Supplementary material

SVIRO: Synthetic Vehicle Interior Rear Seat Occupancy Dataset and Benchmark

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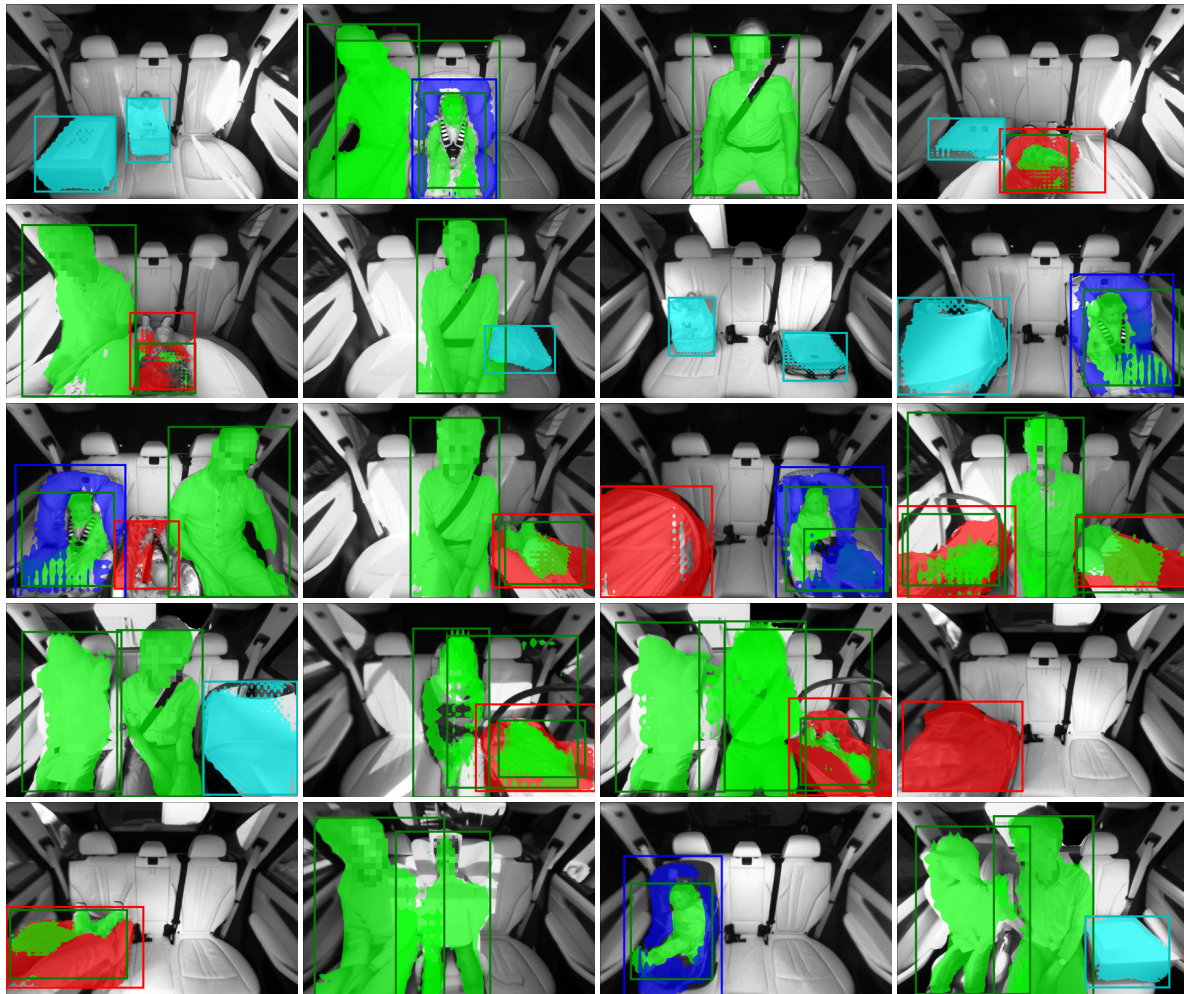[3] University of Kaiserslautern   [4] Trier University of Applied Sciences

Figure 11. Additional instance segmentation predictions on real images by a model fine-tuned on SVIRO.

