[lr 0.0001, batch 32, epoch 50]

모델	전체 data	unique	unique RING x	유사도 HL	유사도 HL RING x
EfficientNetV2	66%	9%	9%	9%	9%
EfficientNet B0	57%	1%	47%	9%	61%

[lr 0.0001, batch 32, epoch 50] → 같은 코드 다시 돌려봤을때

모델	전체 data	unique	unique RING x	유사도 HL	유사도 HL RING x
EfficientNetV2	65%	9%	9%	9%	9%
EfficientNet B0	56%	9%	47%	18%	**68%**

[lr 0.0001, batch 32, epoch 100]

모델	전체 data	unique	unique RING x	유사도 HL	유사도 HL RING x
EfficientNetV2	64%	9%	9%	9%	49%
EfficientNet B0	55%	9%	50%	9%	64%

[lr 0.0001, batch 8, epoch 50]

모델	전체 data	unique	unique RING x	유사도 HL	유사도 HL RING x
EfficientNetV2	62%	9%	53%	9%	10%
EfficientNet B0	50%	9%	37%	49%	57%

LDAM_DRW 적용 (batch 32, lr 0.0001)

전체 data

LDAM : class별 margin 고려하여 성능향상시키는 loss function

DRW : 초기 학습 단계에서 re-weighting 미루는 효과적인 학습 스케줄

EfficientNet V2

epoch 50

Model: EfficientNetV2
Confusion Matrix:

```
[[ 9  0  0  0  0  0  1  0  0  0  0  0]
 [ 0 10  0  0  0  0  0  0  0  0  0  0]
 [ 3  0  6  0  0  0  0  0  0  0  0  1]
 [ 2  1  0  1  0  1  3  0  1  0  1  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0  7  0  0  0  0  3  0]
 [ 1  0  0  1  0  0  7  0  0  0  1  0]
 [ 2  0  3  0  0  0  0  5  0  0  0  0]
 [ 0  0  0  0  0  0  0  0 10  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  1  0  0]
 [ 1  0  0  0  0  3  0  0  0  0  6  0]
 [ 2  0  2  0  0  2  2  0  0  0  1  1]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.45	0.90	0.60	10
BUBBLE	0.91	1.00	0.95	10
BURR	0.55	0.60	0.57	10
DAMAGE	0.50	0.10	0.17	10
DOT	0.00	0.00	0.00	10
DUST	0.30	0.70	0.42	10
FOLD	0.54	0.70	0.61	10
LINE	1.00	0.50	0.67	10
REACT	0.91	1.00	0.95	10
RING	0.00	0.00	0.00	1
SCRATCH	0.46	0.60	0.52	10
TIP	0.50	0.10	0.17	10
accuracy			0.56	111
macro avg	0.51	0.52	0.47	111
weighted avg	0.55	0.56	0.51	111

epoch 100

Model: EfficientNetV2
Confusion Matrix:

```
[[10  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  9  0  0  0  1  0  0  0  0  0  0]
 [ 0  0  6  0  0  0  1  3  0  0  0  0]
 [ 0  1  0  2  0  1  4  0  1  0  1  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 1  0  0  0  0  0  9  0  0  0  0  0]
 [ 1  0  3  0  0  0  1  5  0  0  0  0]
 [ 0  0  0  0  0  0  0  0 10  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  1  0  0]
 [ 0  0  0  0  0  2  0  0  0  0  8  0]
 [ 3  1  0  0  0  1  1  0  1  0  3  0]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.67	1.00	0.80	10
BUBBLE	0.82	0.90	0.86	10
BURR	0.67	0.60	0.63	10
DAMAGE	1.00	0.20	0.33	10
DOT	0.00	0.00	0.00	10
DUST	0.40	1.00	0.57	10
FOLD	0.56	0.90	0.69	10
LINE	0.62	0.50	0.56	10
REACT	0.83	1.00	0.91	10
RING	1.00	1.00	1.00	1
SCRATCH	0.67	0.80	0.73	10
TIP	0.00	0.00	0.00	10
accuracy			0.63	111
macro avg	0.60	0.66	0.59	111
weighted avg	0.57	0.63	0.56	111

epoch 500

Model: EfficientNetV2
Confusion Matrix:

```
[[ 9  0  0  0  0  0  1  0  0  0  0  0]
 [ 0  9  0  0  0  1  0  0  0  0  0  0]
 [ 0  0  7  0  0  0  1  2  0  0  0  0]
 [ 0  2  0  5  0  0  1  1  0  0  1  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  1  0  1  7  0  0  0  1  0]
 [ 0  0  2  0  0  0  0  7  0  0  0  1]
 [ 0  0  0  0  0  0  0  0 10  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  1  0  0]
 [ 0  0  0  0  1  2  0  0  0  0  7  0]
 [ 3  0  1  1  0  0  4  0  1  0  0  0]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.75	0.90	0.82	10
BUBBLE	0.82	0.90	0.86	10
BURR	0.70	0.70	0.70	10
DAMAGE	0.71	0.50	0.59	10
DOT	0.00	0.00	0.00	10
DUST	0.42	1.00	0.59	10
FOLD	0.50	0.70	0.58	10
LINE	0.70	0.70	0.70	10
REACT	0.91	1.00	0.95	10
RING	1.00	1.00	1.00	1
SCRATCH	0.78	0.70	0.74	10
TIP	0.00	0.00	0.00	10
accuracy			0.65	111
macro avg	0.61	0.67	0.63	111
weighted avg	0.58	0.65	0.60	111

EfficientNet B0

전처리 data

epoch 50

Model: EfficientNet B0
Confusion Matrix:

