Convolutional Neural Networks experiment coursework report

Víctor Bonilla Pardo

Image Processing and Deep Learning – MSc. Data Science

University of Surrey

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3 ABSTRACT

This document describes the experiment and discusses the effect in the outcomes caused by different changes in the factors considered in the process of developing a Convolutional Neural Network with the NVIDIA Digits system. AlexNet and GoogLeNet architectures are trained over the "Stanford cars" data set.

4 EXPERIMENTAL METHOD

The data set used in this experiment is the "Stanford cars" data set (J. Krause, 2013) suggested in the coursework specification.

Some guidelines used in Full Factorial Design have been used to design the experiment alongside with domain knowledge to avoid inefficient treatments. In this experiment, five components take place:

1) The tests. These were carried out using the tool Digits from Nvidia. Digits provides a UI allowing a user to create, train and evaluate deep learning models easily without coding (NVIDIA Corporation, 2020). All tests were executed using the Caffe framework. Each test presents three phases:
   a) Configure the parameters of the model, i.e. inputs or factors of the test.
   b) Train the model, i.e. execute the test.
   c) Evaluate the performance of the trained model, i.e. assess the outputs or responses of the test.
2) The factors and the levels (two different components):
   a) The split proportion of the data set for training, validating and testing. Two levels (train_val_test respectively in %): [90_9_1, 80_15_5]
   b) The architecture of the Convolutional Neural Network: [AlexNet, GoogLeNet]
   c) The type of subtract mean as data transformation: [Image, Pixel]
   d) The number of epochs for training the model: [30, 60]
   e) The validation intervals (number of epochs between validations): [1, 6]
   f) The batch size: [default value in DIGITS, 20, 50, 100]
   g) The solver type: [SGD, NAG, Adam, AdaGrad, RMSprop]
   h) The base learning rate: [0.1, 0.01, 0.001]
   i) The learning rate policy: [Step Down, Sigmoid Decay, Exponential Decay]
   j) The learning rate step size (in %): [33, 50]
   k) The learning rate gamma: [0.1, 0.05]
3) Treatments. Considering a treatment as a combination of levels of factors, in a Full Factorial Design (Factorial experiment, 2020) there are 23,040 possible treatments with the factors and levels described above, but it is inefficient to test that huge amount of treatments. Consequently, another strategy has been used for selecting the treatments, which is described in the methodology section.
4) Evaluation metrics. The metrics used to evaluate the performance of each model and measure the effects in each test are the following:
   a) The loss error and the accuracy of a model in its last epoch. Details for each architecture:
      i) AlexNet (Krizhevsky, 2012): validation loss error (lower is better) and the accuracy from the validation phase (higher is better).

ii) GoogLeNet (Szegedy, 2015): validation loss error of the last layer (lower is better) and the accuracy of the last layer from the validation phase (higher is better).

b) In addition, a single average ratio was created to evaluate and compare effectively between models. Previous min-max normalization of the validation loss error, the formula is as follows:

$$r = \frac{(1 - \varepsilon_v) + \alpha_v}{2}$$

Equation 1.Single average ratio for Deep Learning models trained with validation phase. $\varepsilon_v \equiv normalised\ validation\ error\ loss;\ \alpha_v \equiv the\ accuracy.$

c) Finally, a model can be manually tested with the option "Classify many" in Digits returning "Top-1" and "Top-5" accuracy percentages. To avoid spending time in treatments whose outcome's information is insignificant, this additional measure is obtained when a model achieves around 0.50 of accuracy or more (with exceptions). 100 images will be classified. **Note:** some of the tests apply to be tested with the "Classify Many" option but they weren't due to the loss of the models when restarting the Digits servers.

4.1 METHODOLOGY

The factors *a* and *b* are the most influential in the tests because the effect is likely to be significant when changing a level. Therefore, these factors are semi-fixed. In other words, the treatments are divided in groups by architecture and data set split, so the process of finding a treatment that performs well is more efficient and organize.

Then, within each group, a treatment is set as the default (also named as base treatment) having as levels the default values in digits when creating a new model (except factors *a* and *b*). This treatment is tested and evaluated. Its results are set as the base comparison, so the goal of following tests is to outperform them.

Consequently, a new treatment that differs in one level of one factor from the *default treatment* is selected. After testing and evaluating it, if the effect of this change is beneficial, the level changed is taken into consideration for further exploration of treatments.

Doing this process iteratively, the treatments obtained present combination of levels of factors that caused beneficial changes in tests in which the level itself was an individual change comparing to the *default treatment*.

The information given by the change of these levels is also used in different groups of *a* and *b* factors, so it may cause the finding process in other groups to be more efficient.

Finally, stop testing new treatments when the effect of adding prior information (changed levels causing a better effect) doesn't improve or improve insignificantly.

5 RELEVANT TESTS

The tests showed in this section either showed a significant better effect when adding the prior information or are relevant to the comparisons. For clarity, the section is divided by groups of levels of factors *a* and *b*.

The train and validation loss error resulted from each test are presented unnormalized.

5.1 DATA SET SPLIT 90_9_1 – ALEXNET

#	Subt. mean	Epochs	Val. interval	Batch size	Solver	Base LR	LR policy	LR step	LR gamma
1	Image	30	1	Default	SGD	0.01	Step Down	33%	0.1
3	Image	60	1	Default	SGD	0.01	Step Down	33%	0.1
4	Image	30	1	Default	SGD	0.01	Sigmoid D.	50%	0.05
13	Image	30	1	Default	NAG	0.01	Step Down	33%	0.1
21	Image	30	1	50	SGD	0.01	Step Down	33%	0.1
16	Image	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05

Table 1: Treatments specification for group 90_9_1-AlexNet.

#	Train loss error	Val. loss error	Accuracy	Average ratio	Top-1 acc.	Top-5 acc.
1	2.96942	3.49164	0.201087	0.5882780138	NA	NA
3	0.499812	2.37867	0.488451	0.7384342792	39.00%	65.00%
4	0.932482	2.7707	0.370245	0.6770507988	25.00%	59.00%
13	2.25553	2.96253	0.286005	0.6338149032	NA	NA
21	1.83916	2.68595	0.349333	0.6262375567	NA	NA
16	0.0503703	2.55963	0.555027	0.7706696156	49.00%	70.00%

Table 2: Tests results for group 90_9_1-AlexNet.

The default treatment is treatment 1 which shows poor accuracy results during the last validation iteration with 20%. In the Figure 1 where the training and validation progress of the model is showed, it can be seen that the model doesn't converge.

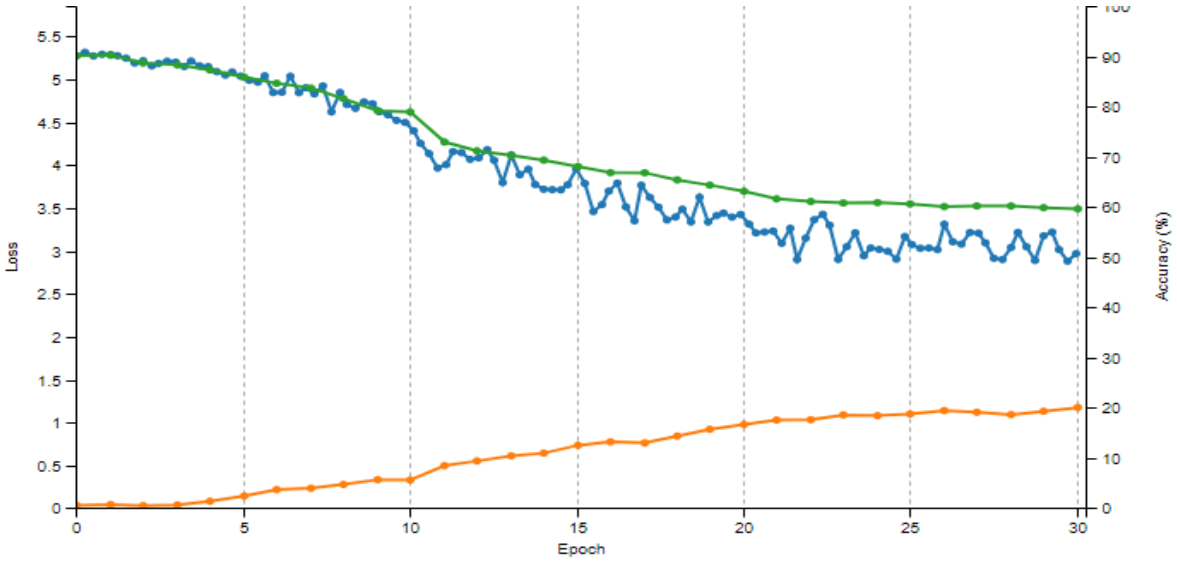


Figure 1: Test results for treatment 1. Training loss error (blue), validation loss error (green) and accuracy (orange).

Given the results of treatment 1, it can be deduced that there is a need to learn faster or during a longer period. Several treatments are tested to allow the model to converge. For example, the

epochs are doubled in the treatment 3 causing an immediate rise in performance to 48% accuracy in the last validation iteration. The training and validation progress of the model is showed in Figure 2.

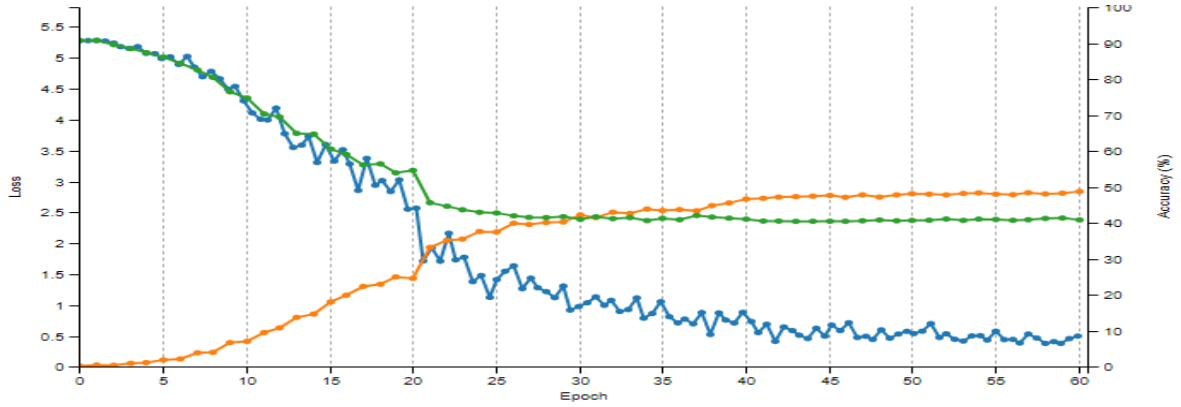


Figure 2: Test results for treatment 3. Training loss error (blue), validation loss error (green) and accuracy (orange).

Other factors are changed in order to find the desire effect in the model like the learning rate configuration (treatment 4), the solver (treatment 13) or the batch size (treatment 21). Although the effect caused is good, it isn't as significant as incrementing the epochs. The results of the different treatments are showed in the Figure 3.