1. Additional evaluations on real data

In Figure 11 we provide additional examples of the instance segmentation mask predictions of the model presented in Section 5. Some of the infant seats (red) with sun-protection are classified as an everyday object (light blue), however, this is understandable as we did not have any infant seats with sun-protection in the training data. Nevertheless, as some of those infant seats with sun-protection are classified correctly, we believe that this is in favour of our assumption that insights on SVIRO are transferable to real images. As the model was trained on a very limited amount of variation, some objects are not detected at all. We believe this will be improved once generalization is improved on SVIRO as well.

2. Additional SVIRO examples

In order to provide a better overview of the variability in SVIRO, we report in this section additional examples for each vehicle in our dataset. We show the RGB images together with the grayscale images which should imitate an active infrared camera system. Our grayscale infrared imitation provides a more uniform illumination across the different environmental lightning conditions.

Figure 12. Mercedes A-Class

Figure 13. Ford Escape

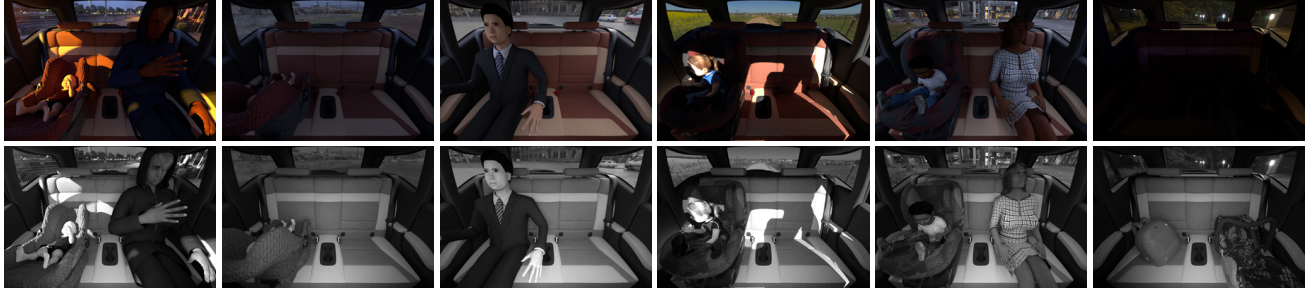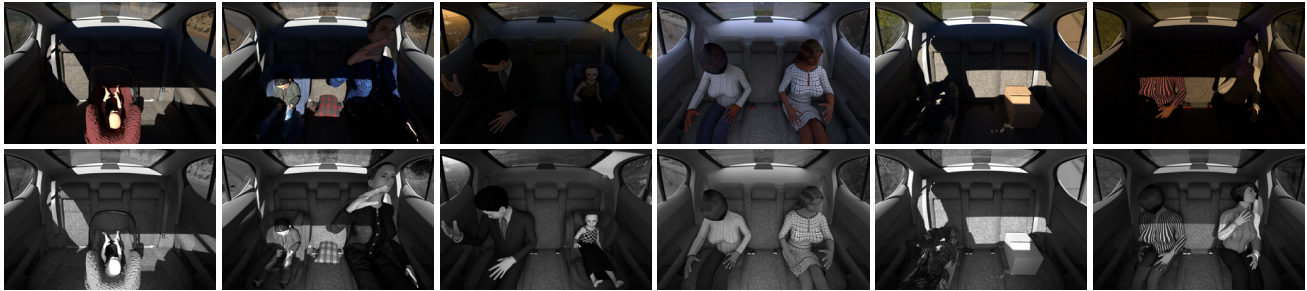Figure 14. Toyota Hilux