```
[[ 8  1  0  0  0  0  1  0  0  0  0  0]
 [ 0  9  0  1  0  0  0  0  0  0  0  0]
 [ 1  0  3  0  0  0  4  2  0  0  0  0]
 [ 2  2  0  2  0  0  3  0  0  0  1  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0  9  0  0  0  0  1  0]
 [ 2  0  0  0  0  0  8  0  0  0  0  0]
 [ 2  0  2  0  0  0  3  3  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  9  0  1  0]
 [ 0  0  0  0  0  0  0  0  0  0  1  0]
 [ 1  1  0  0  0  1  2  0  0  0  5  0]
 [ 1  0  0  1  0  1  4  0  2  0  0  1]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.47	0.80	0.59	10
BUBBLE	0.69	0.90	0.78	10
BURR	0.60	0.30	0.40	10
DAMAGE	0.50	0.20	0.29	10
DOT	0.00	0.00	0.00	10
DUST	0.43	0.90	0.58	10
FOLD	0.32	0.80	0.46	10
LINE	0.60	0.30	0.40	10
REACT	0.82	0.90	0.86	10
RING	0.00	0.00	0.00	1
SCRATCH	0.56	0.50	0.53	10
TIP	1.00	0.10	0.18	10
accuracy			0.51	111
macro avg	0.50	0.48	0.42	111
weighted avg	0.54	0.51	0.46	111

epoch 100

Model: EfficientNet B0
Confusion Matrix:

```
[[ 8  0  0  0  0  1  0  1  0  0  0  0]
 [ 0 10  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  8  0  0  2  0]
 [ 1  2  0  1  0  0  1  2  0  0  3  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0  8  0  0  0  0  2  0]
 [ 0  0  0  1  0  1  5  0  0  0  2  1]
 [ 0  1  0  0  0  0  1  8  0  0  0  0]
 [ 0  0  0  0  0  0  0  0 10  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  1  0]
 [ 1  1  0  0  0  0  0  0  0  0  8  0]
 [ 0  0  1  0  0  0  3  0  0  0  5  1]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.80	0.80	0.80	10
BUBBLE	0.71	1.00	0.83	10
BURR	0.00	0.00	0.00	10
DAMAGE	0.50	0.10	0.17	10
DOT	0.00	0.00	0.00	10
DUST	0.40	0.80	0.53	10
FOLD	0.50	0.50	0.50	10
LINE	0.42	0.80	0.55	10
REACT	1.00	1.00	1.00	10
RING	0.00	0.00	0.00	1
SCRATCH	0.35	0.80	0.48	10
TIP	0.50	0.10	0.17	10
accuracy			0.53	111
macro avg	0.43	0.49	0.42	111
weighted avg	0.47	0.53	0.45	111

epoch 400

Model: EfficientNet B0
Confusion Matrix:

```
[[ 9  0  1  0  0  0  0  0  0  0  0  0]
 [ 0 10  0  0  0  0  0  0  0  0  0  0]
 [ 0  0 10  0  0  0  0  0  0  0  0  0]
 [ 3  2  0  3  0  1  0  0  0  0  1  0]
 [ 0  0  0  0  0 10  0  0  0  0  0  0]
 [ 0  0  0  0  0  9  0  0  0  0  1  0]
 [ 3  0  2  0  0  0  2  0  0  0  3  0]
 [ 0  1  3  0  0  0  0  6  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  8  0  2  0]
 [ 0  0  0  0  0  0  0  0  0  0  1  0]
 [ 1  0  0  0  0  3  0  0  0  0  6  0]
 [ 2  1  2  1  0  3  0  0  0  0  1  0]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.50	0.90	0.64	10
BUBBLE	0.71	1.00	0.83	10
BURR	0.56	1.00	0.71	10
DAMAGE	0.75	0.30	0.43	10
DOT	0.00	0.00	0.00	10
DUST	0.35	0.90	0.50	10
FOLD	1.00	0.20	0.33	10
LINE	1.00	0.60	0.75	10
REACT	1.00	0.80	0.89	10
RING	0.00	0.00	0.00	1
SCRATCH	0.40	0.60	0.48	10
TIP	0.00	0.00	0.00	10
accuracy			0.57	111
macro avg	0.52	0.53	0.46	111
weighted avg	0.56	0.57	0.50	111