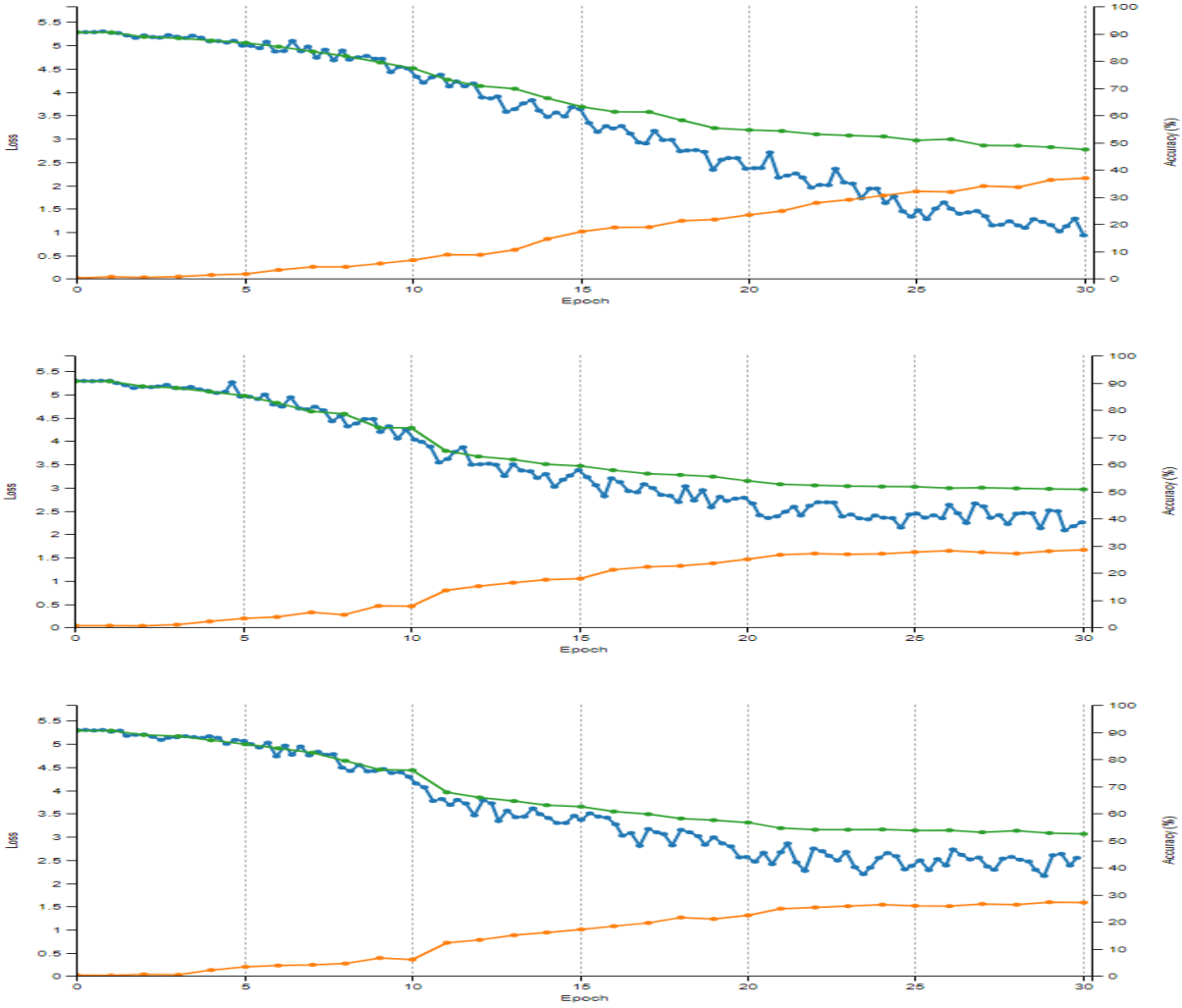


Figure 3. From top to bottom: Test results for treatment 4 (learning rate configuration), treatment 13 (solver) and treatment 21 (batch size). Training loss error (blue), validation loss error (green) and accuracy (orange).

With all the information obtained from these treatments, the treatment 16 is defined resulting the best selection of this group. The evolution of the model is showed in the Figure 4, where it can be seen the fast learning process leading the CNN to converge and achieving 49% and 70% Top-1 and Top-5 accuracy respectively in the "Classify Many" process.

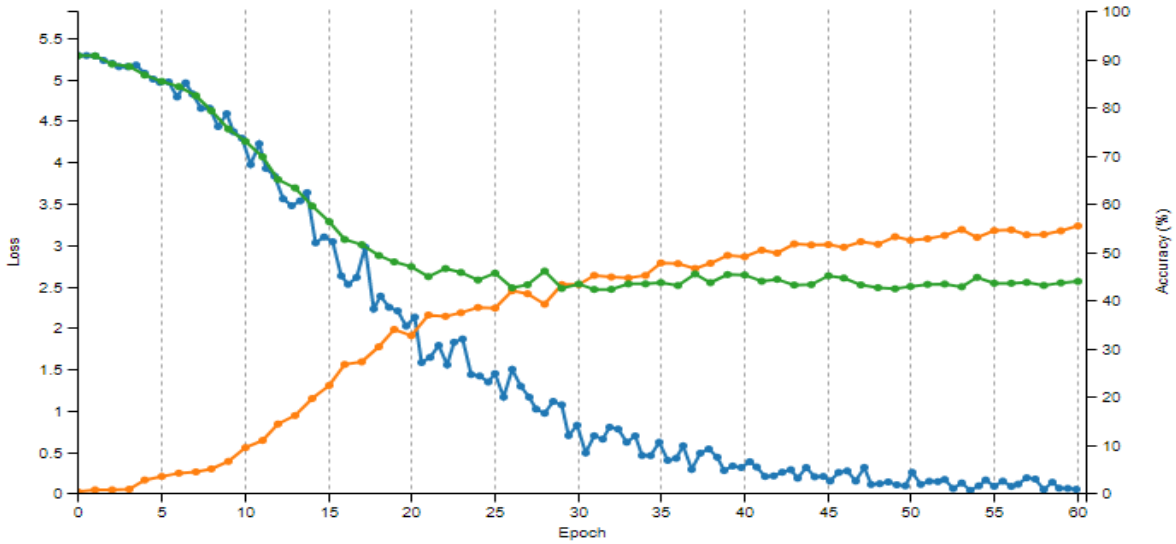


Figure 4: Test results for treatment 16. Training loss error (blue), validation loss error (green) and accuracy (orange).

5.2 DATA SET SPLIT 90_9_1 – GOOGLENET

#	Subt. mean	Epochs	Val. interval	Batch size	Solver	Base LR	LR policy	LR step	LR gamma
8	Image	30	1	Default	SGD	0.01	Step Down	33%	0.1
10	Image	60	1	Default	SGD	0.01	Step Down	33%	0.1
11	Image	30	1	Default	SGD	0.01	Sigmoid D.	50%	0.05
23	Image	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05

Table 3: Treatments specification for group 90_9_1-GoogLeNet.

#	Train loss error	Val. loss error	Accuracy	Average ratio	Top-1 acc.	Top-5 acc.
8	4.41124	4.41367	0.0618132	0.5132775667	NA	NA
10	1.1333	1.89526	0.494505	0.7442733269	35.00%	71.00%
11	2.19497	2.38785	0.355769	0.6720398782	NA	NA
23	0.0630354	1.38312	0.754808	0.877404	71.00%	93.00%

Table 4: Tests results for group 90_9_1-GoogLeNet.

The default treatment is treatment 8. Like the default treatment for the group 90_9_1-AlexNet, treatment 8 presents a very poor accuracy result during the last validation iteration with 6%. In the Figure 5, it can be seen that the model doesn't converge.

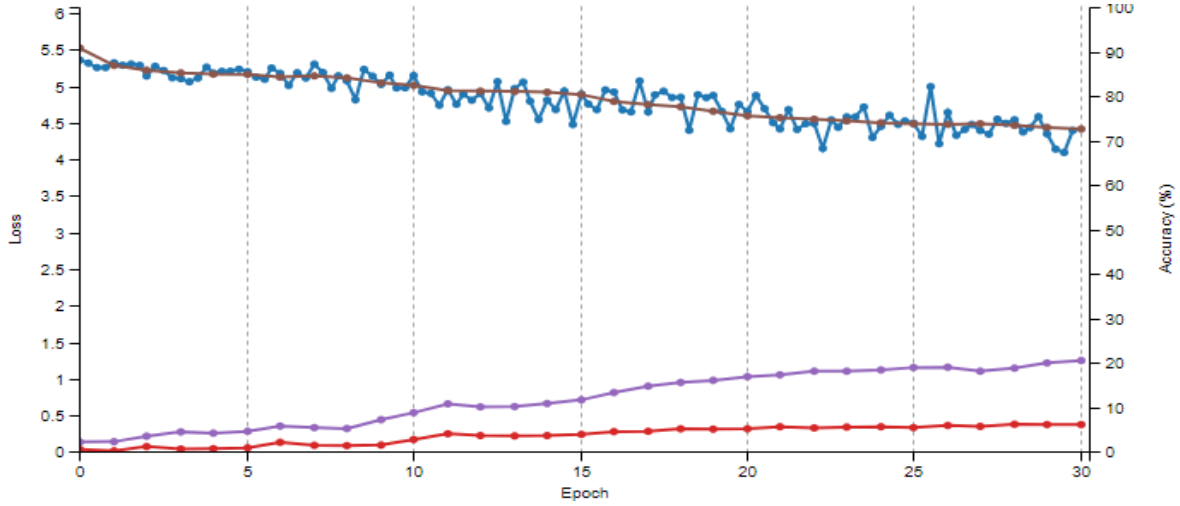


Figure 5: Test results for treatment 8. Training loss error (blue), validation loss error (brown) and accuracy (red).

As in the previous group, the results of the default treatment show the need for the model to learn faster, so the same strategy is applied for selecting the treatments. Now taking advantage of the information from the group 90_9_1-AlexNet, treatments 10 (change in epochs) and 11 (change in the learning rate configuration) are tested resulting in a significant rise of the accuracy during the validation phase to 49% and 35% respectively. The evolution of these are showed in the Figure 6.