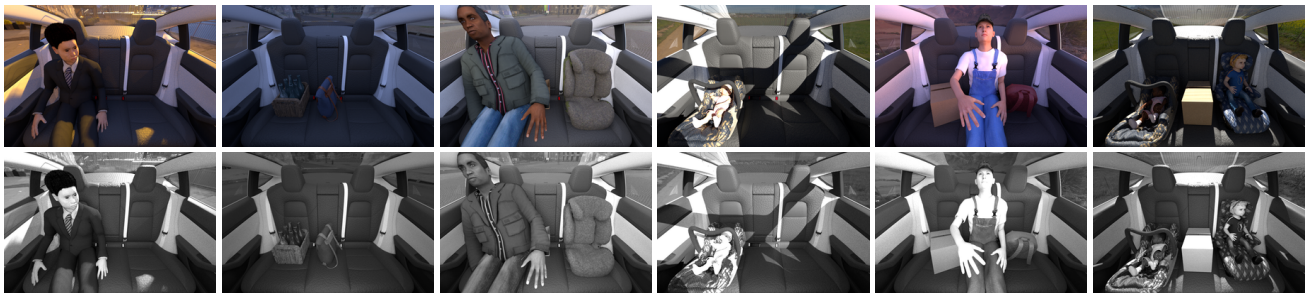Figure 15. BMW i3

Figure 16. Lexus GS F

Figure 17. Tesla Model 3

Figure 18. Volkswagen Tiguan

Figure 19. Hyundai Tucson

Figure 20. BMW X5

Figure 21. Renault Zoe

3. Detailed baseline evaluation

We provide an additional and exhaustive comparison of different training approaches across different models. The performance fluctuates a lot: a model with the same performance on the test set of the X5 can have a very different behaviour on unseen vehicles. Sometimes a model performs equally good on both unseen vehicles, sometimes it perform quite better on one of both, and sometimes the best model on unseen vehicles is not the best one for the test set of the X5. Hence, additional investigations need to be performed to better understand the behaviour of machine learning models for the generalization to unseen vehicles, when trained on limited amount of variation.

In the following tables, we highlighted some of the most interesting rows. All the models were trained on two different versions of the training dataset of the X5: the standard X5 training data with fixed textures and backgrounds (Fixed) and half of the standard X5 training data is replaced by randomly textured X5 training data with random backgrounds (Fixed and Random). Some of the models were pre-trained on ImageNet, while the others were trained from scratch. We allowed 1) all weights, 2) the last block or 3) the last layer only to be trainable. W. Decay refers to weight decay to punish large model weights in the cost function. W. Cost refers to weighted cost, where the contribution to the cost function of an input image is scaled according to the class distribution. I. Sampling refers to imbalanced sampling, where under-represented classes are

sampled more often, and over-represented classes are sampled less frequently. All models were then evaluated on the test set of the X5, i3 and Tucson. We performed a detailed investigation on ResNet-18 and a reduced investigations for the other models.

3.1. ResNet-18

Dataset (X5)	Pre-Trained	Trainable	W. Decay	W. Cost	I. Sampling	X5	i3	Tucson
Fixed	True	all	0	True	True	73	44	32
Fixed	True	all	0	True	False	67	34	24
Fixed	True	all	0	False	True	71	38	31
Fixed	True	all	0	False	False	71	37	28
Fixed	True	all	1e-05	True	True	74	45	38
Fixed	True	all	1e-05	True	False	75	44	31
Fixed	True	all	1e-05	False	True	67	34	23
Fixed	True	all	1e-05	False	False	70	42	30
Fixed	True	all	1e-04	True	True	69	40	28
Fixed	True	all	1e-04	True	False	71	39	31
Fixed	True	all	1e-04	False	True	75	41	35
Fixed	True	all	1e-04	False	False	68	38	28
Fixed	True	all	1e-03	True	True	71	50	38
Fixed	True	all	1e-03	True	False	66	36	43
Fixed	True	all	1e-03	False	True	71	40	28
Fixed	True	all	1e-03	False	False	67	35	31
Fixed	True	last layer	1e-03	False	True	70	44	40
Fixed	True	last layer	0	True	True	65	46	38
Fixed	True	last layer	0	True	False	65	48	39
Fixed	True	last layer	0	False	True	68	50	41
Fixed	True	last layer	0	False	False	69	48	44
Fixed	True	last layer	1e-05	True	True	68	52	42
Fixed	True	last layer	1e-05	True	False	69	49	46
Fixed	True	last layer	1e-05	False	True	66	45	36
Fixed	True	last layer	1e-05	False	False	68	48	37
Fixed	True	last layer	1e-04	True	True	69	51	51
Fixed	True	last layer	1e-04	True	False	69	52	46
Fixed	True	last layer	1e-04	False	True	70	50	44
Fixed	True	last layer	1e-04	False	False	69	48	44
Fixed	True	last layer	1e-03	True	True	70	49	43
Fixed	True	last layer	1e-03	True	False	67	49	46
Fixed	True	last layer	1e-03	False	False	67	48	42
Fixed	True	last block	0	True	True	71	40	33
Fixed	True	last block	0	True	False	73	40	32
Fixed	True	last block	0	False	True	74	41	34
Fixed	True	last block	0	False	False	72	41	33

