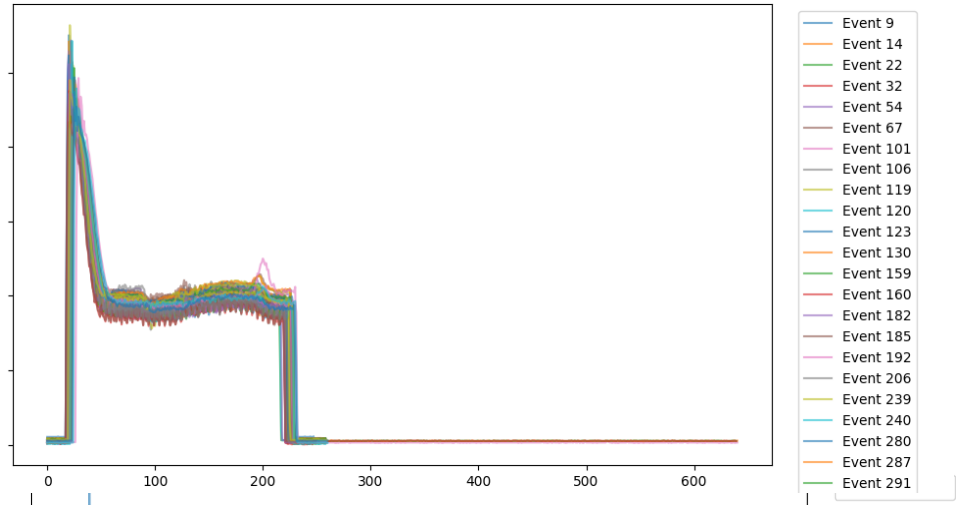
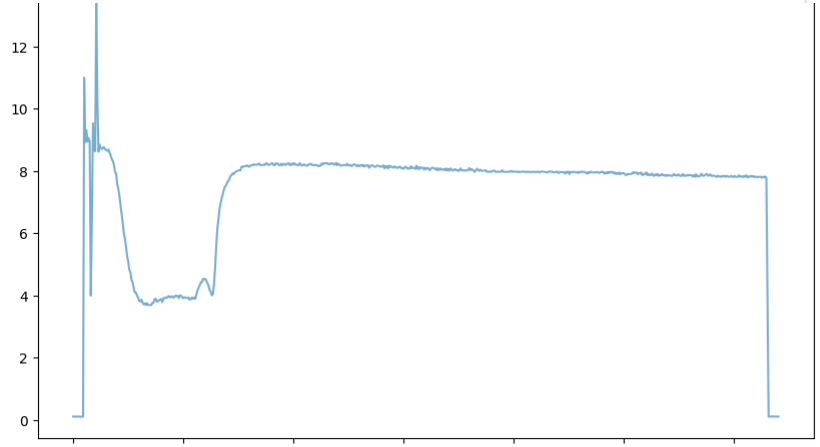


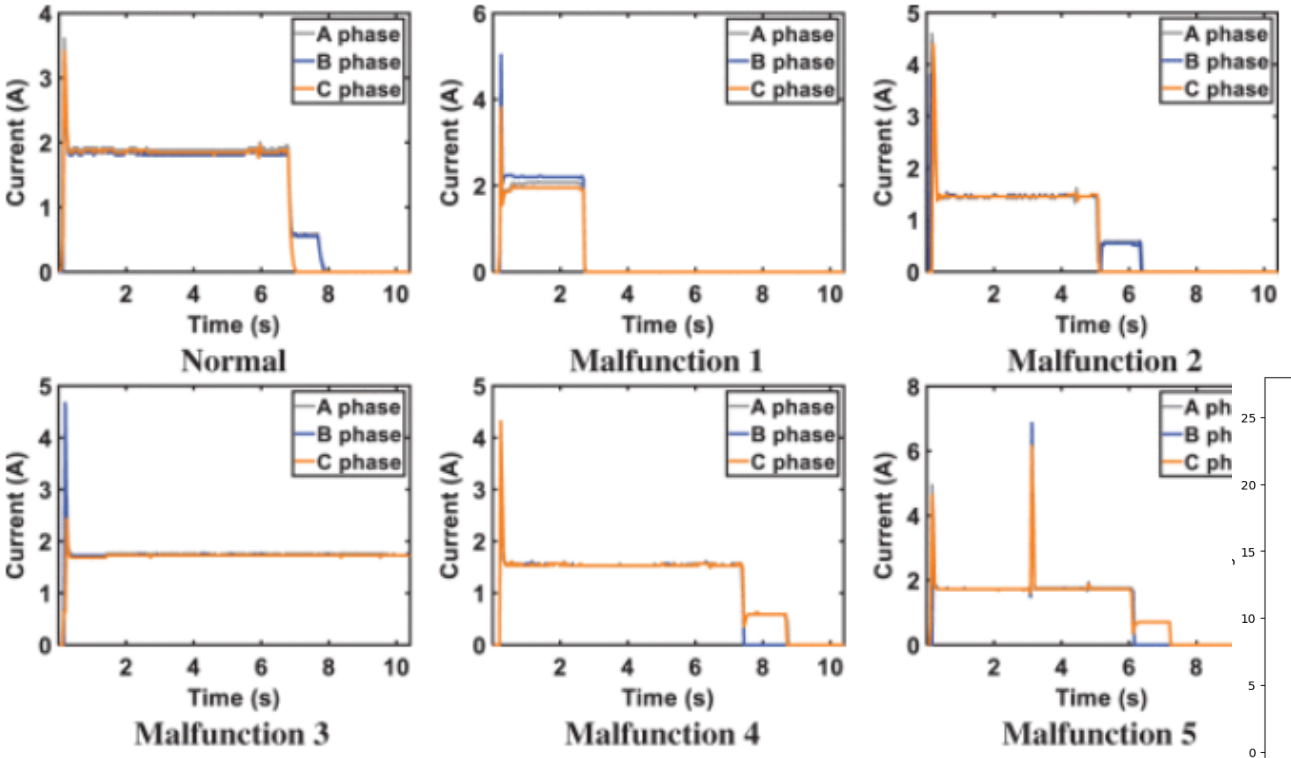
클래스 4

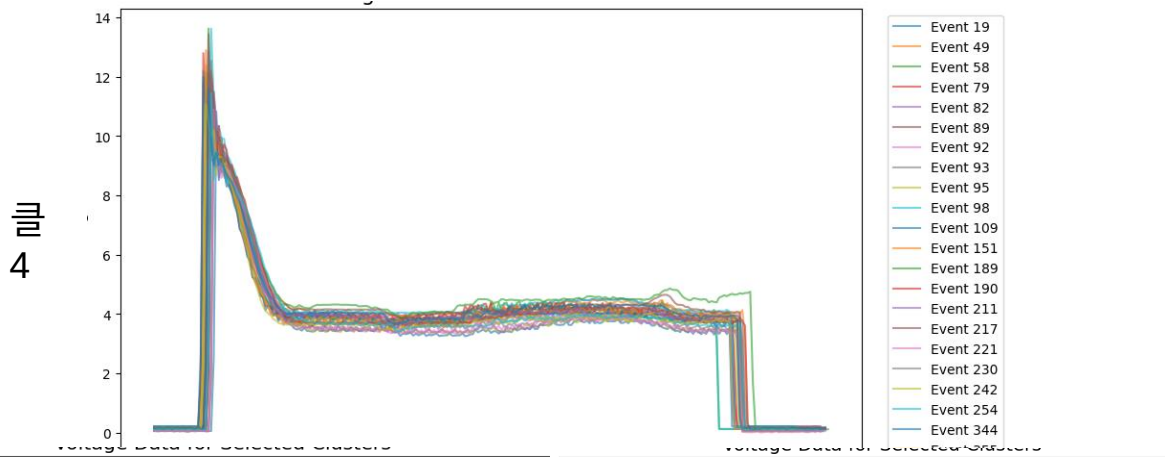


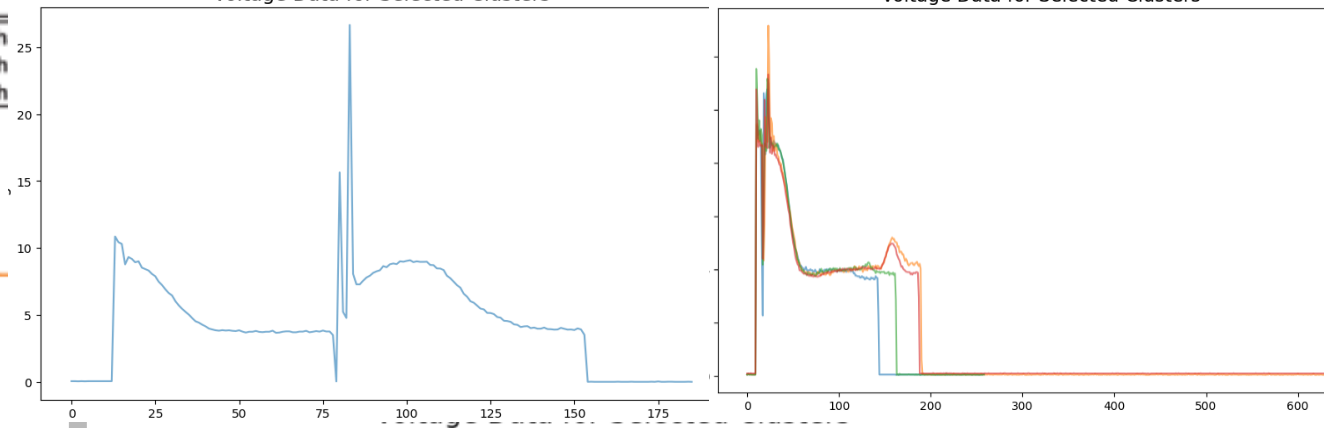
클래스 5











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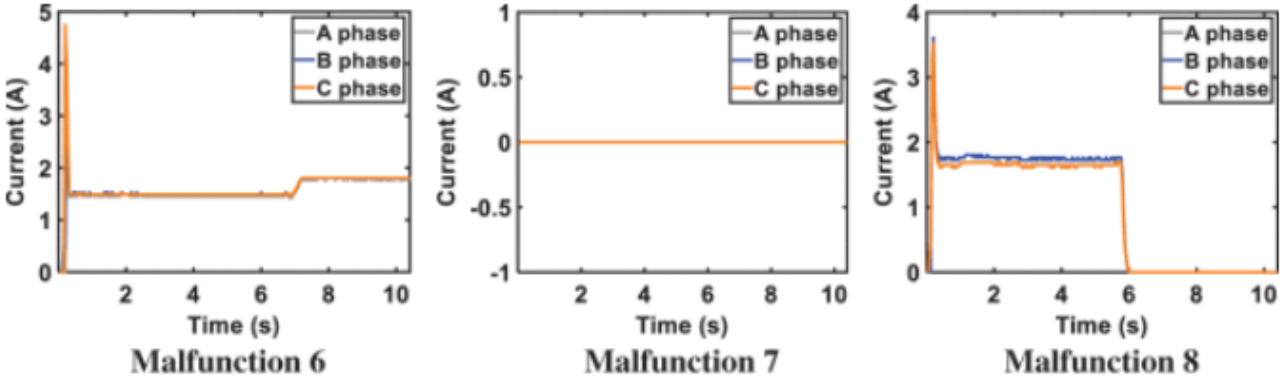