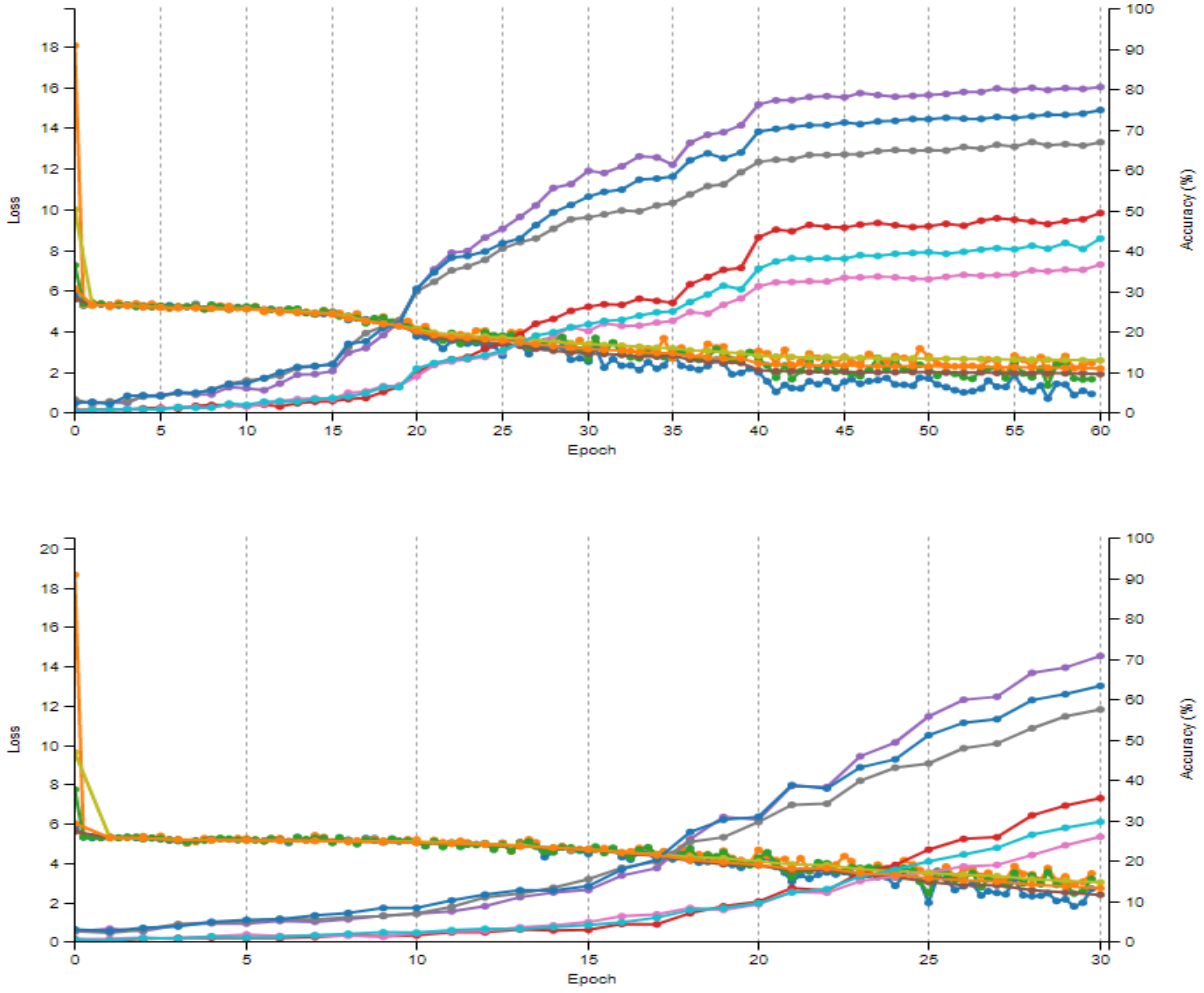


Figure 6. From top to bottom: Test results for treatment 10 (epochs) and treatment 11 (learning rate configuration). Training loss error (blue), validation loss error (brown) and accuracy (red).

With all the prior information, the treatment 23 is defined resulting the best selection of this group and the experiment with 75% of accuracy during the validation phase. The evolution of the model is showed in the Figure 7, where it can be seen the fast learning process leading the CNN to converge and achieving 71% and 93% Top-1 and Top-5 accuracy respectively in the "Classify Many" process.

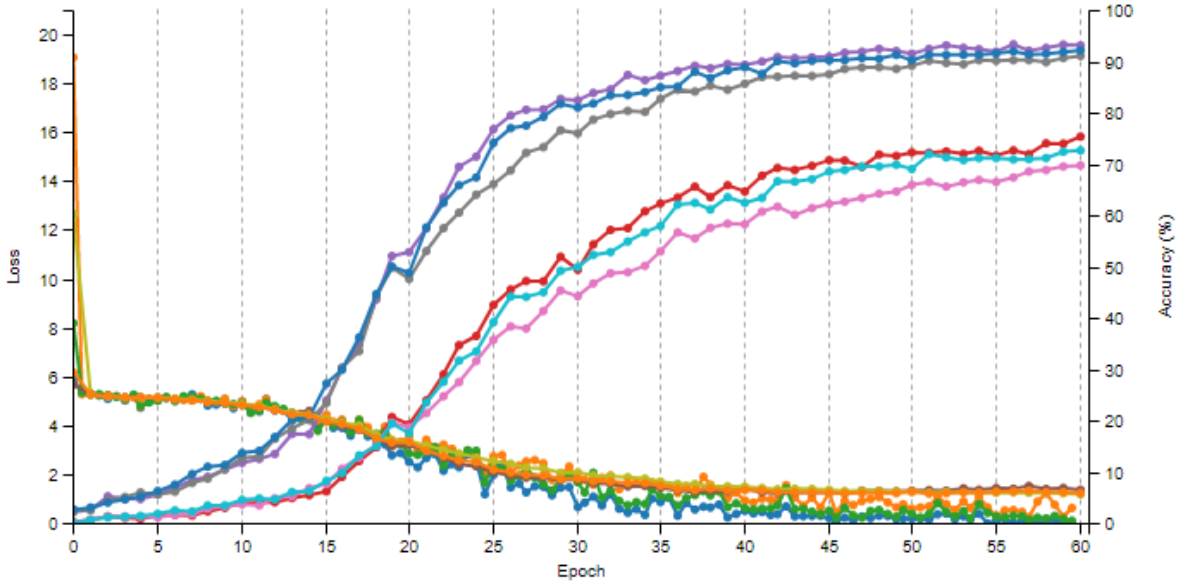


Figure 7: Test results for treatment 23. Training loss error (blue), validation loss error (brown) and accuracy (red).

5.3 DATA SET SPLIT 80_15_5 – ALEXNET

#	Subt. mean	Epochs	Val. interval	Batch size	Solver	Base LR	LR policy	LR step	LR gamma
25	Image	30	1	Default	SGD	0.01	Step Down	33%	0.1
29	Image	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05
41	Pixel	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05
42	Image	60	6	Default	NAG	0.01	Sigmoid D.	50%	0.05

Table 5: Treatments specification for group 80_15_5-AlexNet.

#	Train loss error	Val. loss error	Accuracy	Average ratio	Top-1 acc.	Top-5 acc.
25	3.38903	3.70125	0.172286	0.57265819	NA	NA
29	0.0930393	2.90014	0.479441	0.7308958325	NA	NA
41	0.059693	2.59685	0.513569	0.7497241028	95.00%	97.00%
42	0.179152	2.8429	0.491776	0.7373963037	85.00%	91.00%

Table 6: Tests results for group 80_15_5-AlexNet.

The default treatment is treatment 25. In the Figure 8, it can be seen the similarity to the treatment 1 (default treatment for 90_9_1-AlexNet) clearly indicating that the model does not converge.

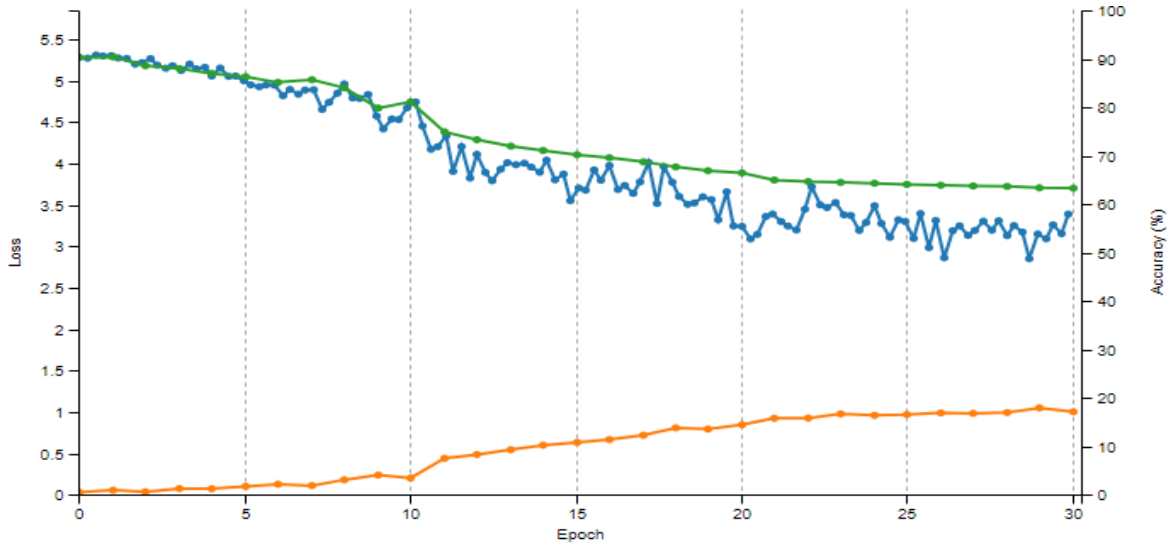


Figure 8: Test results for treatment 25. Training loss error (blue), validation loss error (green) and accuracy (orange).

Taking advantage of the prior information from groups 90_9_1-AlexNet and 90_9_1-GoogLeNet, and following the same reasoning to select the combinations, treatments 29, 41 and 42 are defined taking advantage of many previous changes. The best performing treatment is treatment 41 whose training and validation loss error, and accuracy evolution can be seen in Figure 9. However, the results of these tests are quite similar meaning that the small changes between them cause little effects in the outcomes.

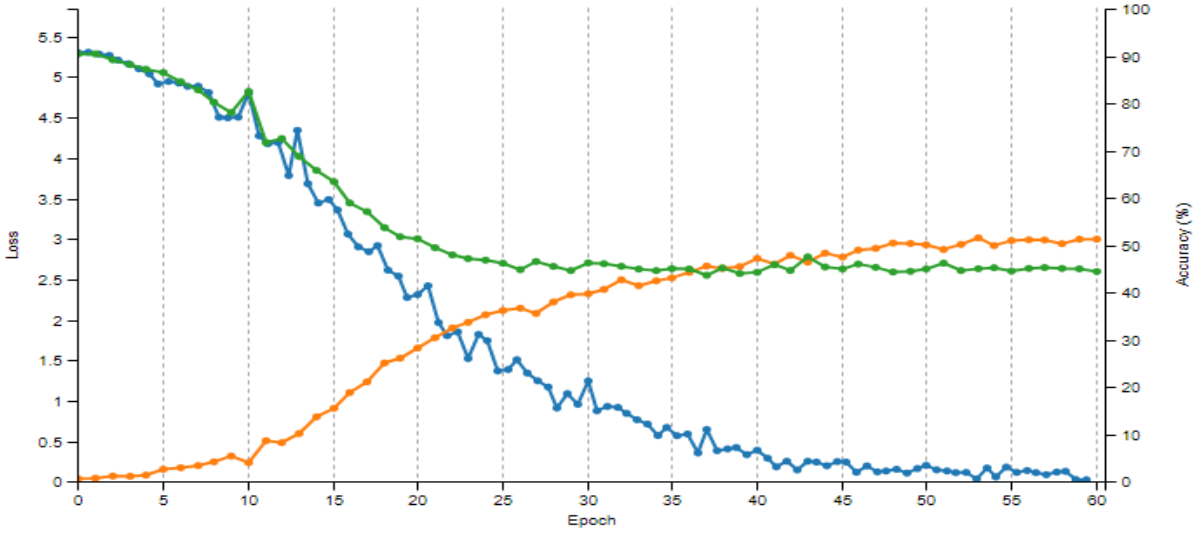


Figure 9: Test results for treatment 41. Training loss error (blue), validation loss error (green) and accuracy (orange).

5.4 DATA SET SPLIT 80_15_5 – GOOGLENET

#	Subt. mean	Epochs	Val. interval	Batch size	Solver	Base LR	LR policy	LR step	LR gamma
43	Image	30	1	Default	SGD	0.01	Step Down	33%	0.1
30	Image	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05
39	Pixel	60	1	Default	NAG	0.01	Sigmoid D.	50%	0.05
40	Pixel	60	6	50	NAG	0.01	Sigmoid D.	50%	0.05

Table 7: Treatments specification for group 80_15_5-GoogLeNet.