Fixed	True	last block	1e-05	True	True	73	40	31
Fixed	True	last block	1e-05	True	False	72	40	31
Fixed	True	last block	1e-05	False	True	72	40	35
Fixed	True	last block	1e-05	False	False	75	42	34
Fixed	True	last block	1e-04	True	True	73	42	35
Fixed	True	last block	1e-04	True	False	76	42	34
Fixed	True	last block	1e-04	False	True	74	42	32
Fixed	True	last block	1e-04	False	False	71	42	35
Fixed	True	last block	1e-03	True	True	68	39	31
Fixed	True	last block	1e-03	True	False	70	40	34
Fixed	True	last block	1e-03	False	True	73	40	33
Fixed	True	last block	1e-03	False	False	70	40	31
Fixed	False	all	0	True	True	66	36	17
Fixed	False	all	0	True	False	67	36	20
Fixed	False	all	0	False	True	63	23	17
Fixed	False	all	0	False	False	68	34	18
Fixed	False	all	1e-05	True	True	64	23	14
Fixed	False	all	1e-05	True	False	67	20	19
Fixed	False	all	1e-05	False	True	65	23	24
Fixed	False	all	1e-05	False	False	67	28	16
Fixed	False	all	1e-04	True	True	66	40	15
Fixed	False	all	1e-04	True	False	68	42	21
Fixed	False	all	1e-04	False	True	66	23	16
Fixed	False	all	1e-04	False	False	65	26	16
Fixed	False	all	1e-03	True	True	68	37	18
Fixed	False	all	1e-03	True	False	66	31	17
Fixed	False	all	1e-03	False	True	55	22	17
Fixed	False	all	1e-03	False	False	69	30	20
Fixed and Random	True	all	0	True	True	84	57	50
Fixed and Random	True	all	0	True	False	82	54	37
Fixed and Random	True	all	0	False	True	82	70	71
Fixed and Random	True	all	0	False	False	83	61	61
Fixed and Random	True	all	1e-05	True	True	88	57	46
Fixed and Random	True	all	1e-05	True	False	85	52	57
Fixed and Random	True	all	1e-05	False	True	84	55	45
Fixed and Random	True	all	1e-05	False	False	79	56	53
Fixed and Random	True	all	1e-04	True	True	78	61	56
Fixed and Random	True	all	1e-04	True	False	85	53	51
Fixed and Random	True	all	1e-04	False	True	87	75	68
Fixed and Random	True	all	1e-04	False	False	83	68	57