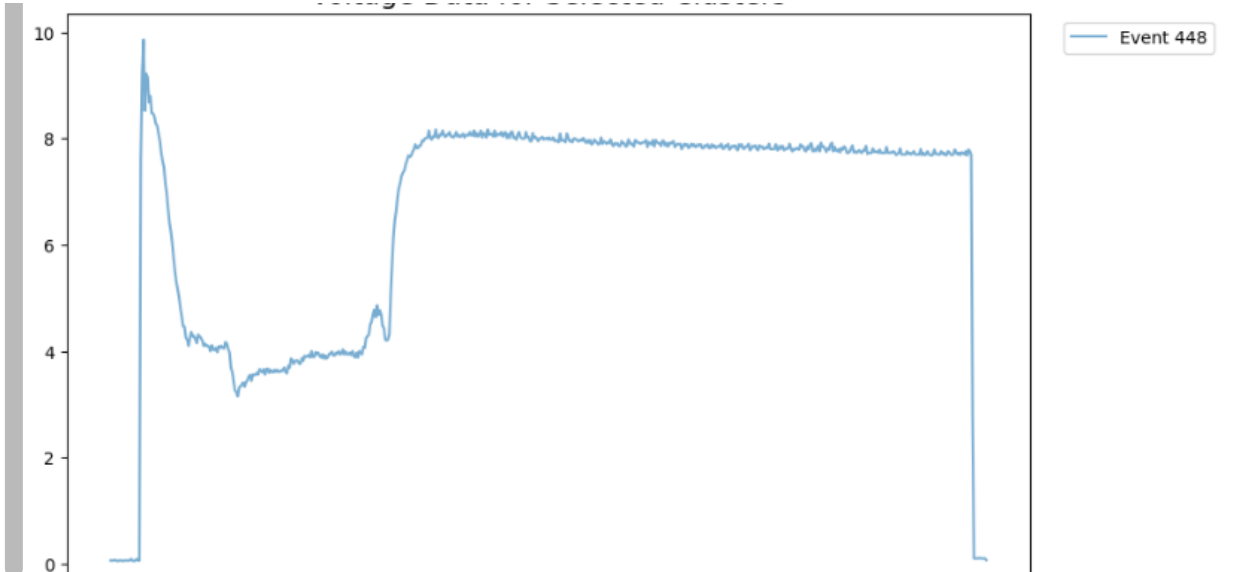

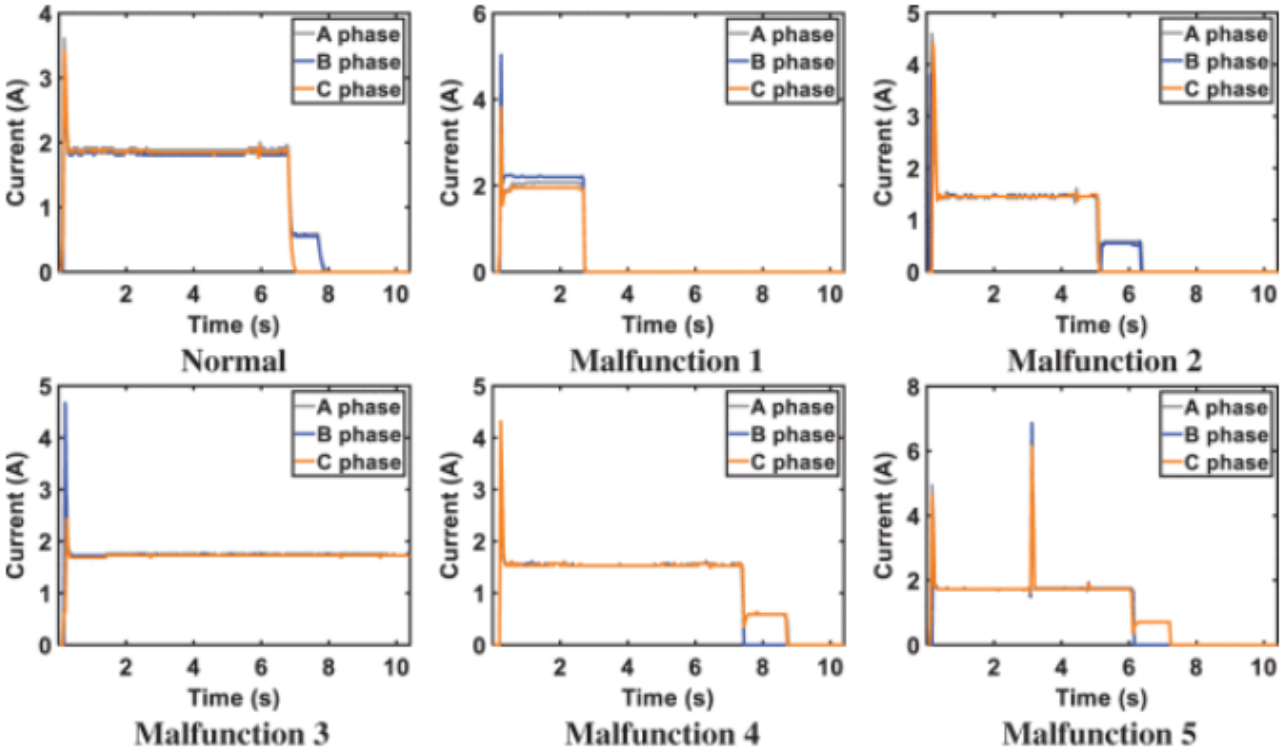

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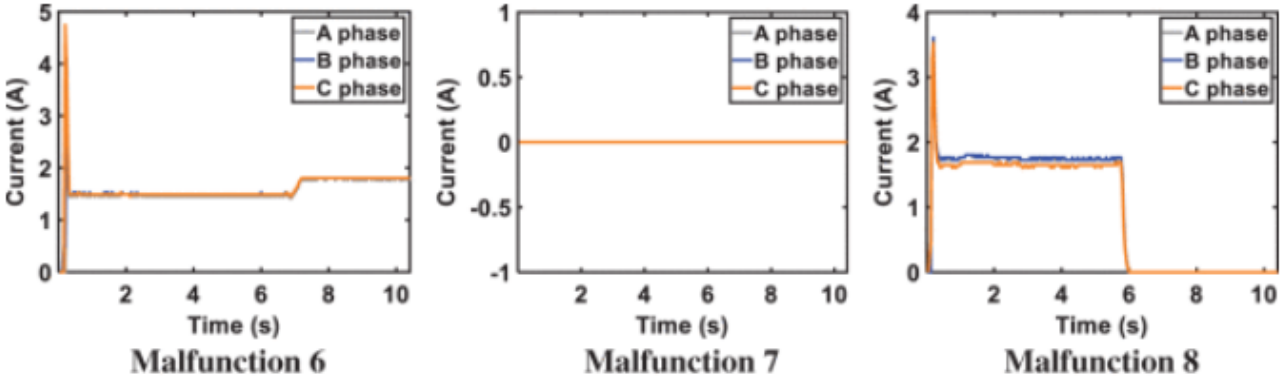

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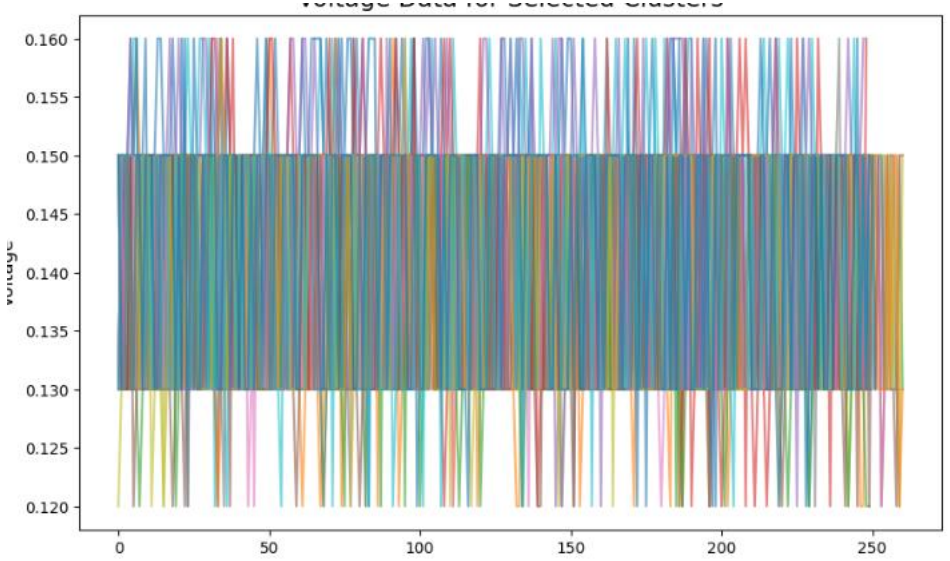