image augmentation – 좌우반전, 상하반전, 90도회전 이미지도 학습 데이터로 추가
validation 결과 같이 출력 (loss · accuracy curve)

lr 0.0001 loss ↑ ⇒ epoch 2 부터 loss 너무 커짐
lr 0.00001 loss ↑ ⇒ 학습하면서 loss 값 크게 증가

전체 data

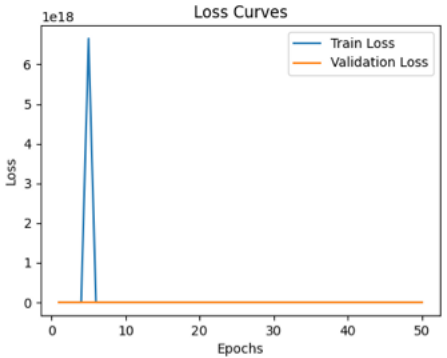
lr 0.001 batch 32

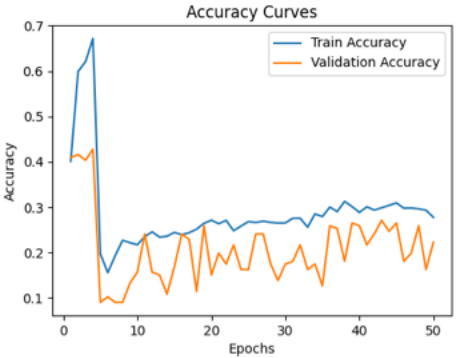
epoch 50

```
Model: EfficientNetV2
Confusion Matrix:
[[ 0  0  0  0  0  2  0  0  0  0 13  0]
 [ 0  9  0  0  0  2  0  0  4  0  0  0]
 [ 0  3  0  0  0  5  0  0  0  0  7  0]
 [ 0  2  0  0  0  4  0  0  1  0  8  0]
 [ 0  1  0  0  0  6  0  0  1  0  7  0]
 [ 0  1  0  0  0  7  0  0  1  0  6  0]
 [ 0  1  0  0  0  2  0  0  4  0  8  0]
 [ 0  0  0  0  0  5  0  0  0  0 10  0]
 [ 0  1  0  0  0  3  0  0 10  0  1  0]
 [ 0  0  0  0  0  1  0  0  0  0  0  0]
 [ 2  0  0  0  0  7  0  0  0  0  6  0]
 [ 1  0  0  0  0  5  0  0  0  0  9  0]]
Classification Report:
              precision    recall  f1-score   support

        BOLD       0.00      0.00      0.00        15
      BUBBLE       0.50      0.60      0.55        15
        BURR       0.00      0.00      0.00        15
      DAMAGE       0.00      0.00      0.00        15
         DOT       0.00      0.00      0.00        15
        DUST       0.14      0.47      0.22        15
        FOLD       0.00      0.00      0.00        15
        LINE       0.00      0.00      0.00        15
       REACT       0.48      0.67      0.56        15
        RING       0.00      0.00      0.00         1
     SCRATCH       0.08      0.40      0.13        15
         TIP       0.00      0.00      0.00        15

    accuracy                           0.19       166
   macro avg       0.10      0.18      0.12       166
weighted avg       0.11      0.19      0.13       166
```





전처리 data

epoch 50

Model: EfficientNetB0
Confusion Matrix:

```
[[11  0  0  0  0  0  4  0  0  0  0  0]
 [ 0 15  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  9  0  0  1  1  2  0  0  0  2]
 [ 1  1  0  1  0  1  4  0  0  0  7  0]
 [ 0  5  0  0  5  1  0  0  0  0  4  0]
 [ 0  0  1  0  0 11  1  0  0  0  2  0]
 [ 9  0  0  0  0  0  6  0  0  0  0  0]
 [ 1  0  1  0  0  0  1 12  0  0  0  0]
 [ 0  0  0  0  0  0  0  0 14  0  1  0]
 [ 0  0  0  0  0  0  0  0  0  1  0  0]
 [ 1  1  0  0  0  5  0  0  0  0  8  0]
 [ 5  0  0  0  0  0  6  1  0  0  3  0]]
```

Classification Report:

	precision	recall	f1-score	support
BOLD	0.39	0.73	0.51	15
BUBBLE	0.68	1.00	0.81	15
BURR	0.82	0.60	0.69	15
DAMAGE	1.00	0.07	0.12	15
DOT	1.00	0.33	0.50	15
DUST	0.58	0.73	0.65	15
FOLD	0.26	0.40	0.32	15
LINE	0.80	0.80	0.80	15
REACT	1.00	0.93	0.97	15
RING	1.00	1.00	1.00	1
SCRATCH	0.32	0.53	0.40	15
TIP	0.00	0.00	0.00	15
accuracy			0.56	166
macro avg	0.65	0.59	0.56	166
weighted avg	0.63	0.56	0.53	166