Fixed and Random	True	all	1e-03	True	True	79	60	55
Fixed and Random	True	all	1e-03	True	False	77	56	42
Fixed and Random	True	all	1e-03	False	True	77	51	30
Fixed and Random	True	all	1e-03	False	False	81	59	60
Fixed and Random	True	last layer	0	True	True	73	60	55
Fixed and Random	True	last layer	0	True	False	73	57	56
Fixed and Random	True	last layer	0	False	True	71	57	51
Fixed and Random	True	last layer	0	False	False	71	60	54
Fixed and Random	True	last layer	1e-05	True	True	69	56	52
Fixed and Random	True	last layer	1e-05	True	False	69	60	54
Fixed and Random	True	last layer	1e-05	False	True	68	59	53
Fixed and Random	True	last layer	1e-05	False	False	71	59	50
Fixed and Random	True	last layer	1e-04	True	True	71	60	54
Fixed and Random	True	last layer	1e-04	True	False	72	54	51
Fixed and Random	True	last layer	1e-04	False	True	72	60	55
Fixed and Random	True	last layer	1e-04	False	False	66	57	51
Fixed and Random	True	last layer	1e-03	True	True	70	56	49
Fixed and Random	True	last layer	1e-03	True	False	72	57	51
Fixed and Random	True	last layer	1e-03	False	True	72	59	53
Fixed and Random	True	last layer	1e-03	False	False	71	56	42
Fixed and Random	False	all	0	True	True	75	39	35
Fixed and Random	False	all	0	True	False	73	35	34
Fixed and Random	False	all	0	False	True	74	36	27
Fixed and Random	False	all	0	False	False	76	32	28
Fixed and Random	False	all	1e-05	True	True	75	26	31
Fixed and Random	False	all	1e-05	True	False	76	35	26
Fixed and Random	False	all	1e-05	False	True	73	33	27
Fixed and Random	False	all	1e-05	False	False	77	34	30
Fixed and Random	False	all	1e-04	True	True	77	33	33
Fixed and Random	False	all	1e-04	True	False	74	34	28
Fixed and Random	False	all	1e-04	False	True	77	33	30
Fixed and Random	False	all	1e-04	False	False	78	34	31
Fixed and Random	False	all	1e-03	True	True	72	28	28
Fixed and Random	False	all	1e-03	True	False	73	25	32
Fixed and Random	False	all	1e-03	False	True	73	25	25
Fixed and Random	False	all	1e-03	False	False	72	36	31
Fixed and Random	True	last block	0	True	True	87	68	66
Fixed and Random	True	last block	0	True	False	84	66	46
Fixed and Random	True	last block	0	False	True	82	64	43
Fixed and Random	True	last block	0	False	False	88	64	47

Fixed and Random	True	last block	1e-05	True	True	84	66	46
Fixed and Random	True	last block	1e-05	True	False	87	57	42
Fixed and Random	True	last block	1e-05	False	True	86	66	44
Fixed and Random	True	last block	1e-05	False	False	83	62	40
Fixed and Random	True	last block	1e-04	True	True	84	62	48
Fixed and Random	True	last block	1e-04	True	False	86	60	51
Fixed and Random	True	last block	1e-04	False	True	82	56	45
Fixed and Random	True	last block	1e-04	False	False	84	57	42
Fixed and Random	True	last block	1e-03	True	True	83	59	40
Fixed and Random	True	last block	1e-03	True	False	83	61	47
Fixed and Random	True	last block	1e-03	False	True	79	68	67
Fixed and Random	True	last block	1e-03	False	False	83	57	43