#	Train loss error	Val. loss error	Accuracy	Average ratio	Top-1 acc.	Top-5 acc.
43	4.75882	4.77023	0.0398849	0.500239269	NA	NA
30	0.400171	1.54594	0.661595	0.8298503587	65.00%	80.00%
39	0.248097	1.65262	0.668174	0.8325192897	84.00%	97.00%
40	0.347772	1.81656	0.638776	0.8168666332	NA	NA

Table 8: Tests results for group 80_15_5-GoogLeNet.

The default treatment is treatment 43. In the Figure 10, it can be seen the similarity to the treatment 8 (default treatment for 90_9_1-GoogLeNet) clearly indicating that the model does not converge.

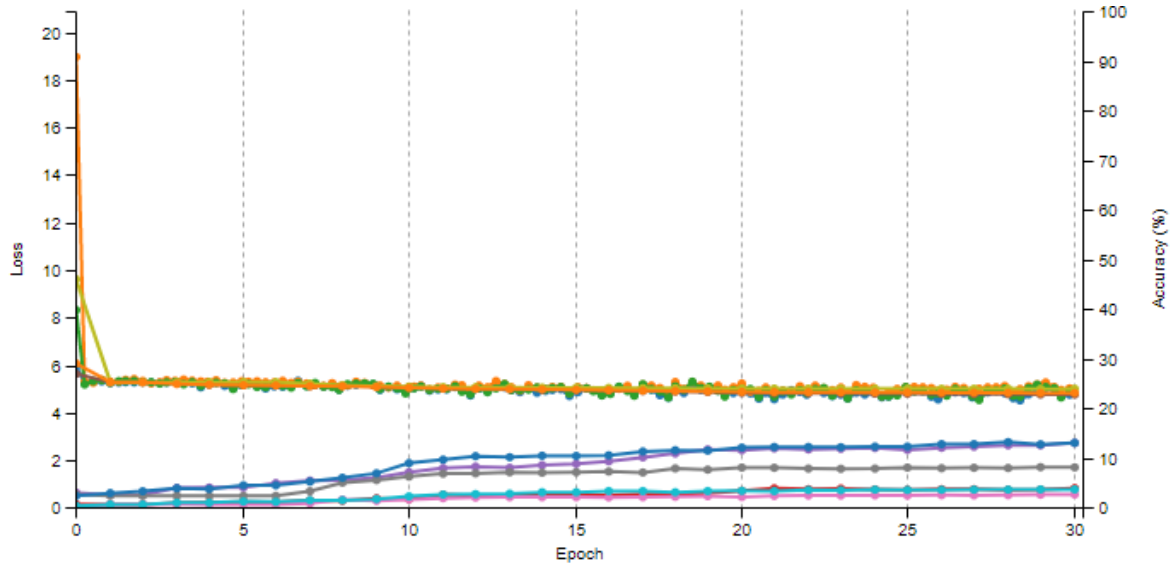


Figure 10: Test results for treatment 43. Training loss error (blue), validation loss error (brown) and accuracy (red).

Taking advantage of the prior information from groups 90_9_1-AlexNet and 90_9_1-GoogLeNet, the same reasoning is followed to select the combinations. Therefore, treatments 30, 39 and 40 are defined and tested. As in the 80_15_5-AlexNet group, the results of these models are quite similar in terms of loss error and accuracy. However, using the option “Classify Many” it can be observed a significant difference between treatments 30 and 39: treatment 30 scores 65% and 80% Top-1 and Top-5 accuracy respectively, and treatment 39 scores 84% and 97% Top-1 and Top-5 accuracy respectively demonstrating that it is the best performing treatment in this group. Its training and validation loss error, and accuracy evolution can be seen in Figure 11.

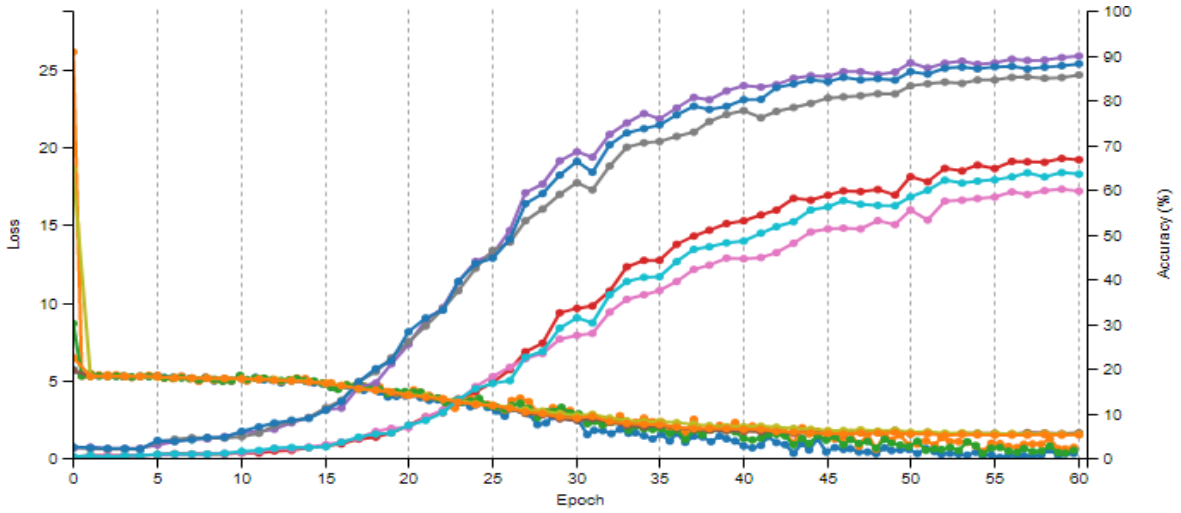


Figure 11: Test results for treatment 39. Training loss error (blue), validation loss error (brown) and accuracy (red).

6 CONCLUSION

In conclusion, the best results were from treatment 23 (Table 3) whose levels are 90_9_1 data set split, GoogLeNet architecture, 60 epochs, NAG solver, Sigmoid Decay configuration and default levels in the rest of factors. It scored 75% of accuracy in the last validation phase, 71% Top-1 accuracy and 93% Top-5 accuracy (Table 4) denoting a stable performance and reliability as a generalist model for this data set.

I'd like to remark the case of treatment 41 (Table 5) from group 80_15_5-AlexNet. It obtained 95% and 97% Top-1 and Top-5 accuracy with "Classify Many" (Table 6) standing out in the group, although it is probably an outlier test because the accuracy of the last validation phase is 51%.

Moreover, the differences between groups are noticeable when changing the architecture with around 20 points of difference in the accuracy during the last validation phase. It means that the change in the architecture factor cause a big effect in the tests. However, when comparing groups changing the data set split factor, the contrast is lower showing around 10 points of difference in the accuracy during the last validation phase meaning that this change in the data set split factor is not as significant as the change in the architecture factor.

Finally, an interesting next step to improve this experiment would be to manipulate the original data set by augmenting it with convolutions in images such as mirroring, grey scaling, etc. Another interesting step is to remove some key layers from the architectures to observe how it behaves.

7 References

Factorial experiment. (2020, April 10). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Factorial_experiment

J. Krause, M. S.-F. (2013). 3D Object Representations for Fine-Grained Categorization. *4th International IEEE Workshop on 3D Representation and Recognition*.

Krizhevsky, A. I. (2012). Imagenet classification with deep convolutional neural networks. *Advances in neural information processing systems.*

NVIDIA Corporation. (2020). Retrieved from NVIDIA DIGITS.

Szegedy, C. e. (2015). Going deeper with convolutions. *Proceedings of the IEEE conference on computer vision and pattern recognition.*

8 Appendix

8.1 Treatments table

#	Data set split	Architecture	Subt. mean	Epochs	Val. interval	Batch size	Solver	Base LR	LR policy	LR step	LR gamma
1	90_9_1	alexnet	Image	30	1	default	sgd	0.01	step down	33%	0.1
2	90_9_1	alexnet	Image	30	1	default	sgd	0.1	step down	33%	0.1
3	90_9_1	alexnet	Image	60	1	default	sgd	0.01	step down	33%	0.1
4	90_9_1	alexnet	Image	30	1	default	sgd	0.01	sigmoid decay	50%	0.05
5	90_9_1	alexnet	Image	60	1	default	sgd	0.01	sigmoid decay	50%	0.05
6	90_9_1	alexnet	Image	30	1	default	adam	0.01	step down	33%	0.1
7	90_9_1	alexnet	Image	30	1	default	adagrad	0.01	step down	33%	0.1
8	90_9_1	googlenet	Image	30	1	default	sgd	0.01	step down	33%	0.1
9	90_9_1	googlenet	Image	30	1	default	sgd	0.1	step down	33%	0.1
10	90_9_1	googlenet	Image	60	1	default	sgd	0.01	step down	33%	0.1
11	90_9_1	googlenet	Image	30	1	default	sgd	0.01	sigmoid decay	50%	0.05
12	90_9_1	alexnet	Image	30	1	default	sgd	0.001	step down	33%	0.1
13	90_9_1	alexnet	Image	30	1	default	nag	0.01	step down	33%	0.1
14	90_9_1	alexnet	Image	30	1	default	rms-0.99	0.01	step down	33%	0.1
15	90_9_1	alexnet	Image	30	1	default	sgd	0.01	exponential decay	NA	0.95
16	90_9_1	alexnet	Image	60	1	default	nag	0.01	sigmoid decay	50%	0.05
17	90_9_1	googlenet	Image	60	1	default	sgd	0.01	sigmoid decay	50%	0.05
18	90_9_1	alexnet	Pixel	30	1	default	sgd	0.01	step down	33%	0.1
19	90_9_1	alexnet	Image	30	1	20	sgd	0.01	step down	33%	0.1
20	90_9_1	alexnet	Image	30	1	50	sgd	0.01	step down	33%	0.1

21	90_9_1	alexnet	Image	30	1	100	sgd	0.01	step down	33%	0.1
22	90_9_1	alexnet	Pixel	60	1	default	nag	0.01	sigmoid decay	50%	0.05
23	90_9_1	googlenet	Image	60	1	default	nag	0.01	sigmoid decay	50%	0.05
24	90_9_1	googlenet	Pixel	60	1	default	sgd	0.01	sigmoid decay	50%	0.05
25	80_15_5	alexnet	Image	30	1	default	sgd	0.01	step down	33%	0.1
26	80_15_5	alexnet	Image	60	1	default	sgd	0.01	sigmoid decay	50%	0.05
27	90_9_1	alexnet	Image	60	6	default	sgd	0.01	step down	33%	0.1
28	80_15_5	googlenet	Image	60	1	default	sgd	0.01	step down	33%	0.1
29	80_15_5	alexnet	Image	60	1	default	nag	0.01	sigmoid decay	50%	0.05
30	80_15_5	googlenet	Image	60	1	default	nag	0.01	sigmoid decay	50%	0.05
31	90_9_1	googlenet	Image	60	6	default	nag	0.01	sigmoid decay	50%	0.05
32	90_9_1	alexnet	Image	60	6	default	nag	0.01	sigmoid decay	50%	0.05
33	90_9_1	googlenet	Image	60	1	50	sgd	0.01	step down	33%	0.1
34	90_9_1	alexnet	Image	60	1	50	nag	0.01	sigmoid decay	50%	0.05
35	90_9_1	googlenet	Pixel	60	1	default	nag	0.01	sigmoid decay	50%	0.05
36	90_9_1	googlenet	Image	60	1	50	nag	0.01	sigmoid decay	50%	0.05
37	90_9_1	alexnet	Image	60	6	50	nag	0.01	sigmoid decay	50%	0.05
38	90_9_1	googlenet	Pixel	60	6	50	nag	0.01	sigmoid decay	50%	0.05
39	80_15_5	googlenet	Pixel	60	1	default	nag	0.01	sigmoid decay	50%	0.05
40	80_15_5	googlenet	Pixel	60	6	50	nag	0.01	sigmoid decay	50%	0.05
41	80_15_5	alexnet	Pixel	60	1	default	nag	0.01	sigmoid decay	50%	0.05
42	80_15_5	alexnet	Image	60	6	default	nag	0.01	sigmoid decay	50%	0.05
43	80_15_5	googlenet	Image	30	1	default	sgd	0.01	step down	33%	0.1

