

Supplementary Material for “Maintaining Discrimination and Fairness in Class Incremental Learning”

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1. Other metrics for normalization factor.

As shown in Eq.(7), we normalize the weights for new classes based on the mean norms of the weight vectors. Here we evaluate other metrics, $Median(\cdot)$ and $Max(\cdot)$. The results are shown in Table 1. We see that these choices produce similar results, which indicates the proposed method is not sensitive to the metric selection.

Table 1: Class incremental learning performance (top-5 accuracy %) on ImageNet100 with 10 incremental steps. The performance at the last incremental step and the average results over all the incremental steps except the first step are reported here.

	last	average
Mean	84.1	90.2
Median	83.9	90.0
Max	85.1	90.8

2. Detailed results on ImageNet-1000

The detailed class incremental learning results on ImageNet-1000 with 10 incremental steps and 100 classes per step are presented in Table 2 (top-5 accuracy %) and Table 3 (top-1 accuracy %).

3. Detailed results on ImageNet-100

The detailed class incremental learning results (top-5 accuracy %) on ImageNet-100 with 10 steps and 10 classes per step are presented in Table 4.

4. Detailed results on CIFAR-100

The detailed class incremental learning results (top-1 accuracy %) on CIFAR-100 with 2, 5, 10 and 20 steps are presented in Table 5, Table 6, Table 7, and Table 8, respectively.

References

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Table 2: Class incremental learning performance (top-5 accuracy %) on ImageNet-1000 with 10 incremental steps and 100 classes per step. The average results over all the incremental steps except the first step are also reported. The results of the compared methods are reported in the original papers. The best results are in bold.

#classes	100	200	300	400	500	600	700	800	900	1000	Average
LwF.MC [3, 5]	90.1	77.7	63.9	51.8	43.0	35.5	31.6	28.4	26.4	24.3	42.5
iCaRL [5]	90.0	83.0	77.5	70.5	63.0	57.5	53.5	50.0	48.0	44.0	60.8
EEIL [2]	94.9	94.9	84.7	77.8	71.7	66.8	62.5	59.0	55.2	52.3	69.4
BiC [6]	94.1	92.5	89.6	89.1	85.7	83.2	80.2	77.5	75.0	73.2	82.9
IL2M [1]	—	—	—	—	—	—	—	—	—	—	78.3
Ours	93.9	91.5	89.4	87.7	86.5	85.6	84.5	83.2	82.1	81.1	85.7
Full					—				89.1		—

Table 3: Class incremental learning performance (top-1 accuracy %) on ImageNet-1000 with 10 incremental steps and 100 classes per step. The results of the compared methods are reported in IL2M [1]. The best results are in bold.

#classes	100	200	300	400	500	600	700	800	900	1000	Average
iCaRL [5]	—	57.9	48.8	40.9	35.5	31.8	28.8	25.5	24.2	22.7	35.1
IL2M [1]	—	74.2	68.8	62.4	56.4	53.3	52.1	48.8	47.6	43.6	56.4
Ours	79.8	75.3	70.9	68.1	65.6	63.6	61.2	59.2	57.4	55.6	64.1
Full				—					69.8		—

Table 4: Class incremental learning performance (top-5 accuracy %) on ImageNet-100 with 10 incremental steps and 10 classes per step. The best results are in bold.

#classes	10	20	30	40	50	60	70	80	90	100	Average
LwF.MC [3, 5]	99.2	95.4	86.2	74.1	63.9	55.1	50.3	44.5	40.4	36.6	60.7
iCaRL [5]	99.5	97.8	94.1	91.8	88.0	82.7	77.3	73.2	67.3	63.8	81.8
EEIL [2]	99.4	99.0	96.4	93.8	90.4	88.8	86.6	84.9	82.2	80.2	89.2
BiC [6]	98.4	96.2	94.0	92.9	91.1	89.4	88.1	86.5	85.4	84.4	89.8
RPS [4]	99.4	97.4	94.2	92.6	89.4	86.2	83.7	82.1	79.5	74.0	86.6
Ours	98.8	96.8	94.5	93.1	90.5	89.9	88.8	88.0	86.2	84.1	90.2
Full				—					95.1		—

Table 5: Class incremental learning performance (top-1 accuracy %) on CIFAR-100 with 2 incremental steps. The best results are in bold.

#classes	50	100	Average
LwF.MC [3, 5]	75.7	52.6	52.6
iCaRL [5]	74.9	62.0	62.0
EEIL [2]	74.1	60.8	60.8
BiC [6]	76.4	64.9	64.9
Ours	78.0	65.1	65.1

Table 6: Class incremental learning performance (top-1 accuracy %) on CIFAR-100 with 5 incremental steps and 20 classes per step. The best results are in bold.

#classes	20	40	60	80	100	Average
LwF.MC [3, 5]	82.3	62.6	50.3	41.1	34.6	47.1
iCaRL [5]	82.9	73.1	66.0	59.7	54.3	63.3
EEIL [2]	80.7	74.6	66.7	59.9	53.6	63.7
BiC [6]	84.0	74.7	67.9	61.3	56.7	65.1
Ours	83.5	75.5	68.7	63.1	59.2	66.6

Table 7: Class incremental learning performance (top-1 accuracy %) on CIFAR-100 with 10 incremental steps and 10 classes per step. The best results are in bold.

#classes	10	20	30	40	50	60	70	80	90	100	Average
LwF.MC [3, 5]	85.4	68.9	54.9	46.3	40.6	36.6	31.4	28.6	26.0	24.6	39.7
iCaRL [5]	86.0	78.6	72.6	67.4	63.7	60.6	56.9	54.3	51.4	49.1	61.6
EEIL [2]	80.2	80.9	76.1	71.3	66.2	62.5	58.9	54.8	52.2	49.5	63.6
BiC [6]	90.3	82.2	75.2	70.2	65.5	61.3	57.7	55.2	53.7	50.2	63.5
Ours	92.1	79.7	75.6	70.3	66.4	63.3	61.0	57.0	54.7	52.4	64.5

Table 8: Class incremental learning performance (top-1 accuracy %) on CIFAR-100 with 20 incremental steps and 5 classes per step. The best results are in bold.

#classes	5	10	15	20	25	30	35	40	45	50	
LwF.MC [3, 5]	89.4	69.1	59.7	50.9	44.6	38.9	34.9	30.6	27.7	25.7	
iCaRL [5]	89.7	82.6	77.7	74.6	70.9	68.6	66.0	63.4	61.1	59.4	
EEIL [2]	82.5	86.8	84.8	81.0	77.7	74.4	70.6	67.9	65.3	63.0	
BiC [6]	95.8	90.3	80.8	75.8	73.6	71.6	67.9	65.5	62.9	61.9	
Ours	97.6	91.6	82.3	76.5	73.9	71.6	69.6	66.3	65.2	62.4	

#classes	55	60	65	70	75	80	85	90	95	100	Average
LwF.MC [3, 5]	24.0	22.0	20.0	19.1	18.3	17.1	16.3	15.7	14.9	14.3	29.7
iCaRL [5]	58.0	56.3	54.9	52.9	51.1	50.0	48.0	47.1	46.0	44.9	59.7
EEIL [2]	61.3	59.2	57.7	55.2	53.7	51.9	50.6	49.4	47.9	46.8	63.4
BiC [6]	59.3	57.3	56.2	55.9	54.0	52.6	49.8	49.6	48.2	47.0	62.1
Ours	61.1	58.9	56.9	55.3	54.5	52.0	50.1	48.0	46.8	46.0	62.6