3.2. DenseNet-121

Dataset (X5)	Pre-Trained	Trainable	W. Decay	W. Cost	I. Sampling	X5	i3	Tucson
Fixed	True	all	0	True	True	74	40	49
Fixed	True	all	0	True	False	68	36	20
Fixed	True	all	0	False	True	73	34	32
Fixed	True	all	0	False	False	75	45	30
Fixed	True	all	1e-05	True	True	72	37	36
Fixed	True	all	1e-05	True	False	77	45	35
Fixed	True	all	1e-05	False	True	77	46	55
Fixed	True	all	1e-05	False	False	73	40	34
Fixed	True	all	1e-04	True	True	71	38	27
Fixed	True	all	1e-04	True	False	74	40	28
Fixed	True	all	1e-04	False	True	72	43	31
Fixed	True	all	1e-04	False	False	73	36	28
Fixed	True	last block	0	True	True	72	39	44
Fixed	True	last block	0	True	False	77	44	37
Fixed	True	last block	0	False	True	74	43	46
Fixed	True	last block	0	False	False	68	37	35
Fixed	True	last block	1e-05	True	True	72	40	38
Fixed	True	last block	1e-05	True	False	73	40	41
Fixed	True	last block	1e-05	False	True	67	41	31
Fixed	True	last block	1e-05	False	False	75	43	35
Fixed	True	last block	1e-04	True	True	75	43	46
Fixed	True	last block	1e-04	True	False	77	41	42
Fixed	True	last block	1e-04	False	True	77	43	50
Fixed	True	last block	1e-04	False	False	77	44	42
Fixed	True	all	1e-04	True	False	81	50	39

Fixed	True	all	1e-04	False	False	71	42	52
Fixed	True	last block	1e-04	True	False	75	39	40
Fixed	True	last block	1e-04	False	False	76	42	47
Fixed	True	last layer	1e-04	True	False	69	51	35
Fixed	True	last layer	1e-04	False	False	68	48	36
Fixed	False	all	1e-04	True	False	64	32	14
Fixed	False	all	1e-04	False	False	62	27	11
Fixed and Random	True	all	0	True	True	83	52	45
Fixed and Random	True	all	0	True	False	76	59	68
Fixed and Random	True	all	0	False	True	81	52	54
Fixed and Random	True	all	0	False	False	85	60	75
Fixed and Random	True	all	1e-05	True	True	82	60	47
Fixed and Random	True	all	1e-05	True	False	83	64	61
Fixed and Random	True	all	1e-05	False	True	78	54	50
Fixed and Random	True	all	1e-05	False	False	85	62	60
Fixed and Random	True	all	1e-04	True	True	83	55	42
Fixed and Random	True	all	1e-04	True	False	82	67	72
Fixed and Random	True	all	1e-04	False	True	81	60	59
Fixed and Random	True	all	1e-04	False	False	84	62	56
Fixed and Random	True	last block	0	True	True	88	80	66
Fixed and Random	True	last block	0	True	False	90	82	74
Fixed and Random	True	last block	0	False	True	89	81	62
Fixed and Random	True	last block	0	False	False	86	81	61
Fixed and Random	True	last block	1e-05	True	True	88	78	64
Fixed and Random	True	last block	1e-05	True	False	86	77	55
Fixed and Random	True	last block	1e-05	False	True	88	75	59
Fixed and Random	True	last block	1e-05	False	False	83	69	66
Fixed and Random	True	last block	1e-04	True	True	88	75	66
Fixed and Random	True	last block	1e-04	True	False	92	70	56
Fixed and Random	True	last block	1e-04	False	True	92	76	60
Fixed and Random	True	last block	1e-04	False	False	85	82	67
Fixed and Random	True	all	1e-04	True	False	79	55	74
Fixed and Random	True	all	1e-04	False	False	79	57	44
Fixed and Random	True	last block	1e-04	True	False	88	72	60
Fixed and Random	True	last block	1e-04	False	False	82	60	40
Fixed and Random	True	last layer	1e-04	True	False	76	67	54
Fixed and Random	True	last layer	1e-04	False	False	78	71	48
Fixed and Random	False	all	1e-04	True	False	76	43	35
Fixed and Random	False	all	1e-04	False	False	77	43	32