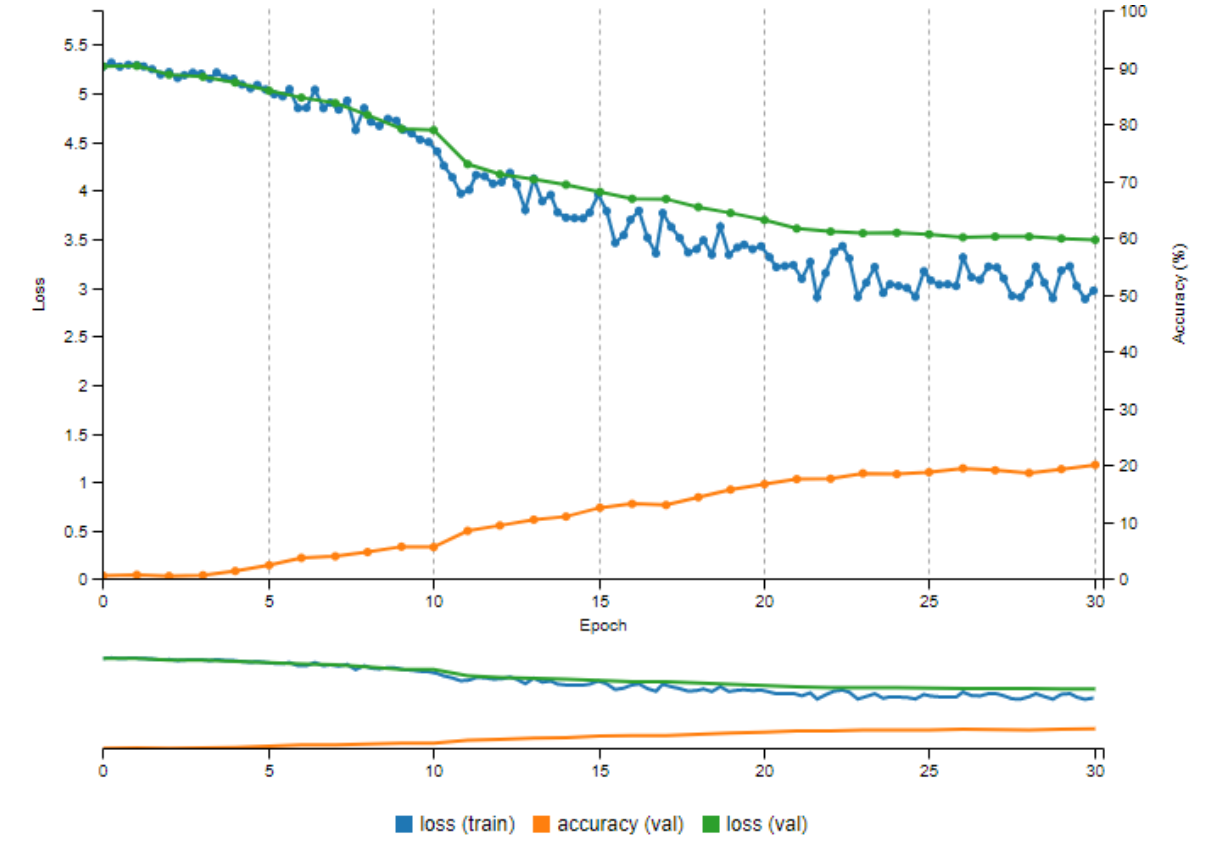
8.2 RESULTS TABLE

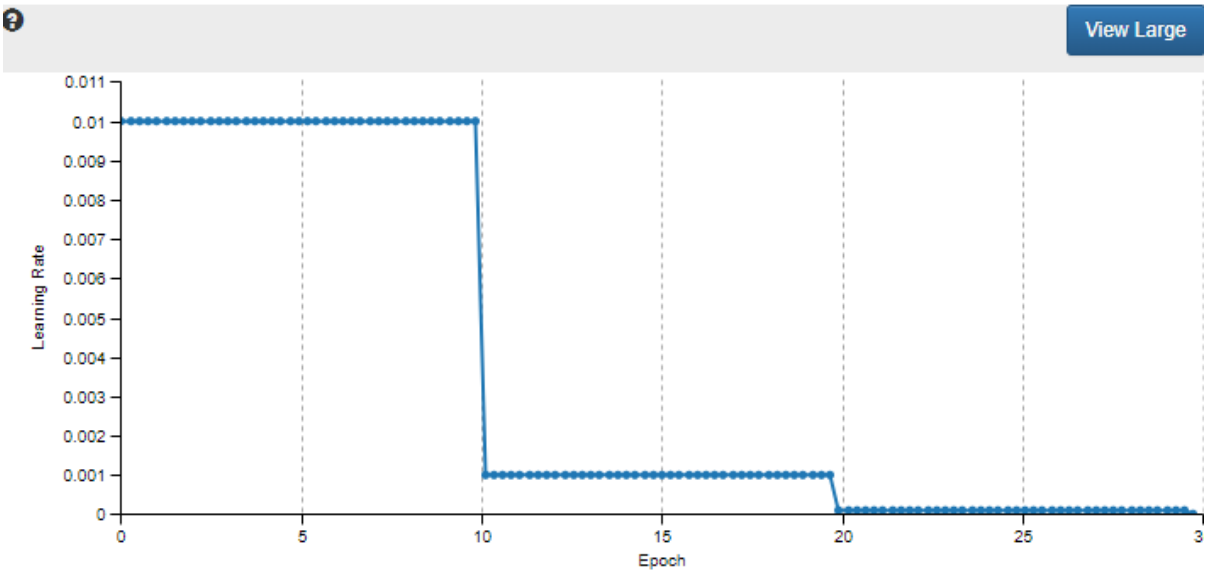
#	Train loss error	Val. loss error	Accuracy	Average ratio	Top-1 acc.	Top-5 acc.
1	2.96942	3.49164	0.201087	0.5882780138	NA	NA
2	5.2793	5.28537	0.00747283	0.4810366096	NA	NA
3	0.499812	2.37867	0.488451	0.7384342792	39.00%	65.00%
4	0.932482	2.7707	0.370245	0.6770507988	25.00%	59.00%
5	0.099128	2.58309	0.518342	0.7521906462	50.00%	74.00%
6	5.27818	5.28562	0.00747283	0.4810351553	NA	NA
7	5.27754	5.28129	0.00747283	0.4810603434	NA	NA

8	4.41124	4.41367	0.0618132	0.5132775667	NA	NA
9	87.3365	87.3365	0	0	NA	NA
10	1.1333	1.89526	0.494505	0.7442733269	35.00%	71.00%
11	2.19497	2.38785	0.355769	0.6720398782	NA	NA
12	5.01253	5.05116	0.0230978	0.4902115192	NA	NA
13	2.25553	2.96253	0.286005	0.6338149032	NA	NA
14	5.27897	5.2854	0.00747283	0.4810364351	NA	NA
15	3.66628	4.11759	0.116168	0.5421772957	NA	NA
16	0.0503703	2.55963	0.555027	0.7706696156	49.00%	70.00%
17	0.116378	1.57126	0.686126	0.8419685695	63.00%	85.00%
18	2.82116	3.28487	0.224864	0.601369317	NA	NA
19	3.18175	3.52603	0.20137	0.5882194634	NA	NA
20	1.83916	2.68595	0.349333	0.6670877986	NA	NA
21	2.48012	3.06135	0.272	0.6262375567	NA	NA
22	0.121717	2.44117	0.550951	0.76932071	48.00%	74.00%
23	0.0630354	1.38312	0.754808	0.877404	71.00%	93.00%
24	0.240521	1.63547	0.638049	0.8175565531	66.00%	91.00%
25	3.38903	3.70125	0.172286	0.57265819	NA	NA
26	0.150061	2.91043	0.480674	0.7314524745	NA	NA
27	0.504552	2.43913	0.477582	0.7326480769	NA	NA
28	1.40301	2.38907	0.409539	0.6989177813	NA	NA
29	0.0930393	2.90014	0.479441	0.7308958325	NA	NA
30	0.400171	1.54594	0.661595	0.8298503587	65.00%	80.00%
31	0.0846662	1.39966	0.727335	0.8635712851	64.00%	94.00%
32	0.126336	2.60079	0.539402	0.7626176834	48.00%	68.00%
33	2.41482	2.87075	0.28	0.6313462973	NA	NA
34	0.141077	2.5236	0.493333	0.7400322059	39.00%	60.00%
35	0.183553	1.45884	0.717033	0.8580760287	68.00%	93.00%
36	0.0994606	1.50308	0.696	0.8473021799	67.00%	88.00%
37	0.132427	2.47292	0.488667	0.7379940169	42.00%	63.00%
38	0.1447	1.56372	0.691334	0.8446164305	61.00%	83.00%
39	0.248097	1.65262	0.668174	0.8325192897	84.00%	97.00%
40	0.347772	1.81656	0.638776	0.8168666332	NA	NA
41	0.059693	2.59685	0.513569	0.7497241028	95.00%	97.00%
42	0.179152	2.8429	0.491776	0.7373963037	85.00%	91.00%
43	4.75882	4.77023	0.0398849	0.500239269	NA	NA