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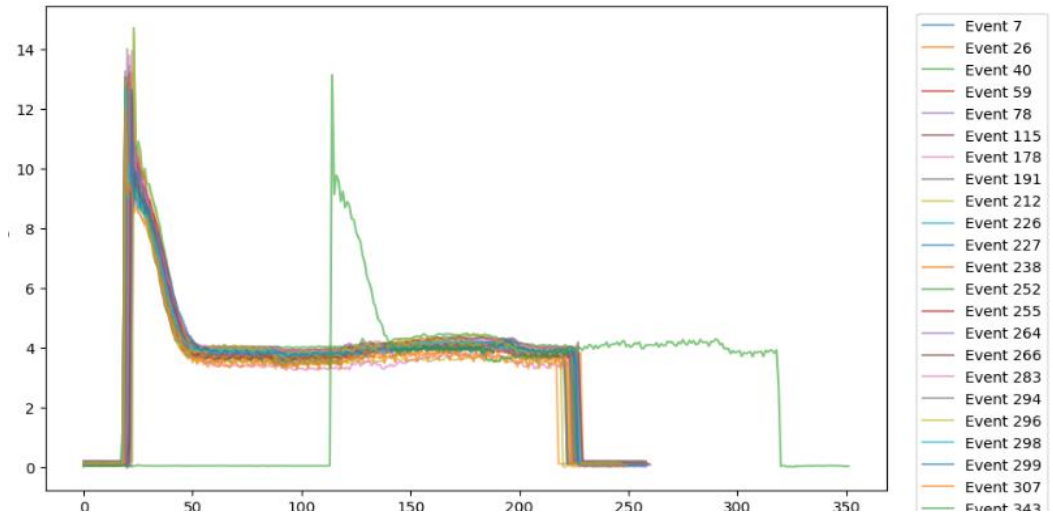
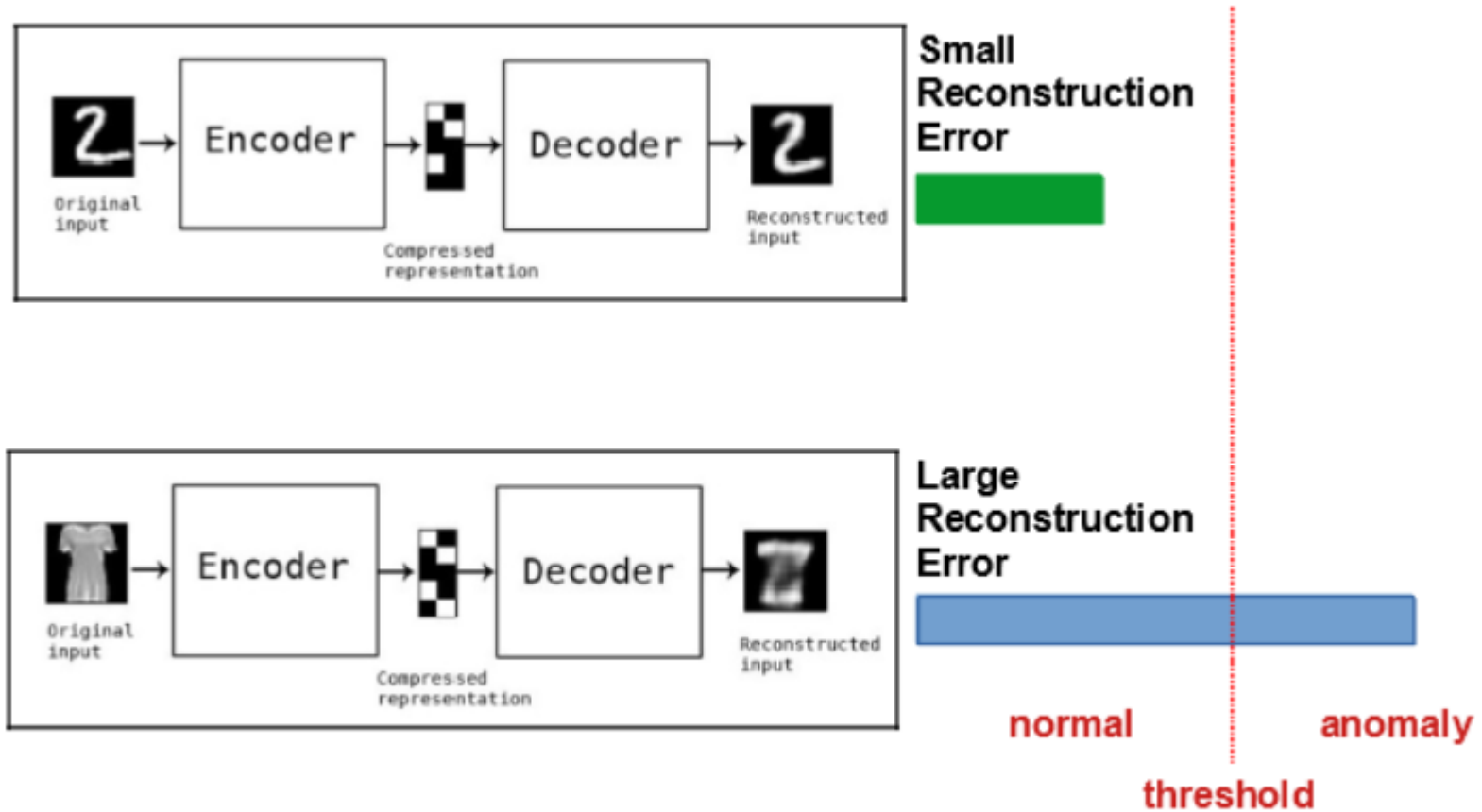
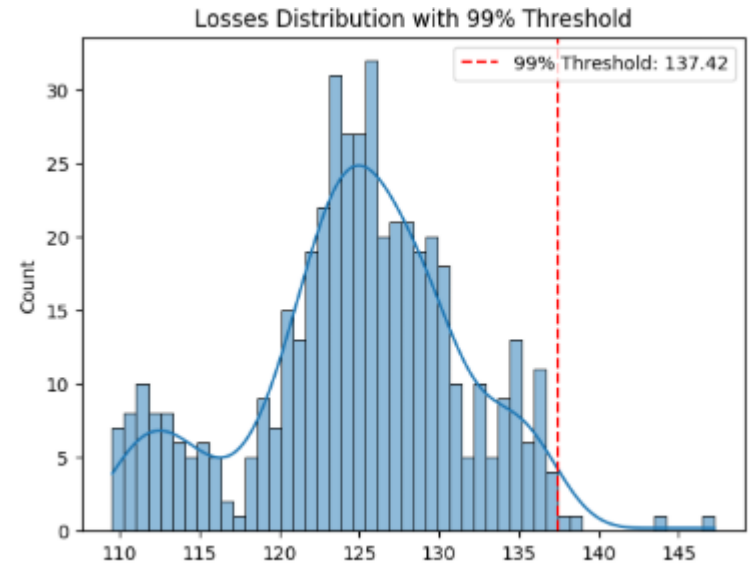


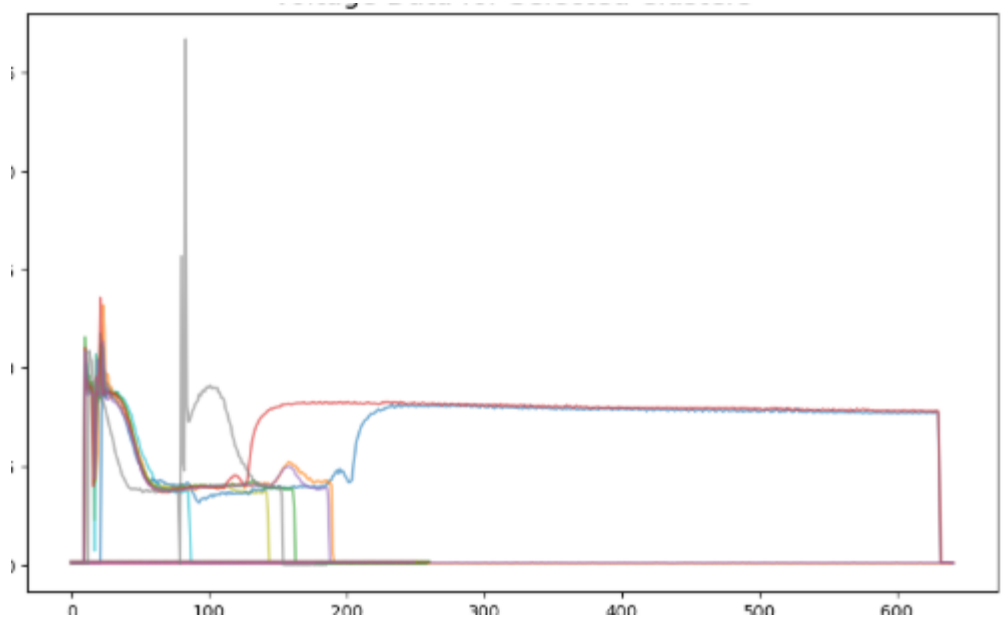
검측 모델

LSTM AE


Encoder
Decoder
Original input
Compressed representation
Reconstructed input
Small Reconstruction Error
Encoder
Decoder
Original input
Compressed representation
Reconstructed input
Large Reconstruction Error
normal
anomaly
threshold