3.3. SqueezeNet V1.1

Dataset (X5)	Pre-Trained	Trainable	W. Decay	W. Cost	I. Sampling	X5	i3	Tucson
Fixed	True	all	0	True	True	61	25	15
Fixed	True	all	0	True	False	80	50	32
Fixed	True	all	0	False	True	70	46	41
Fixed	True	all	0	False	False	67	36	26
Fixed	True	all	1e-05	True	True	67	40	25
Fixed	True	all	1e-05	True	False	74	43	26
Fixed	True	all	1e-05	False	True	64	44	28
Fixed	True	all	1e-05	False	False	71	46	23
Fixed	True	all	1e-04	True	True	66	45	27
Fixed	True	all	1e-04	True	False	75	41	37
Fixed	True	all	1e-04	False	True	67	43	26
Fixed	True	all	1e-04	False	False	65	46	24
Fixed	True	last block	0	True	True	72	46	44
Fixed	True	last block	0	True	False	69	47	41
Fixed	True	last block	0	False	True	70	47	36
Fixed	True	last block	0	False	False	68	45	46
Fixed	True	last block	1e-05	True	True	66	38	40
Fixed	True	last block	1e-05	True	False	66	43	43
Fixed	True	last block	1e-05	False	True	72	46	40
Fixed	True	last block	1e-05	False	False	68	41	42
Fixed	True	last block	1e-04	True	True	70	46	42
Fixed	True	last block	1e-04	True	False	66	40	42
Fixed	True	last block	1e-04	False	True	67	42	44
Fixed	True	last block	1e-04	False	False	73	48	46
Fixed	True	all	1e-04	True	False	68	38	38
Fixed	True	all	1e-04	False	False	66	37	39
Fixed	True	last block	1e-04	True	False	65	40	34
Fixed	True	last block	1e-04	False	False	64	42	34
Fixed	True	last layer	1e-04	True	False	62	45	28
Fixed	True	last layer	1e-04	False	False	61	47	28
Fixed	False	all	1e-04	True	False	67	37	22
Fixed	False	all	1e-04	False	False	55	34	17
Fixed and Random	True	all	0	True	True	80	62	53
Fixed and Random	True	all	0	True	False	78	47	49
Fixed and Random	True	all	0	False	True	76	46	52
Fixed and Random	True	all	0	False	False	83	51	56
Fixed and Random	True	all	1e-05	True	True	75	56	48
Fixed and Random	True	all	1e-05	True	False	70	50	48
Fixed and Random	True	all	1e-05	False	True	51	56	31

Fixed and Random	True	all	1e-05	False	False	78	56	54
Fixed and Random	True	all	1e-04	True	True	80	46	34
Fixed and Random	True	all	1e-04	True	False	73	49	46
Fixed and Random	True	all	1e-04	False	True	78	49	36
Fixed and Random	True	all	1e-04	False	False	85	54	44
Fixed and Random	True	last block	0	True	True	83	65	37
Fixed and Random	True	last block	0	True	False	77	62	50
Fixed and Random	True	last block	0	False	True	74	56	47
Fixed and Random	True	last block	0	False	False	78	55	47
Fixed and Random	True	last block	1e-05	True	True	79	54	53
Fixed and Random	True	last block	1e-05	True	False	78	65	55
Fixed and Random	True	last block	1e-05	False	True	82	61	55
Fixed and Random	True	last block	1e-05	False	False	80	72	50
Fixed and Random	True	last block	1e-04	True	True	82	67	57
Fixed and Random	True	last block	1e-04	True	False	82	68	53
Fixed and Random	True	last block	1e-04	False	True	82	59	55
Fixed and Random	True	last block	1e-04	False	False	82	55	54
Fixed and Random	True	all	1e-04	True	False	78	53	51
Fixed and Random	True	all	1e-04	False	False	81	42	52
Fixed and Random	True	last block	1e-04	True	False	77	63	48
Fixed and Random	True	last block	1e-04	False	False	75	61	49
Fixed and Random	True	last layer	1e-04	True	False	66	68	40
Fixed and Random	True	last layer	1e-04	False	False	67	63	33
Fixed and Random	False	all	1e-04	True	False	30	32	24
Fixed and Random	False	all	1e-04	False	False	45	28	44