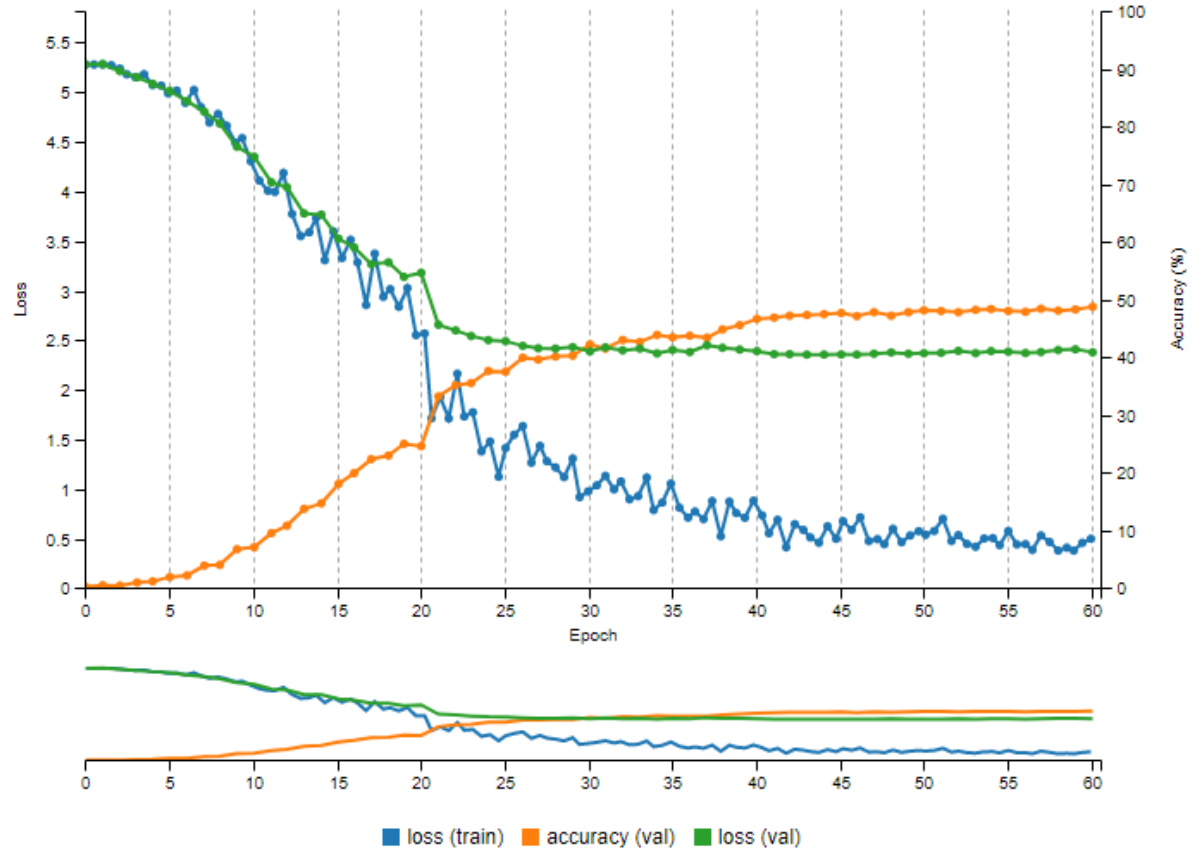
8.3 MODEL EVOLUTION CHARTS

8.3.1 Treatment 1





8.3.2 Treatment 3



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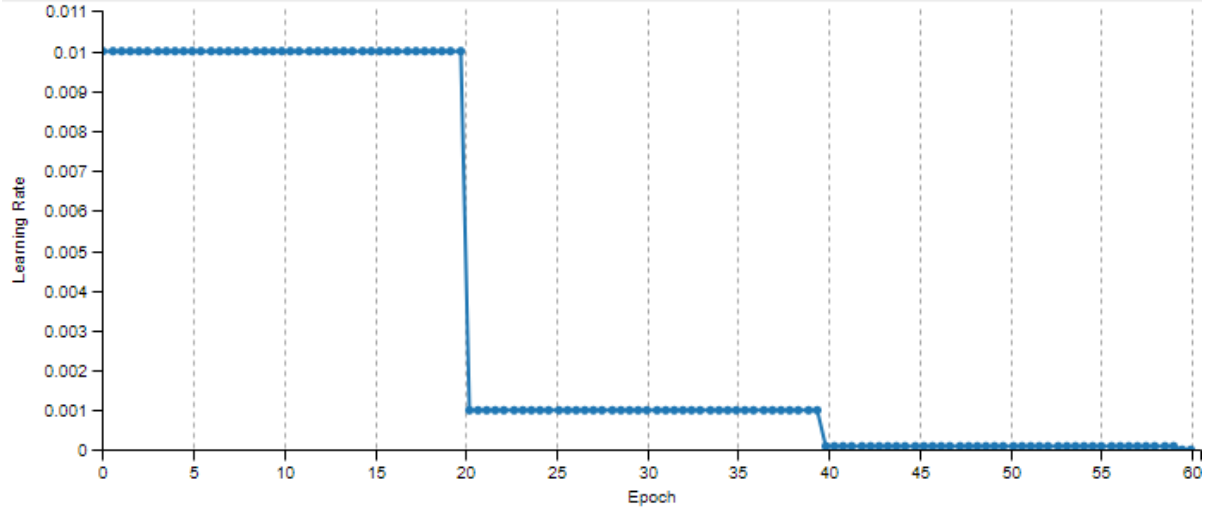
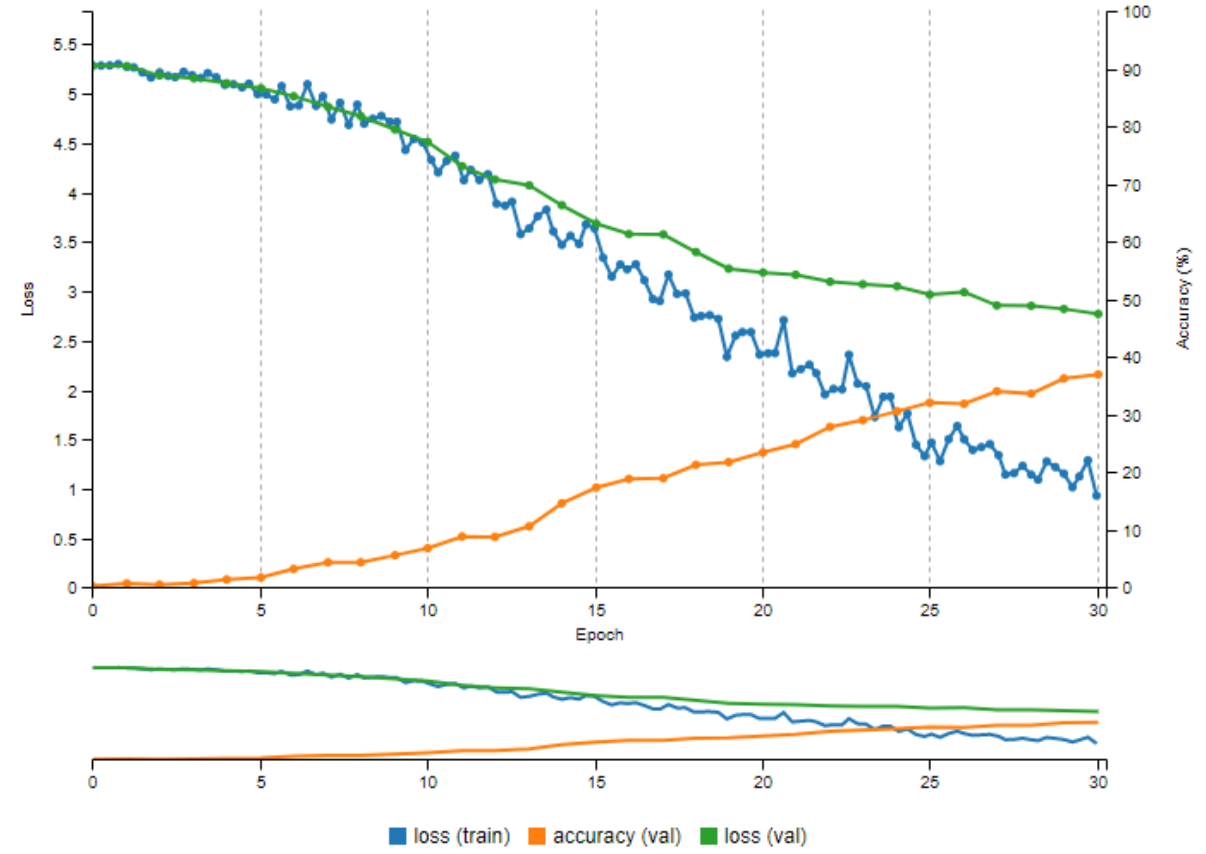


8.3.3 Treatment 4



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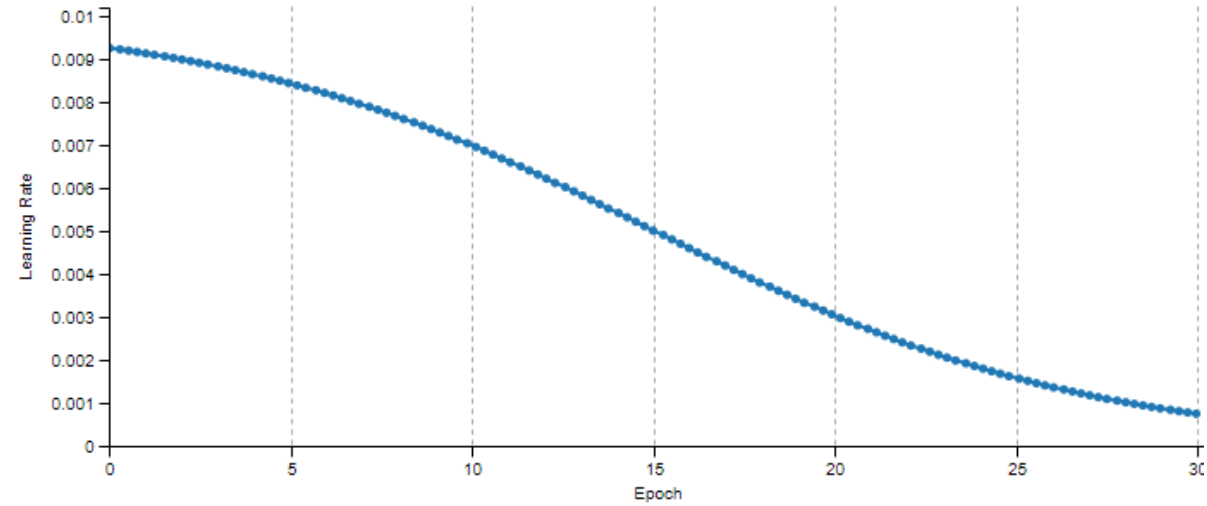
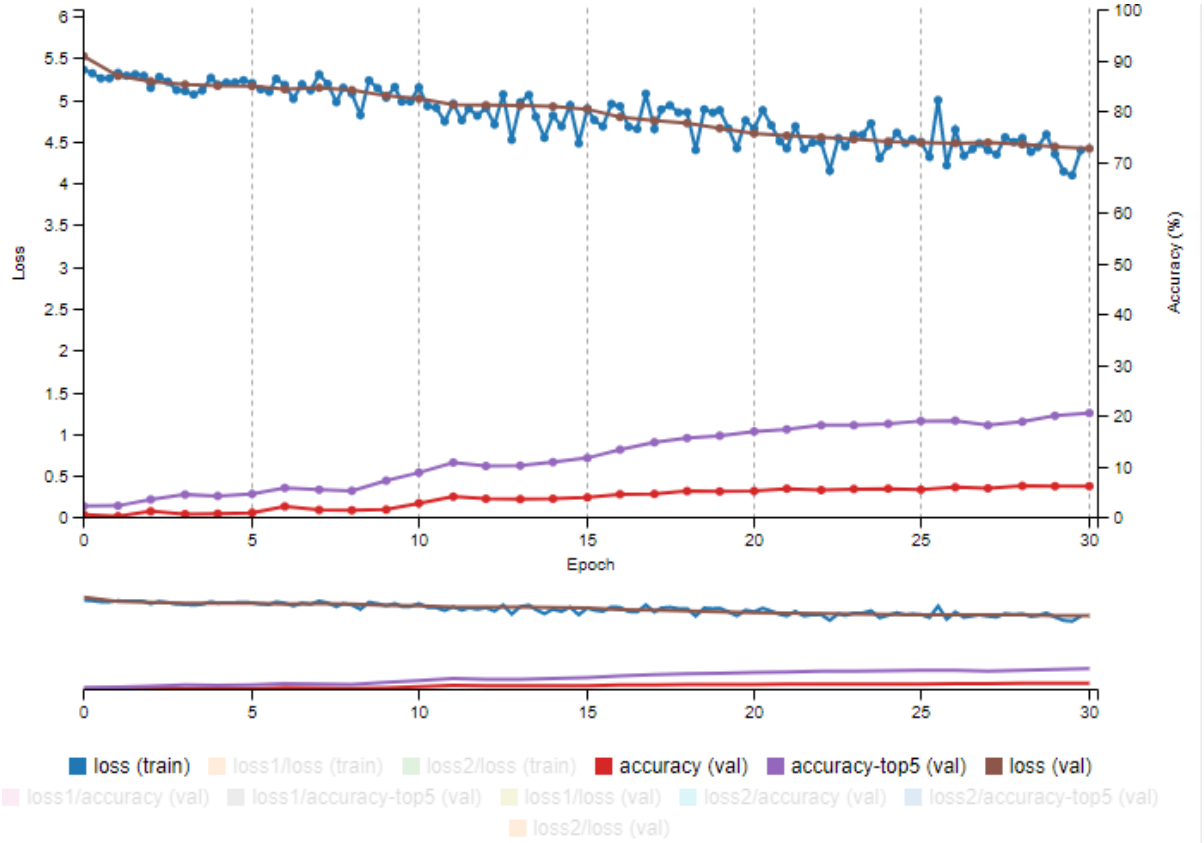