The value at which the cumulative distribution reaches 99% is: 137.42



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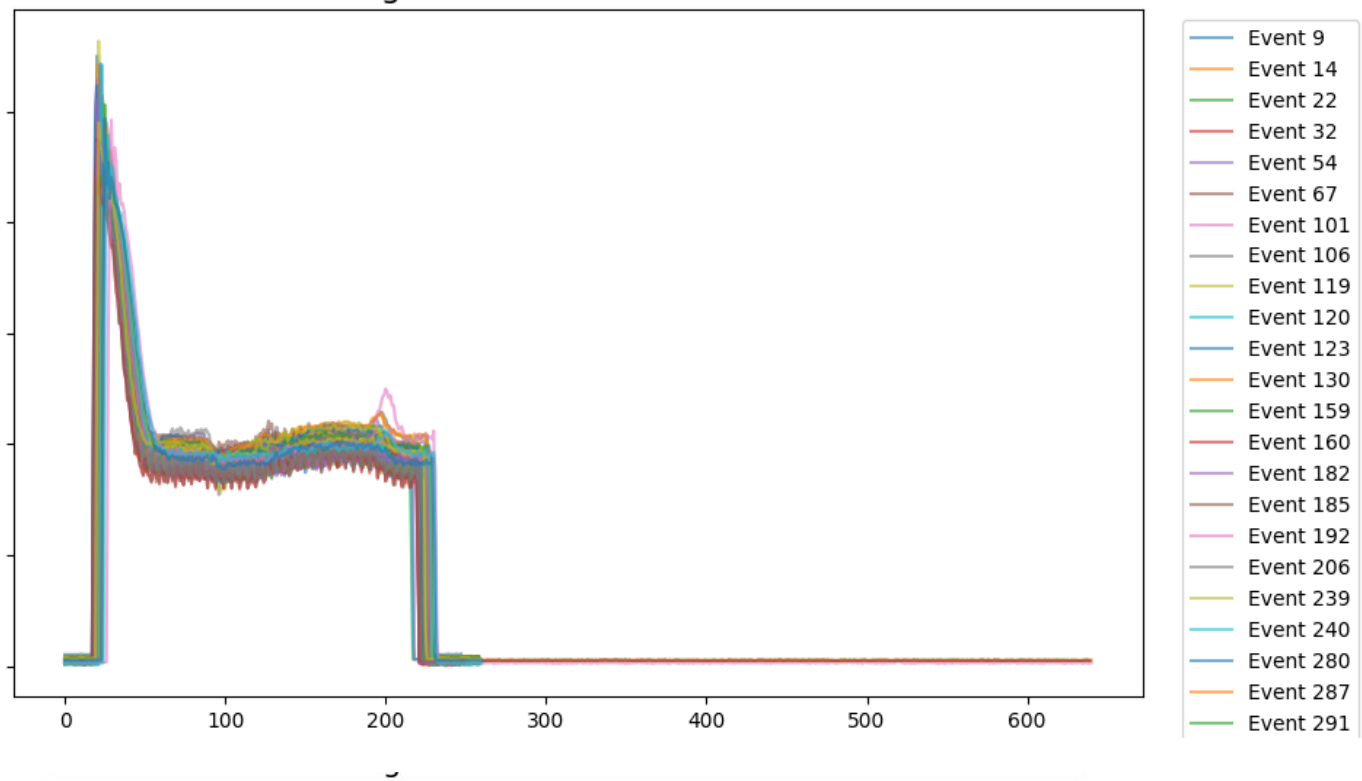
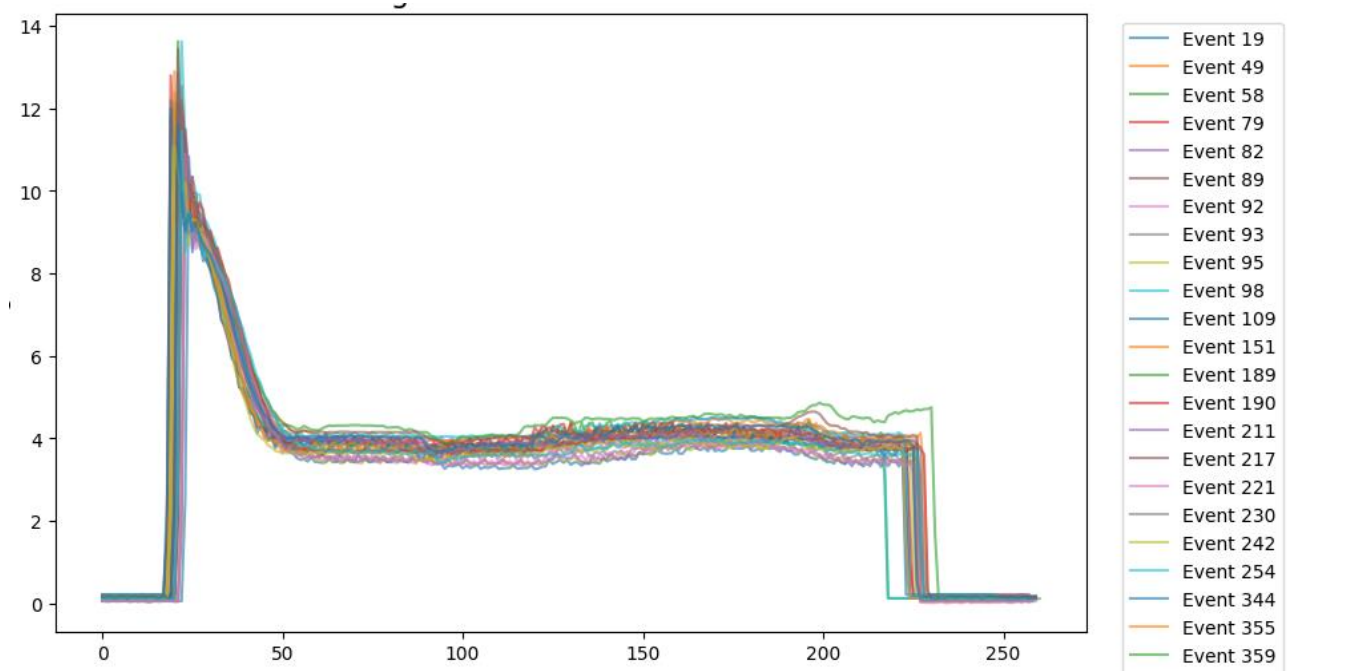
Indices of Selected Clusters: [428 429 430 431 432 433 434 435 443 445 447 448 458 499 500 512 513 514
 515 516 517 530 531 532 538 538 539 540 541 542 543 544 545 546 547 548
 549 554 555 556 557 558 559 560 561 578 598 599]

	event_num	voltage_as
428	429	[0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.13, 0.1...
429	430	[0.15, 0.15, 0.15, 0.13, 0.15, 0.15, 0.13, 0.1...
430	431	[0.16, 0.15, 0.16, 0.16, 0.15, 0.16, 0.16, 0.1...
431	432	[0.17, 0.16, 0.16, 0.16, 0.15, 0.16, 0.15, 0.1...
432	433	[0.13, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15, 0.1...
433	434	[0.13, 0.13, 0.13, 0.13, 0.15, 0.13, 0.15, 0.1...
434	435	[0.16, 0.16, 0.15, 0.16, 0.16, 0.16, 0.16, 0.1...
435	436	[0.16, 0.16, 0.17, 0.16, 0.16, 0.16, 0.16, 0.1...
443	444	[0.06, 0.09, 0.06, 0.06, 0.09, 0.06, 0.06, 0.0...
445	446	[0.06, 0.05, 0.06, 0.09, 0.06, 0.06, 0.06, 0.0...
447	448	[0.06, 0.06, 0.06, 0.07, 0.06, 0.05, 0.06, 0.0...
448	449	[0.06, 0.06, 0.09, 0.07, 0.06, 0.06, 0.06, 0.0...
458	459	[0.06, 0.09, 0.06, 0.06, 0.06, 0.06, 0.06, 0.0...
499	500	[0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.09, 0.1,...
500	501	[0.1, 0.1, 0.1, 0.1, 0.11, 0.1, 0.1, 0.1, 0.1,...
512	513	[0.13, 0.13, 0.13, 0.15, 0.13, 0.13, 0.13, 0.1...
513	514	[0.12, 0.13, 0.13, 0.13, 0.13, 0.13, 0.13, 0.1...

Epoch 1: train loss 121.74637644428 18 val loss 120.42776184082031
Epoch 2: train loss 121.3306790162174 val loss 120.30441619997396
Epoch 3: train loss 121.21141942071 val loss 120.20204870050604
Epoch 4: train loss 121.23011277123655 val loss 120.44440987326882
Epoch 5: train loss 121.22763608106926 val loss 121.17769581187865
Epoch 6: train loss 121.18981971008691 val loss 120.41003140536222
Epoch 7: train loss 121.16843407799695 val loss 120.38206316474076
Epoch 8: train loss 121.12148302806212 val loss 120.1722206809804
Epoch 9: train loss 121.17032214980135 val loss 120.44871021617543
Epoch 10: train loss 121.12688523162647 val loss 120.19906810418707
Epoch 11: train loss 121.11492936189241 val loss 120.2920092496006
Epoch 12: train loss 121.12354806627103 val loss 120.3927056052468
Epoch 13: train loss 121.14662080939645 val loss 120.15415261008523
Epoch 14: train loss 121.10518457638792 val loss 120.84520083340782
Epoch 15: train loss 121.12163992680466 val loss 120.24530903209339
Epoch 16: train loss 121.09662210102529 val loss 120.33327206698331
Epoch 17: train loss 121.10172675159185 val loss 120.18421547629616
Epoch 18: train loss 121.11046582447695 val loss 120.36735714999112
Epoch 19: train loss 121.113624117
Epoch 20: train loss 121.113662378
Epoch 21: train loss 121.095182325
Epoch 22: train loss 121.088084549
Epoch 23: train loss 121.082796363
Epoch 24: train loss 121.120267363
Epoch 25: train loss 121.079971834
Epoch 26: train loss 121.096782822
Epoch 27: train loss 121.085780221
Epoch 28: train loss 121.081627217
Epoch 29: train loss 121.07478392120555 val loss 120.28486022949218
Epoch 30: train loss 121.0906363773956 val loss 120.28332966321911
Epoch 31: train loss 121.08718103662421 val loss 120.25897924249823
Epoch 32: train loss 121.0953482268004 val loss 120.46420842950994
Epoch 33: train loss 121.07486391372518 val loss 120.23845311945135
Epoch 34: train loss 121.08721482982518 val loss 120.25595286976207
Epoch 35: train loss 121.08152561147075 val loss 120.28934007124467
Epoch 36: train loss 121.08698887611503 val loss 120.47416312477806
Epoch 37: train loss 121.0876224574768 val loss 120.25155487060547
Epoch 38: train loss 121.07947753386695 val loss 120.32348549582741
Epoch 39: train loss 121.08846658735133 val loss 120.44886127818714
Epoch 40: train loss 121.10118400720137 val loss 120.22623457475142
Epoch 41: train loss 121.07897017098693 val loss 120.26846882218246
Epoch 42: train loss 121.08802137948303 val loss 120.32316603227095
Epoch 43: train loss 121.07689982334942 val loss 120.29971160888672
Epoch 44: train loss 121.10183257080698 val loss 120.45724889581864
Epoch 45: train loss 121.10192723060722 val loss 120.26648046320135

Epoch 138: train loss 121.0811718613854 val loss 120.29810680042614
Epoch 139: train loss 121.07785543348236 val loss 120.25313803932883
Epoch 140: train loss 121.09160466670505 val loss 120.30101054798473
Epoch 141: train loss 121.07124117137526 val loss 120.16563914906895
Epoch 142: train loss 121.0762614556091 val loss 120.18584414395418
Epoch 143: train loss 121.08546589279989 val loss 120.31294902454724
Epoch 144: train loss 121.0810540698401 val loss 120.29681382612749
Epoch 145: train loss 121.07496823634166 val loss 120.26907529963956
Epoch 146: train loss 121.08577498901627 val loss 120.26415252686547
Epoch 147: train loss 121.0765096506822 val loss 120.2754232233221
Epoch 148: train loss 121.08167868738235 val loss 120.26231564608487
Epoch 149: train loss 121.08472369423808 val loss 120.46143410422686
Epoch 150: train loss 121.09458430438661 val loss 120.26998324978367





```
correct = sum(l <= THRESHOLD for l in pred_losses)
print(f'Correct normal predictions: {correct}/{len(test_normal_dataset)}')
```