3.4. MobileNet V2

Dataset (X5)	Pre-Trained	Trainable	W. Decay	W. Cost	I. Sampling	X5	i3	Tucson
Fixed	True	all	0	True	True	72	44	32
Fixed	True	all	0	True	False	71	38	34
Fixed	True	all	0	False	True	67	47	49
Fixed	True	all	0	False	False	70	40	33
Fixed	True	all	1e-05	True	True	77	51	36
Fixed	True	all	1e-05	True	False	72	46	32
Fixed	True	all	1e-05	False	True	82	56	48
Fixed	True	all	1e-05	False	False	69	38	34
Fixed	True	all	1e-04	True	True	72	48	56
Fixed	True	all	1e-04	True	False	71	40	32
Fixed	True	all	1e-04	False	True	74	46	47
Fixed	True	all	1e-04	False	False	75	45	43

Fixed	True	last block	0	True	True	66	39	41
Fixed	True	last block	0	True	False	69	40	33
Fixed	True	last block	0	False	True	71	40	33
Fixed	True	last block	0	False	False	69	38	34
Fixed	True	last block	1e-05	True	True	69	45	39
Fixed	True	last block	1e-05	True	False	66	37	43
Fixed	True	last block	1e-05	False	True	68	41	38
Fixed	True	last block	1e-05	False	False	69	44	34
Fixed	True	last block	1e-04	True	True	70	45	39
Fixed	True	last block	1e-04	True	False	70	42	35
Fixed	True	last block	1e-04	False	True	68	39	38
Fixed	True	last block	1e-04	False	False	68	37	33
Fixed	True	all	1e-04	True	False	72	44	48
Fixed	True	all	1e-04	False	False	76	43	46
Fixed	True	last block	1e-04	True	False	67	38	34
Fixed	True	last block	1e-04	False	False	68	40	36
Fixed	True	last layer	1e-04	True	False	63	46	32
Fixed	True	last layer	1e-04	False	False	64	47	32
Fixed	False	all	1e-04	True	False	66	36	21
Fixed	False	all	1e-04	False	False	66	25	18
Fixed and Random	True	all	0	True	True	88	70	71
Fixed and Random	True	all	0	True	False	82	68	59
Fixed and Random	True	all	0	False	True	78	55	52
Fixed and Random	True	all	0	False	False	78	61	62
Fixed and Random	True	all	1e-05	True	True	87	59	56
Fixed and Random	True	all	1e-05	True	False	85	62	57
Fixed and Random	True	all	1e-05	False	True	82	56	53
Fixed and Random	True	all	1e-05	False	False	81	49	53
Fixed and Random	True	all	1e-04	True	True	81	61	60
Fixed and Random	True	all	1e-04	True	False	88	64	67
Fixed and Random	True	all	1e-04	False	True	78	62	56
Fixed and Random	True	all	1e-04	False	False	79	51	59
Fixed and Random	True	last block	0	True	True	82	68	49
Fixed and Random	True	last block	0	True	False	81	66	61
Fixed and Random	True	last block	0	False	True	81	63	44
Fixed and Random	True	last block	0	False	False	84	63	53
Fixed and Random	True	last block	1e-05	True	True	83	61	55
Fixed and Random	True	last block	1e-05	True	False	83	59	45
Fixed and Random	True	last block	1e-05	False	True	82	60	52
Fixed and Random	True	last block	1e-05	False	False	81	62	53

Fixed and Random	True	last block	1e-04	True	True	83	62	49
Fixed and Random	True	last block	1e-04	True	False	84	66	49
Fixed and Random	True	last block	1e-04	False	True	86	71	51
Fixed and Random	True	last block	1e-04	False	False	82	67	49
Fixed and Random	True	all	1e-04	True	False	80	52	52
Fixed and Random	True	all	1e-04	False	False	83	57	59
Fixed and Random	True	last block	1e-04	True	False	82	65	45
Fixed and Random	True	last block	1e-04	False	False	80	56	47
Fixed and Random	True	last layer	1e-04	True	False	74	61	44
Fixed and Random	True	last layer	1e-04	False	False	69	57	39
Fixed and Random	False	all	1e-04	True	False	72	38	37
Fixed and Random	False	all	1e-04	False	False	74	31	43