8.3.4 Treatment 8



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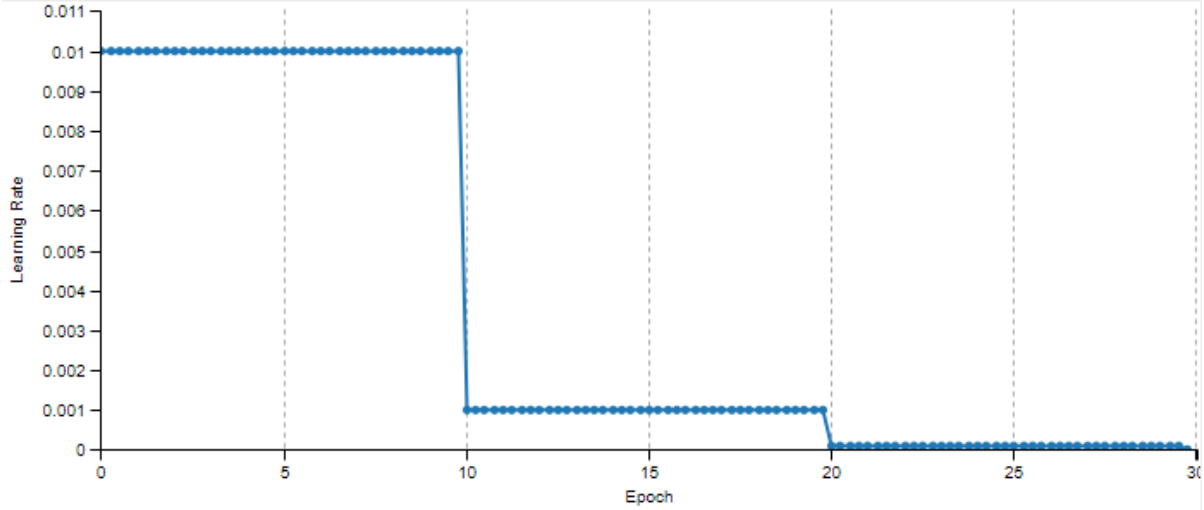
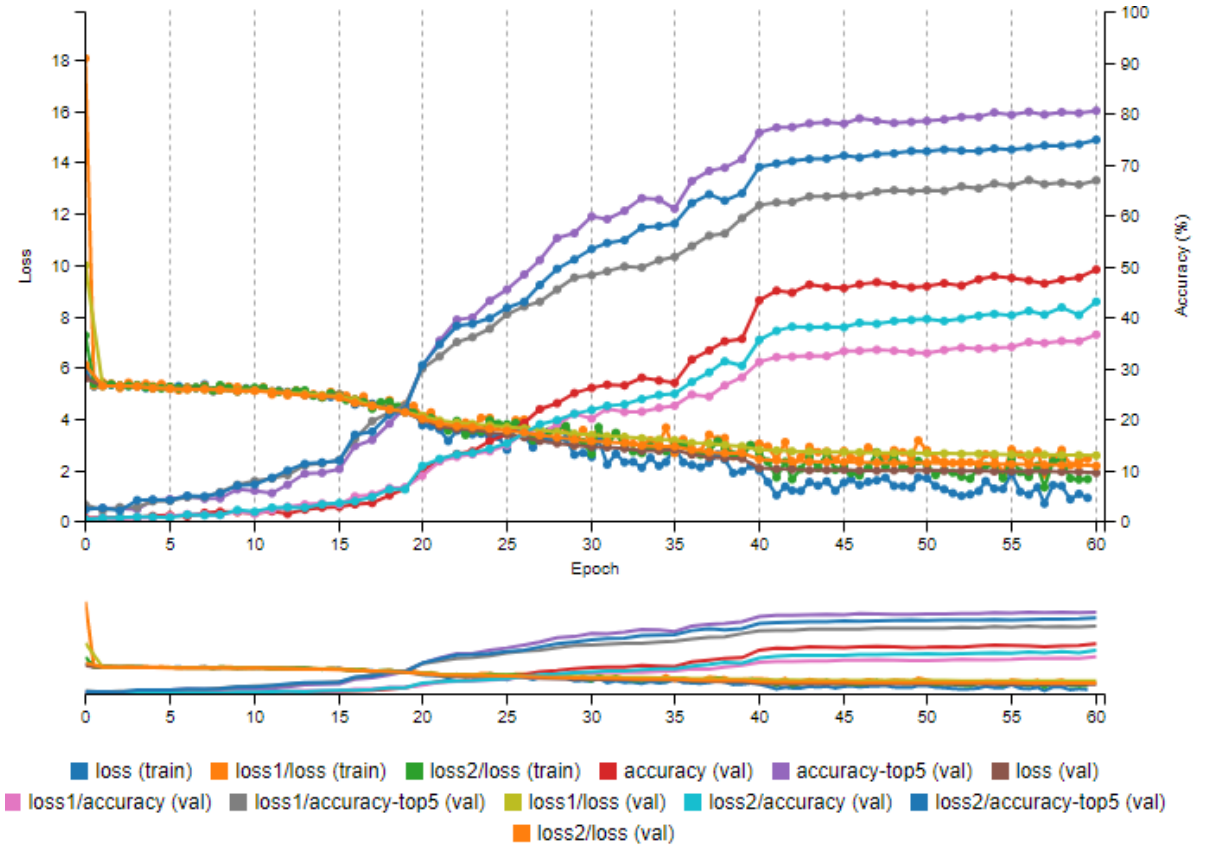


8.3.5 Treatment 10



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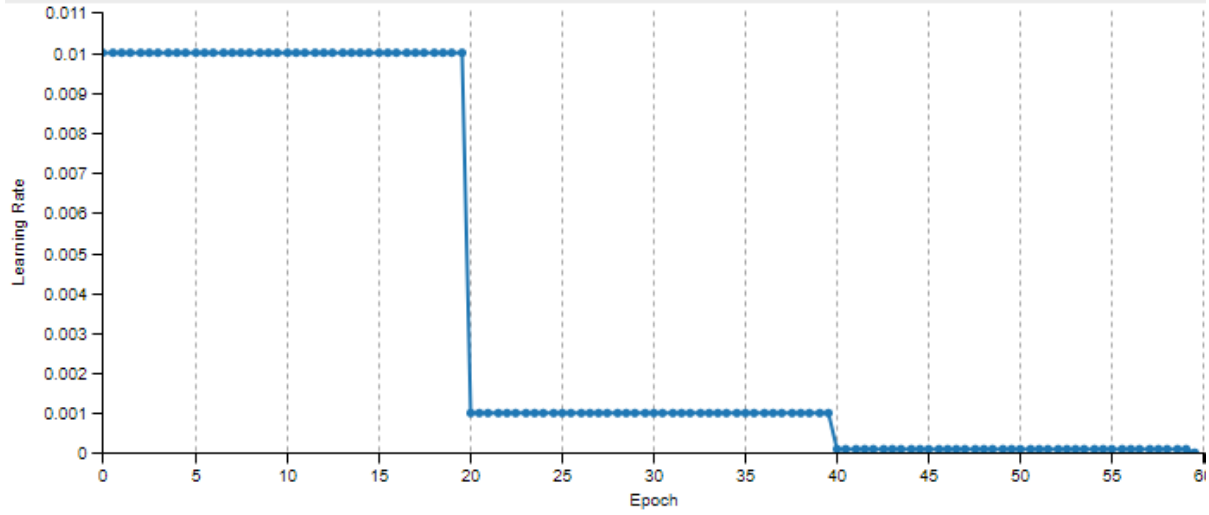
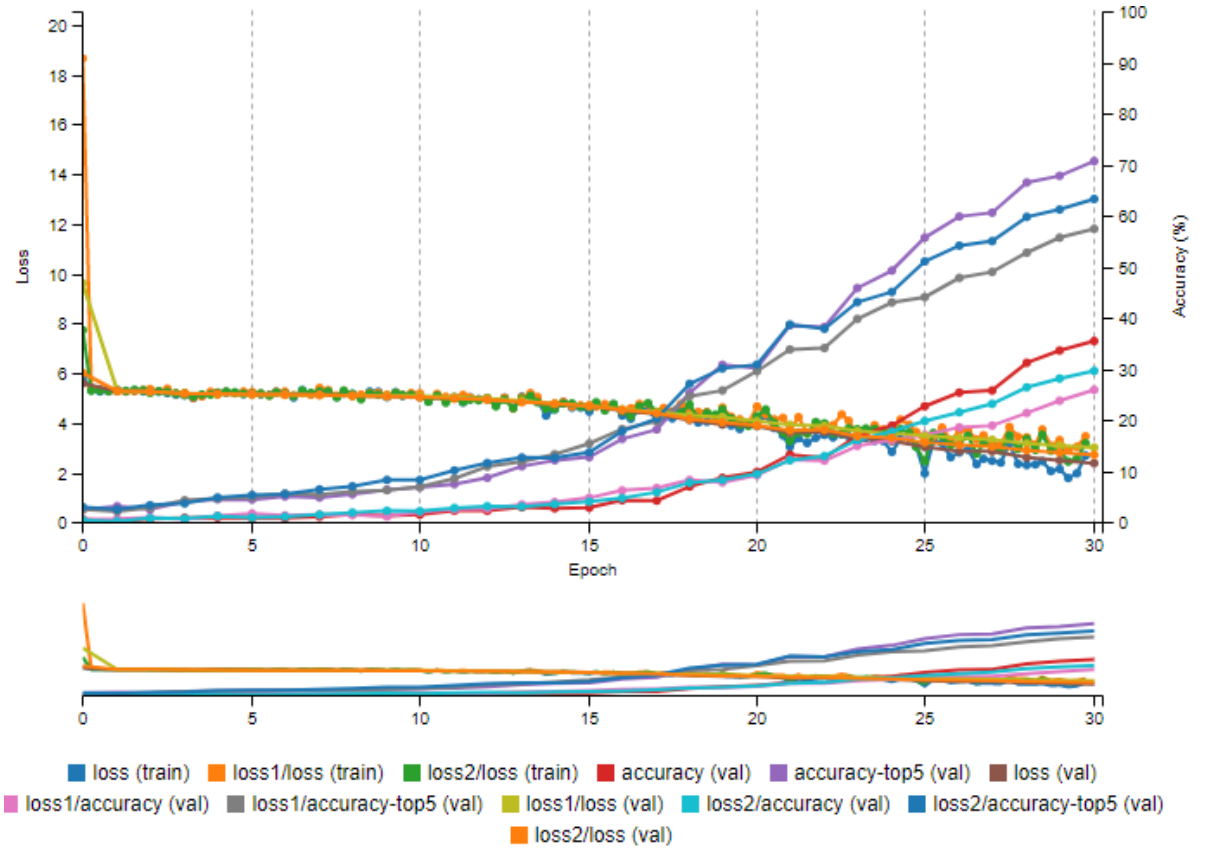