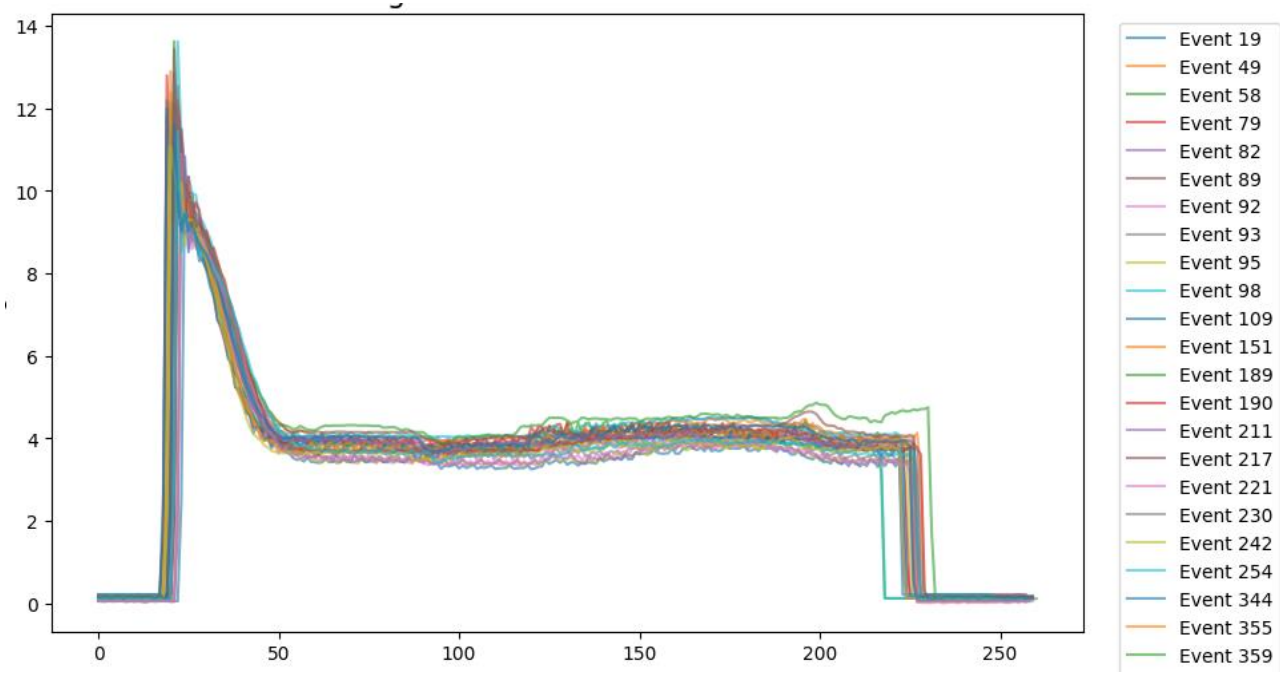
```
Correct normal predictions: 28/28
```

```
correct = sum(l > THRESHOLD for l in pred_losses)
print(f'Correct anomaly predictions: {correct}/{len(anomaly_dataset)}'
```

```
Correct anomaly predictions: 2/28
```

```
Epoch 1: train loss 121.9306970424753 val loss 121.11499578302566
Epoch 2: train loss 121.31077869811042 val loss 120.64640721407804
Epoch 3: train loss 121.24549811226981 val loss 120.61090064969384
Epoch 4: train loss 121.19452552189902 val loss 120.80528779463934
Epoch 5: train loss 121.23832979161811 val loss 120.65399100663742
Epoch 6: train loss 121.24757863051964 val loss 120.63143060453879
Epoch 7: train loss 121.17246133809824 val loss 120.65789621626545
Epoch 8: train loss 121.1766669147665 val loss 120.6051664872603
Epoch 9: train loss 121.15556363706236 val loss 120.4886904629794
Epoch 10: train loss 121.16470597282289 val loss 120.65919720042836
Epoch 11: train loss 121.15089921093491 val loss 120.46738121726297
Epoch 12: train loss 121.19764461214581 val loss 120.59411430368887
Epoch 13: train loss 121.15228533870969 val loss 120.66676604531027
Epoch 14: train loss 121.14774592969783 val loss 120.73604418257946
Epoch 15: train loss 121.11584701967905 val loss 120.48267822804465
Epoch 16: train loss 121.
Epoch 17: train loss 121.
Epoch 18: train loss 121.
Epoch 19: train loss 121.
Epoch 20: train loss 121.
Epoch 21: train loss 121.
Epoch 22: train loss 121.
Epoch 23: train loss 121.
Epoch 24: train loss 121.
Epoch 25: train loss 121.
Epoch 26: train loss 121.
Epoch 27: train loss 121.
Epoch 28: train loss 121.
Epoch 29: train loss 121.
Epoch 30: train loss 121.
Epoch 31: train loss 121.
Epoch 32: train loss 121.
Epoch 33: train loss 121.
Epoch 34: train loss 121.
Epoch 35: train loss 121.
Epoch 36: train loss 121.
Epoch 37: train loss 121.
Epoch 38: train loss 121.
Epoch 39: train loss 121.
Epoch 40: train loss 121.
Epoch 41: train loss 121.
Epoch 42: train loss 121.
Epoch 43: train loss 121.
Epoch 44: train loss 121.08371976822141 val loss 120.46027946472168
Epoch 45: train loss 121.08181926182338 val loss 120.45614242553711
Epoch 46: train loss 121.1058007699472 val loss 120.53982068438388
Epoch 47: train loss 121.0937758148032 val loss 120.53782948680655
Epoch 48: train loss 121.08879832111339 val loss 120.57682054693049
Epoch 49: train loss 121.0971496816055 val loss 120.47324891623881
Epoch 50: train loss 121.09072803815662 val loss 120.47148461776346
Epoch 51: train loss 135.99912041961832 val loss 118.58283025568181
Epoch 52: train loss 38.23850021160469 val loss 15.702141783454202
Epoch 53: train loss 18.69959076573609 val loss 15.77407927946611
Epoch 54: train loss 16.466138521830242 val loss 14.776681157837585
Epoch 55: train loss 15.680474374660108 val loss 14.817283600824596
Epoch 56: train loss 15.967628688408585 val loss 14.121268128778082
Epoch 57: train loss 15.2474330253702 val loss 13.874537901444869
Epoch 58: train loss 15.381042061567603 val loss 13.684780199877508
```

```
Epoch 129: train loss 11.702841774496452 val loss 10.247802174568176
Epoch 130: train loss 11.735179615112014 val loss 10.210140510038896
Epoch 131: train loss 11.70518904009824 val loss 10.647962416302074
Epoch 132: train loss 11.691024476888948 val loss 10.648355145887895
Epoch 133: train loss 11.747669048410245 val loss 10.494984529235147
Epoch 134: train loss 11.633644908824294 val loss 10.69533823706887
Epoch 135: train loss 11.678423167536499 val loss 10.9442166996998826
Epoch 136: train loss 11.631896180450601 val loss 10.395859619487416
Epoch 137: train loss 11.676102724024858 val loss 10.66849226810311
Epoch 138: train loss 11.605405388685762 val loss 10.861118840883428
Epoch 139: train loss 11.60508532372732 val loss 10.35214837030931
Epoch 140: train loss 11.631652047394445 val loss 10.667432306029958
Epoch 141: train loss 11.612187627181845 val loss 10.436632904139431
Epoch 142: train loss 11.594203465883008 val loss 10.704787221821872
Epoch 143: train loss 11.659872317666443 val loss 10.470922416906733
Epoch 144: train loss 11.472087678455171 val loss 10.4300620989366
Epoch 145: train loss 11.685151166512222 val loss 10.456810767000372
Epoch 146: train loss 11.651498589061656 val loss 10.1894487142562B7
Epoch 147: train loss 11.519687488596276 val loss 10.320617881688205
Epoch 148: train loss 11.577047634720608 val loss 10.180768793279476
Epoch 149: train loss 11.419250140114436 val loss 10.43455818666409
Epoch 150: train loss 11.460659510244188 val loss 10.37947725165974
```




```
[34]  threshold = np.percentile(losses, 95)  # 상위 5% 지점
      print(f"임계값 (threshold): {threshold}")
```

```
임계값 (threshold): 18.139021682739025
```

```
[35]  THRESHOLD = 18
```

```
correct = sum(l <= THRESHOLD for l in pred_losses)
print(f'Correct normal predictions: {correct}/{len(test_normal_dataset)}')
```

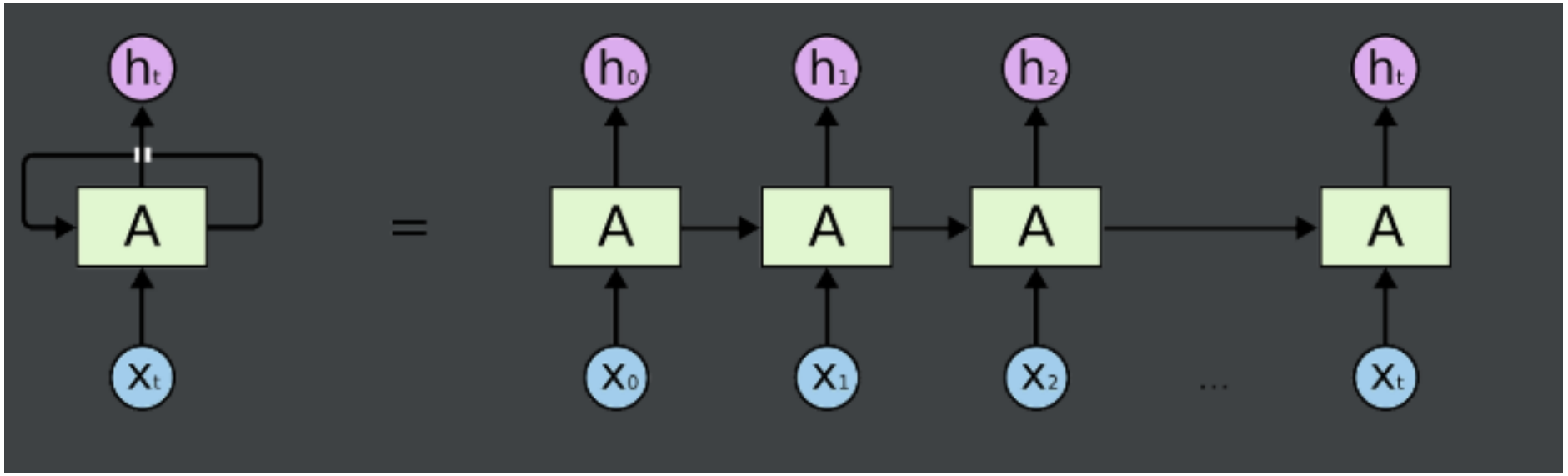
```
Correct normal predictions: 23/23
```

```
[40] correct = sum(l > THRESHOLD for l in pred_losses)
     print(f'Correct anomaly predictions: {correct}/{len(anomaly_dataset)}')
```

```
Correct anomaly predictions: 17/23
```

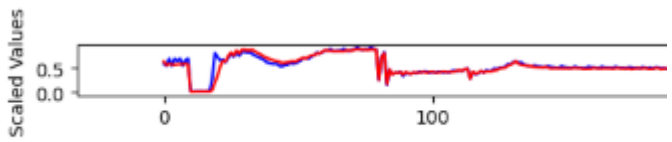
예측 모델

LSTM 시계열 예측

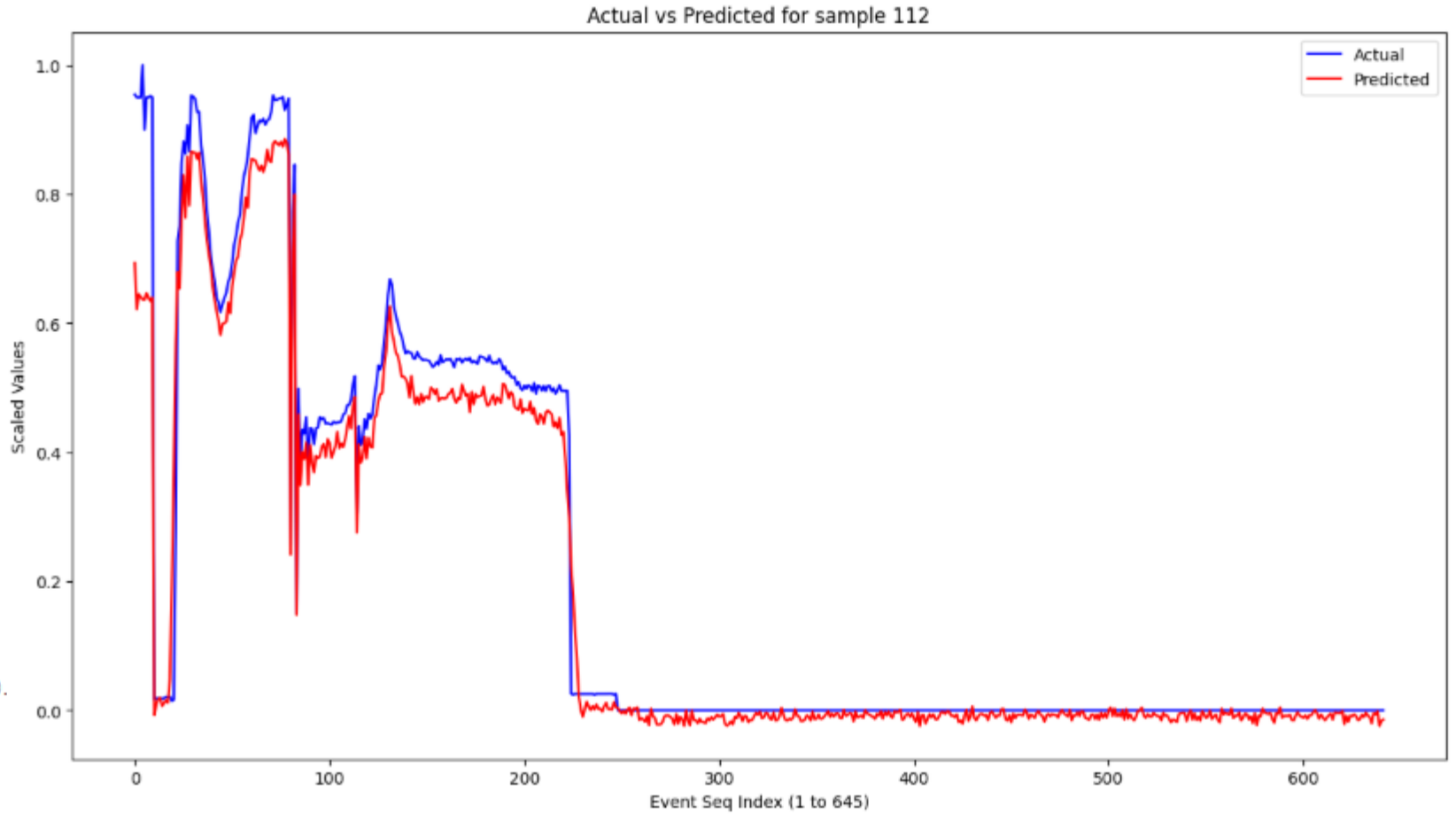


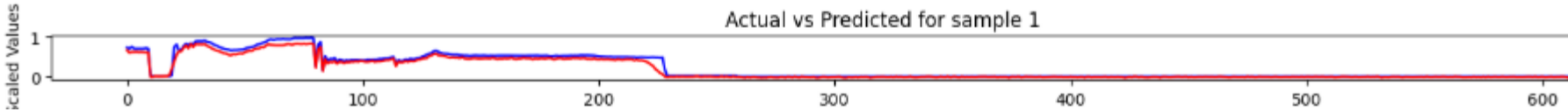
```
-0.01642687]
[ 0.6918032   0.62496924  0.65100175 ... -0.03326954 -0.01899897
 -0.01391169]
[ 0.6932278   0.62169968  0.64518068 ... -0.02417277 -0.01634519
 -0.01434322]]
```

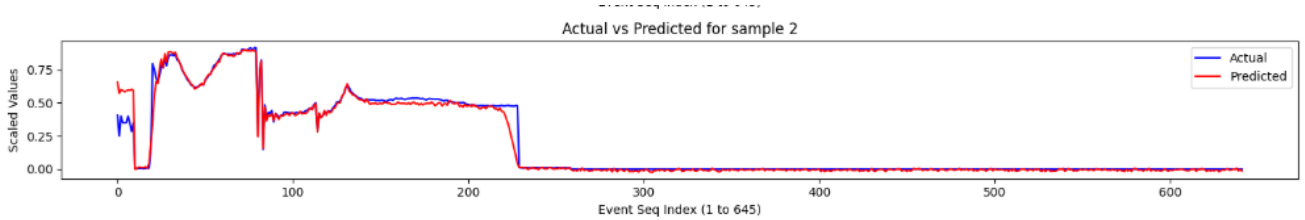
```
Epoch 38/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 39/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 40/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 41/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 42/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 43/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 44/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 45/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 46/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 47/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 48/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 49/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
Epoch 50/60
14/14 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - loss:
4/4 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - loss: 0.
Test Loss: 0.0024719056673347957
```

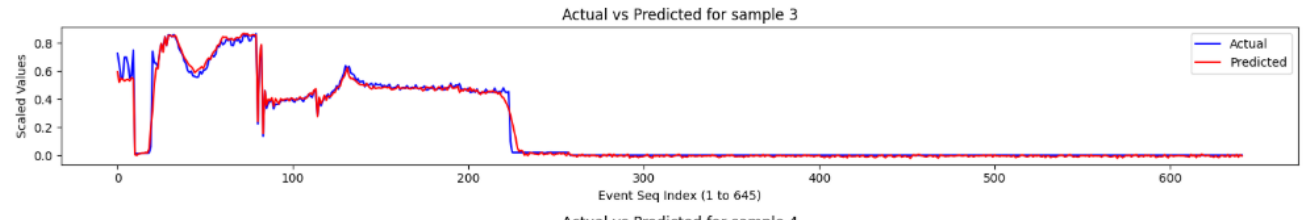


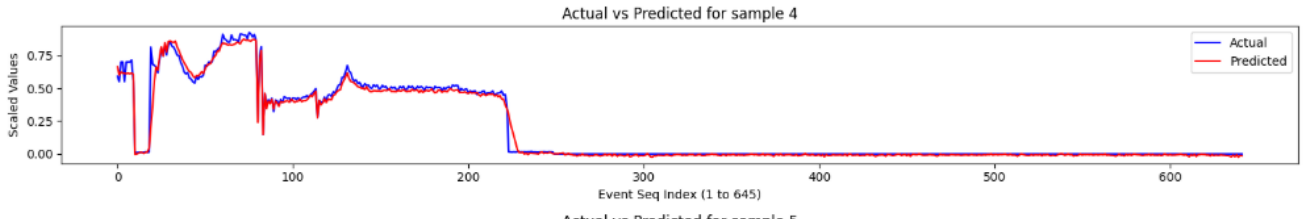

```
Mean Squared Error: 0.0024719057711715 7
```

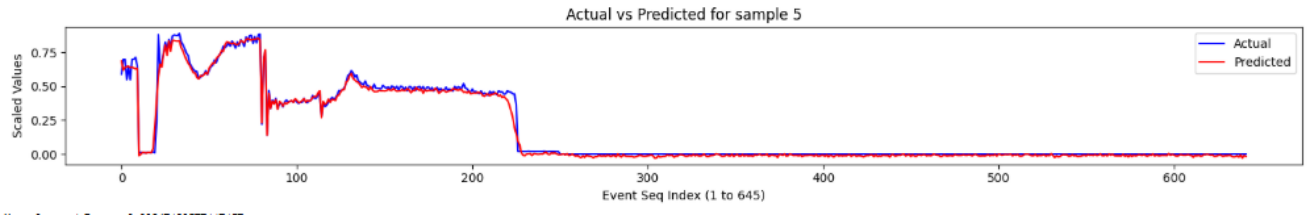


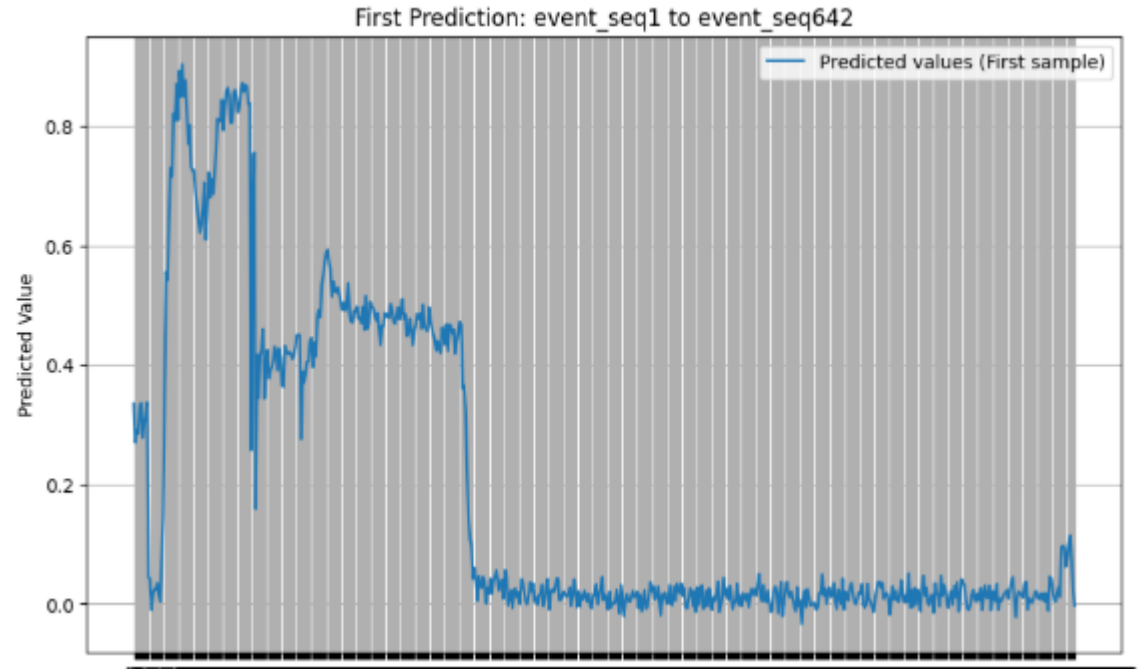



Actual vs Predicted for sample 2
Actual
Predicted
Scaled Values
Event Seq Index (1 to 645)


Actual vs Predicted for sample 3
Actual
Predicted
Scaled Values
Event Seq Index (1 to 645)


Actual vs Predicted for sample 4
Actual
Predicted
Scaled Values
Event Seq Index (1 to 645)


Actual vs Predicted for sample 5
Actual
Predicted
Scaled Values
Event Seq Index (1 to 645)


First Prediction: event_seq1 to event_seq642
Predicted values (First sample)
Predicted Value

Backend

Management Server

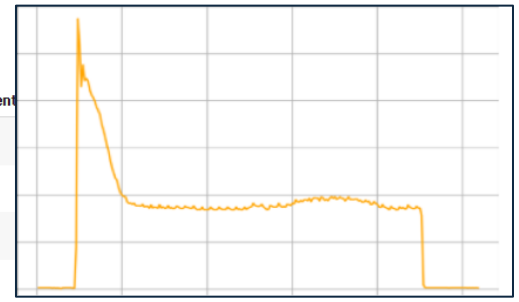
- Display the PMD monitoring screen
- Transmit AC_CURRENT data.
- Receive predicted values.
- Receive detected values.

Fault detect AI Server

- Transmit detected AC_CURRENT
- Transmit Predicted value

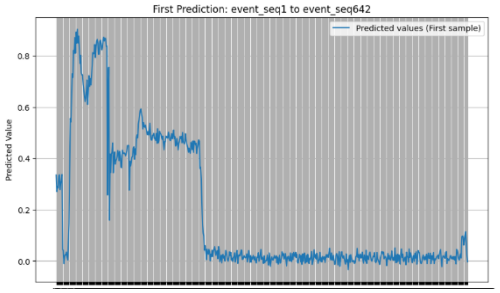
Detected Values

	time_stamp	event_num	pad_type	event_seq1	event_seq2	event_seq3	event_seq4	event_seq5	event				
0	2022-11-01 09:18:34.270	429	PMD013	0.681818	0.65	0.65	0.65	0.65					
1	2022-11-01 09:22:35.210	430	PMD013	0.681818	0.65	0.65	0.55	0.65					
2	2022-11-01 13:50:21.040	431	PMD013	0.727273	0.65	0.70	0.70	0.65					
3	2022-11-01 13:55:17.420	432	PMD013	0.772727	0.70	0.70	0.70	0.65					
4	2022-11-02 09:18:17.360	433	PMD013	0.590909	0.65	0.65	0.65	0.65	0.65	0.65	...	0.0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
595	2023-12-29 11:00:29.480	402	PMD001	0.272727	0.15	0.20	0.20	0.10	0.20	0.20	...	0.0	0.0
596	2023-12-29 11:01:23.690	417	PMD004	0.727273	0.65	0.75	0.55	0.55	0.65	0.75	...	0.0	0.0
597	2023-12-29 11:01:34.010	418	PMD004	0.681818	0.55	0.65	0.65	0.65	0.70	0.65	...	0.0	0.0
598	2023-12-29 11:06:42.180	419	PMD005	0.954545	0.95	0.95	0.95	0.95	0.95	0.95	...	0.0	0.0
599	2023-12-29 11:06:50.860	420	PMD005	0.954545	0.95	0.95	0.95	1.00	0.90	0.95	...	0.0	0.0



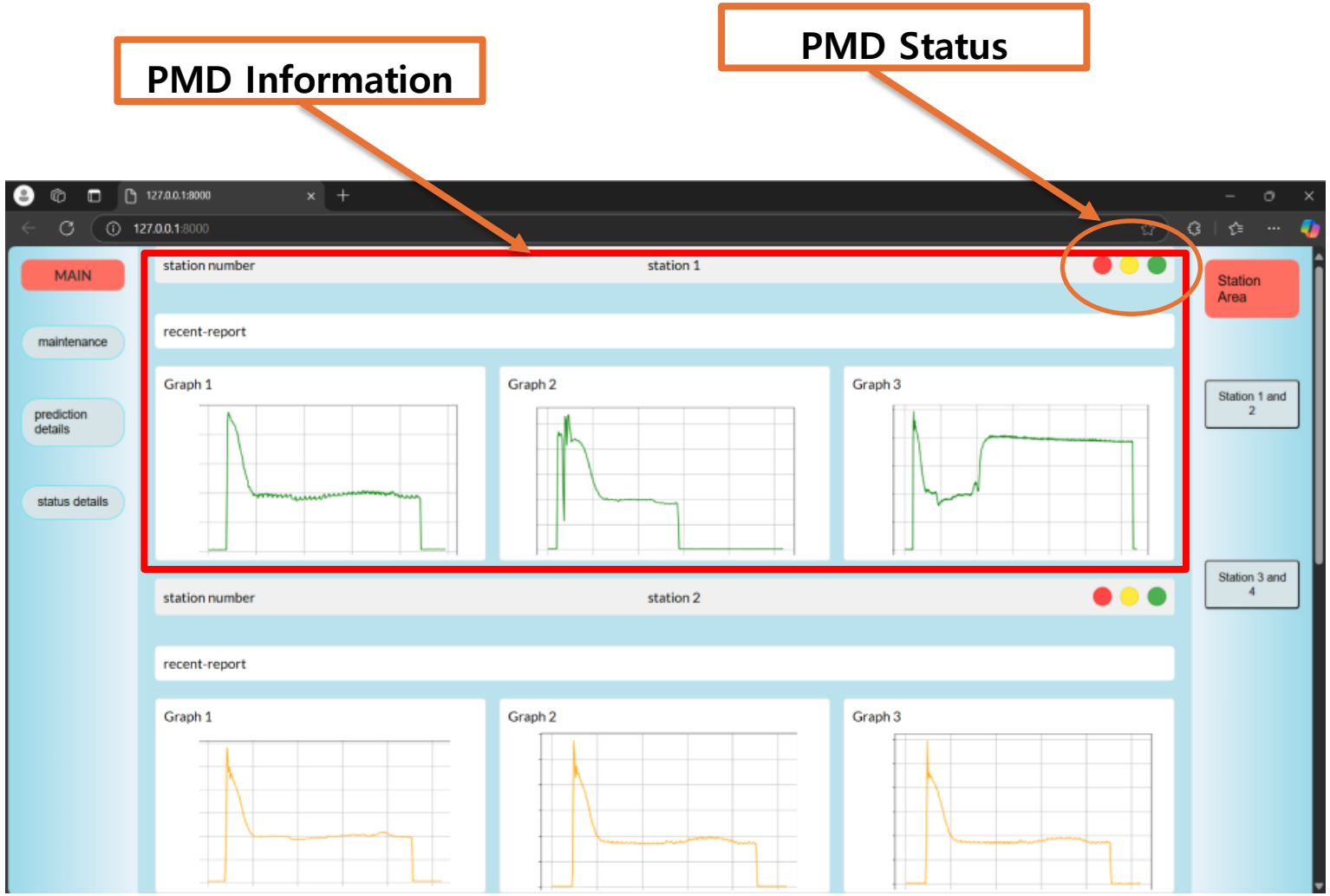
Predicted Values

	event_seq1	event_seq2	event_seq3	event_seq4	event_seq5	event_seq6	event_seq7	eve				
0	0.493187	0.460324	0.492801	0.447848	0.460359	0.502587	0.455525					
1	0.509060	0.482305	0.492894	0.450484	0.470927	0.492469	0.455502					
2	0.526991	0.488251	0.519122	0.474334	0.492422	0.502646	0.483277					
3	0.468648	0.367538	0.373647	0.363102	0.404531	0.392815	0.366651					
4	0.460265	0.354534	0.353635	0.353113	0.392704	0.372638	0.359850	0.359463	0.393198	0.340305	...	0.065960
...	...	...	...	...	...	...	...	...	...	...	...	...
585	0.534122	0.500261	0.494255	0.492915	0.494473	0.493866	0.502016	0.488661	0.504109	0.491396	...	0.013811
586	0.532186	0.485903	0.481898	0.474940	0.479702	0.479891	0.489941	0.477134	0.495854	0.474400	...	0.013624
587	0.565320	0.510777	0.513746	0.506921	0.511801	0.517881	0.518268	0.508446	0.533354	0.514133	...	0.016378
588	0.573627	0.538106	0.537897	0.522708	0.525146	0.526270	0.534509	0.529496	0.538104	0.526604	...	0.007138

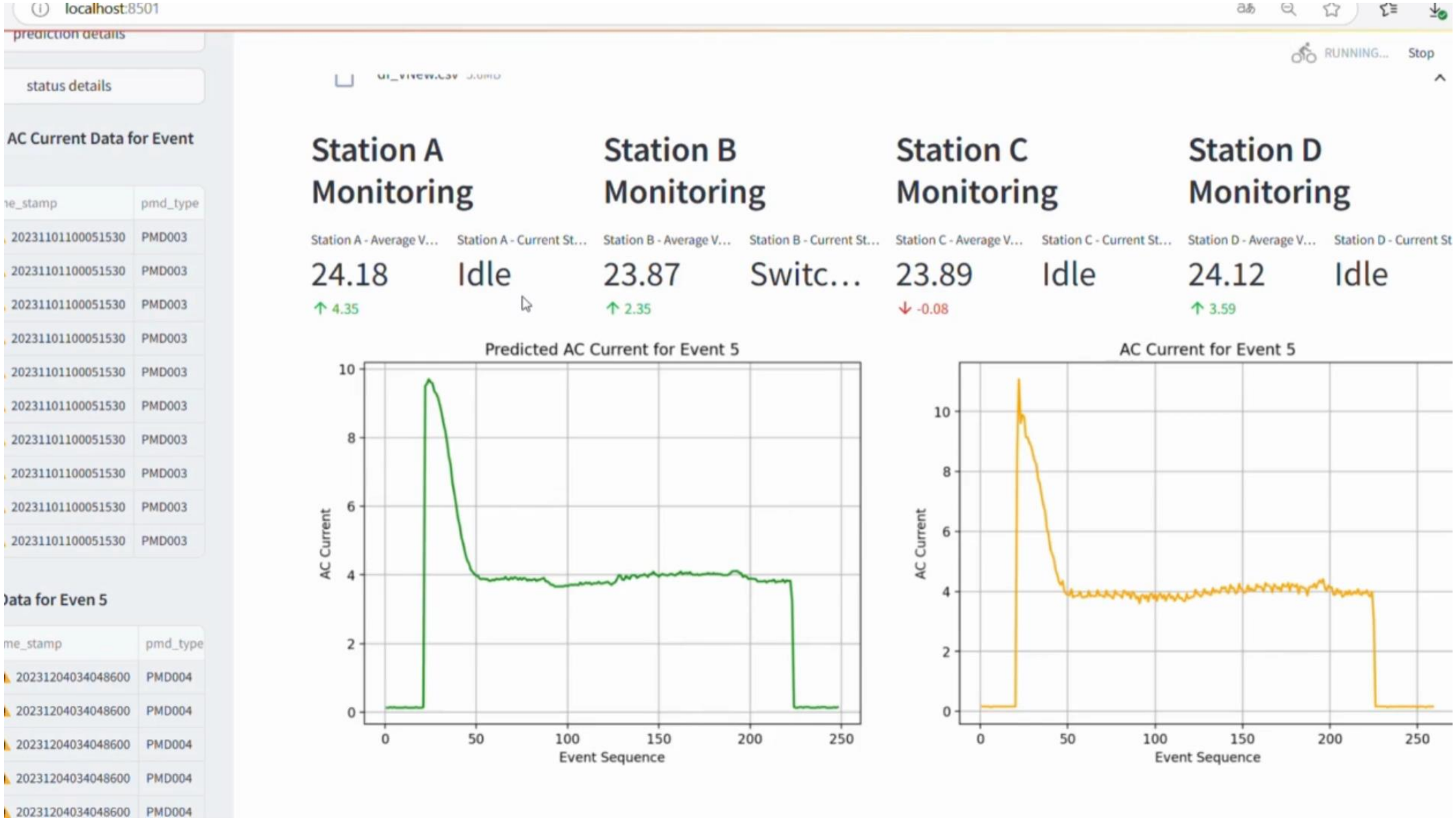


Frontend

- Monitor PMD conditions by station.
  - Station 1
  - Station 2
  - Station 3
- Highlight problematic tracks in colors.
  - Green
  - Yellow
  - Red
- Detailed PMD records can be reviewed.
  - 128 Sequences



DEMO


localhost:8501
prediction details
status details
AC Current Data for Event
me_stamp
pmd_type
20231101100051530
PMD003
Data for Even 5
me_stamp
pmd_type
20231204034048600
PMD004
RUNNING...
Stop
Station A Monitoring
Station B Monitoring
Station C Monitoring
Station D Monitoring
Station A - Average V...
Station A - Current St...
Station B - Average V...
Station B - Current St...
Station C - Average V...
Station C - Current St...
Station D - Average V...
Station D - Current St
24.18
Idle
23.87
Switc...
23.89
Idle
24.12
Idle
↑ 4.35
↑ 2.35
↓ -0.08
↑ 3.59
Predicted AC Current for Event 5
AC Current for Event 5
AC Current
Event Sequence

Project RESULT

- Successfully **Classified** data into normal and abnormal categories.
- Successfully **Detected** abnormal event
- Successfully **Predicted** a future failure through trend analysis.
- **Reported** the status of PMD events on the webpage.

Expected Effect

- **Reducing Accidents**:

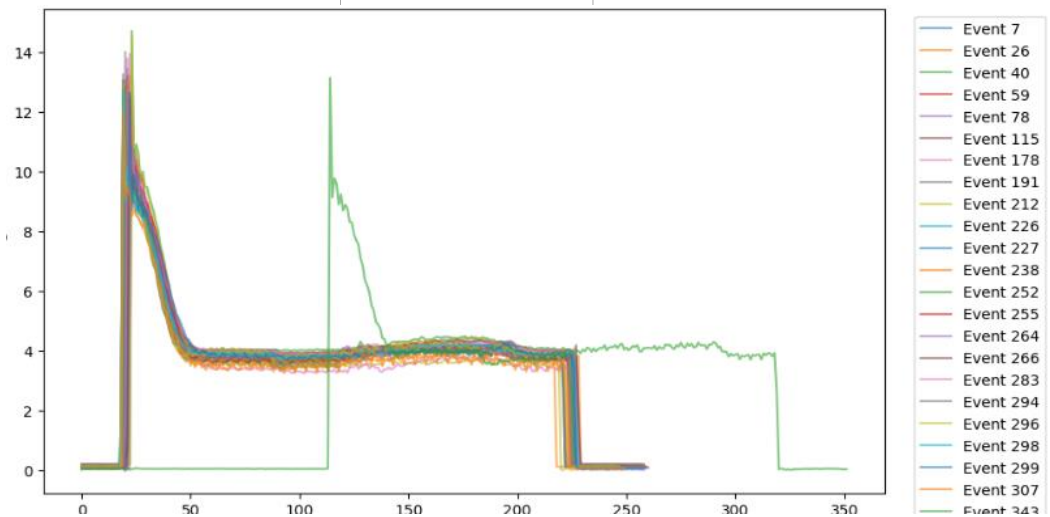
  - Reduce the number of accident, ensuring passenger's safety and decreasing risks of trains.

- **Cost Savings:**

  - Reduce the cost of repair maintaining the railway before the accident

→NEXT STEPS

Category	Curve shape	Condition reason
Normal	Normal.	Normal.
Malfunction 1	The current abruptly falls to zero.	Inadequate contact or not properly locked.
Malfunction 2	Interruption of current flow while releasing.	Irregular switch connection.
Malfunction 3	Current remains steady throughout the release process.	Opposition to mechanical stress.
Malfunction 4	The release time of the current is prolonged.	Irregular state of the motor.
Malfunction 5	A pulse arises amidst the switching process.	Inadequate connection of the automatic switch.
Malfunction 6	During the release process, the current escalates.	Internal obstruction and heightened friction.
Malfunction 7	The current consistently stays at zero.	Dysfunction in the action circuit.
Malfunction 8	Discharge without incremental phases.	Irregularity in the signaling circuit.

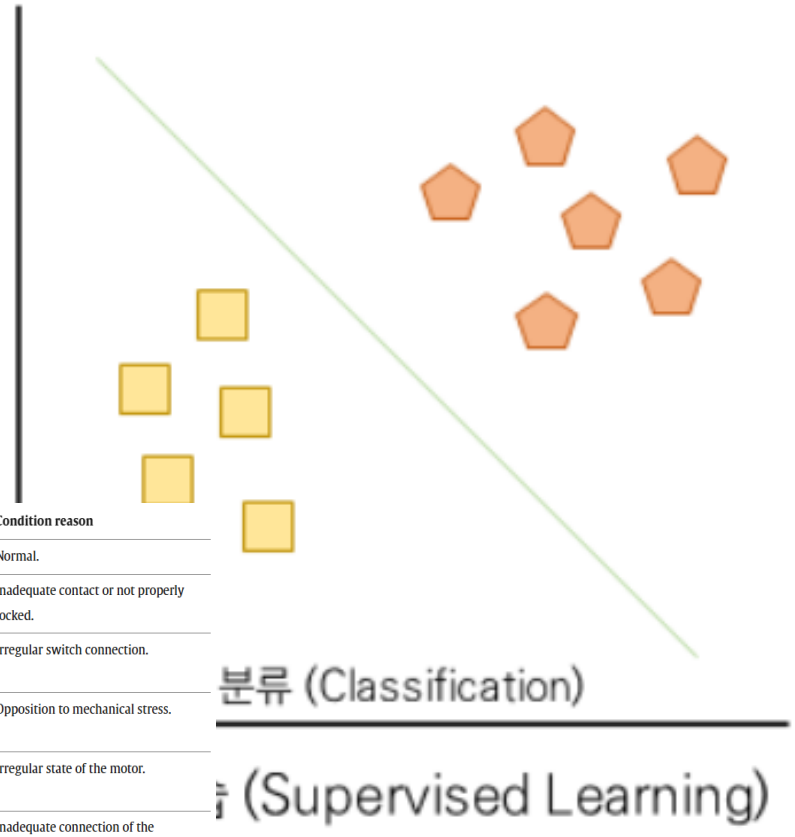


1 Analyzing all types of current and voltage data.

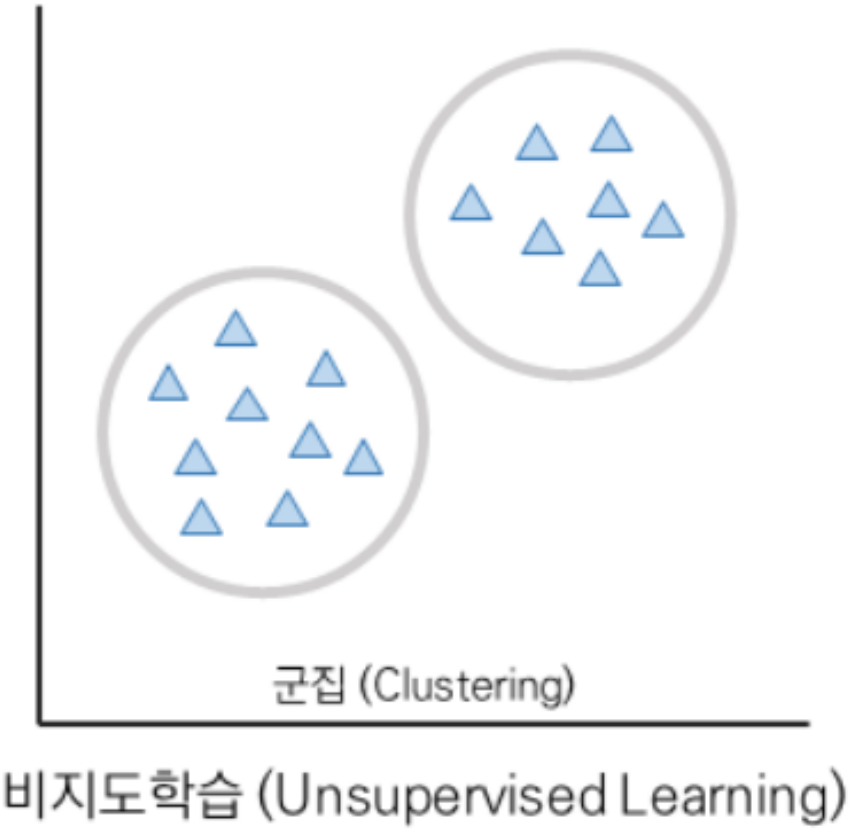
2 Maintenance recommendations

3 Detecting faulty PMD(선로전환기) components.

K-NN



K-Means



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Team: Daejeon X

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THANK YOU