8.3.6 Treatment 11



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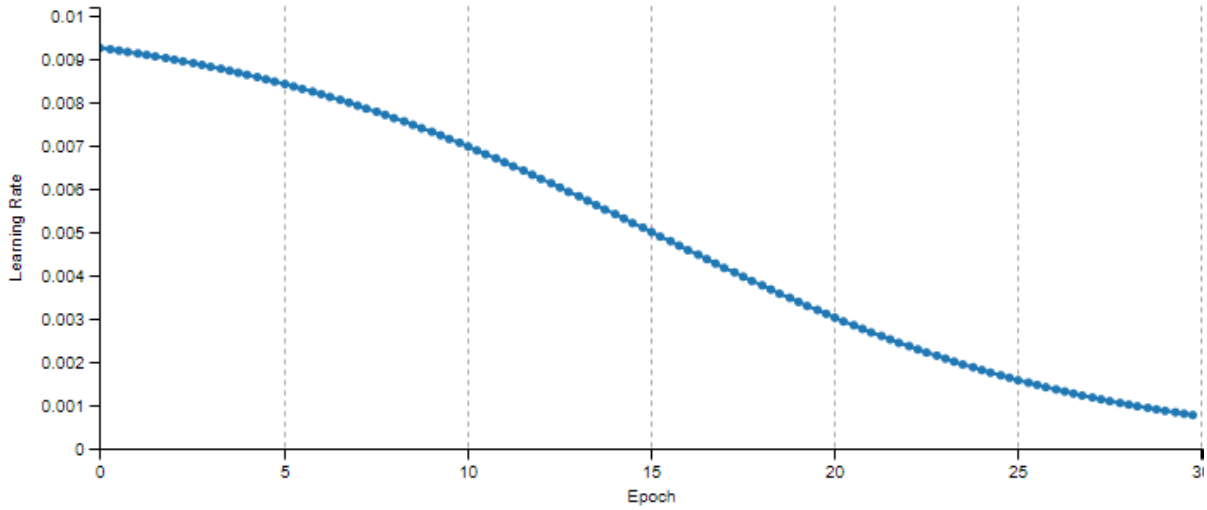
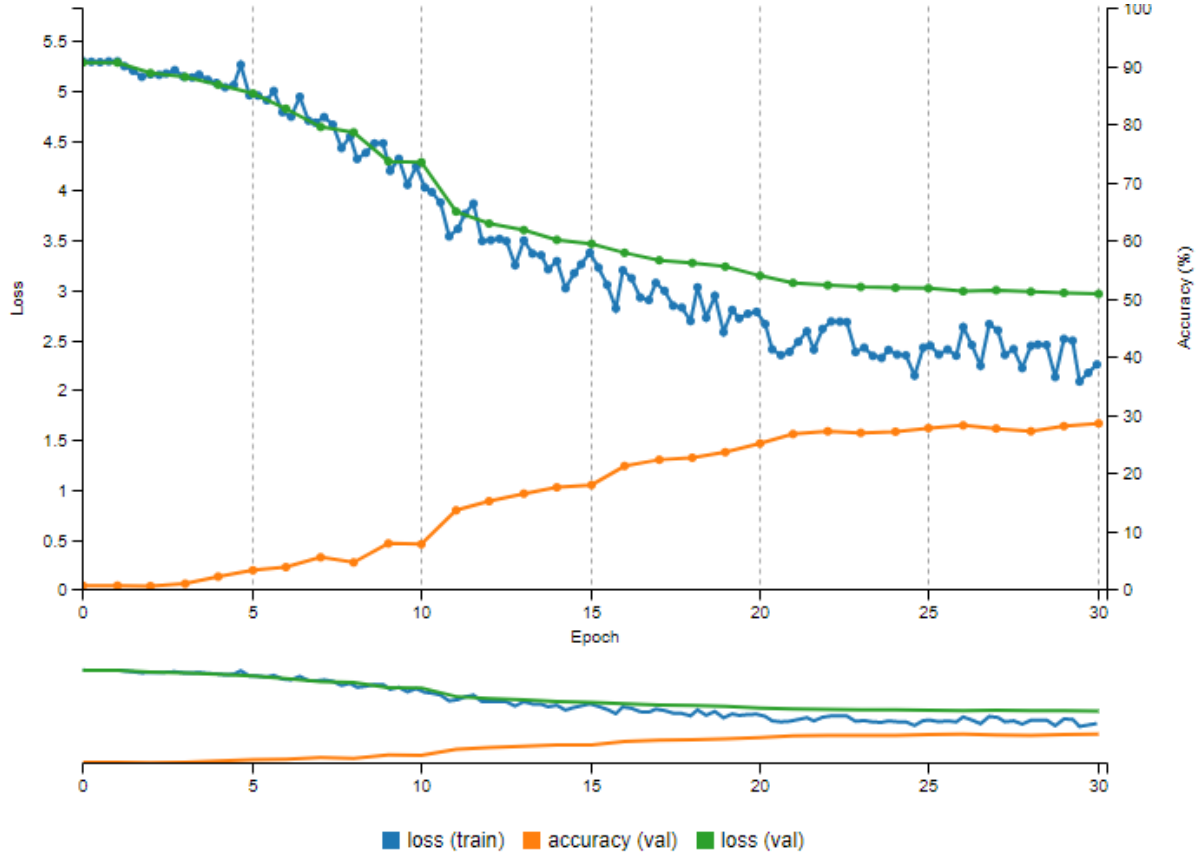


8.3.7 Treatment 13



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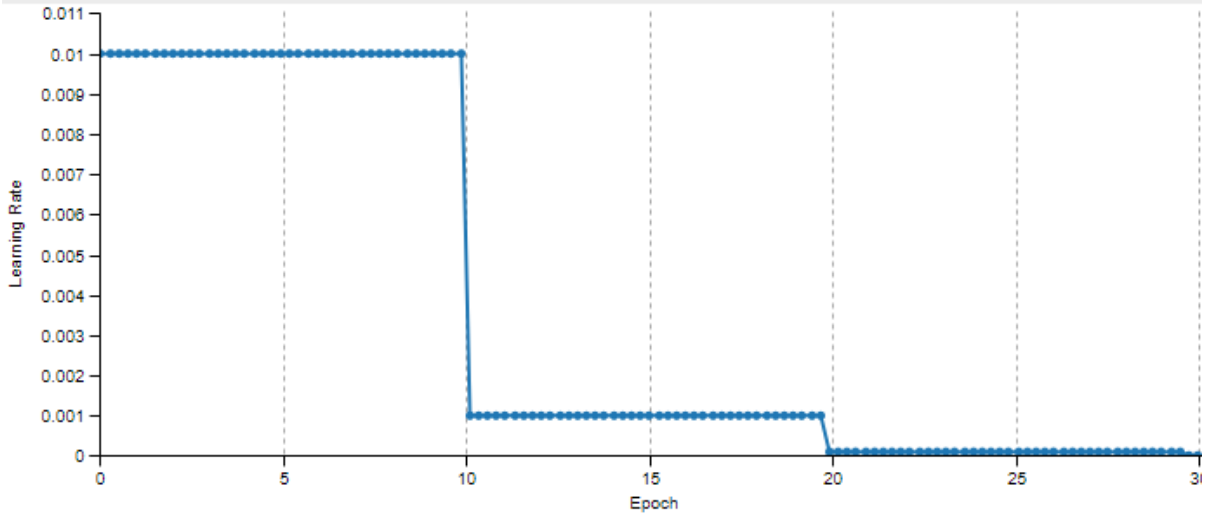
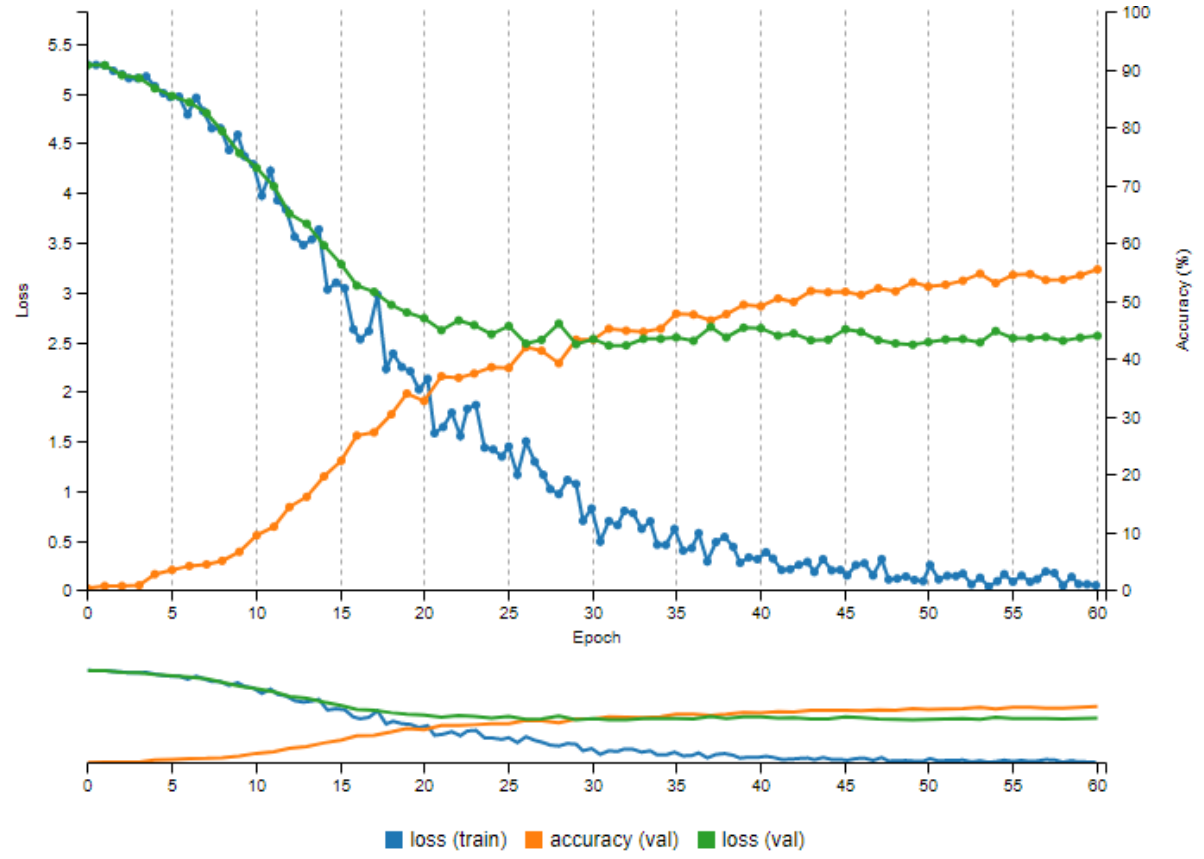


8.3.8 Treatment 16



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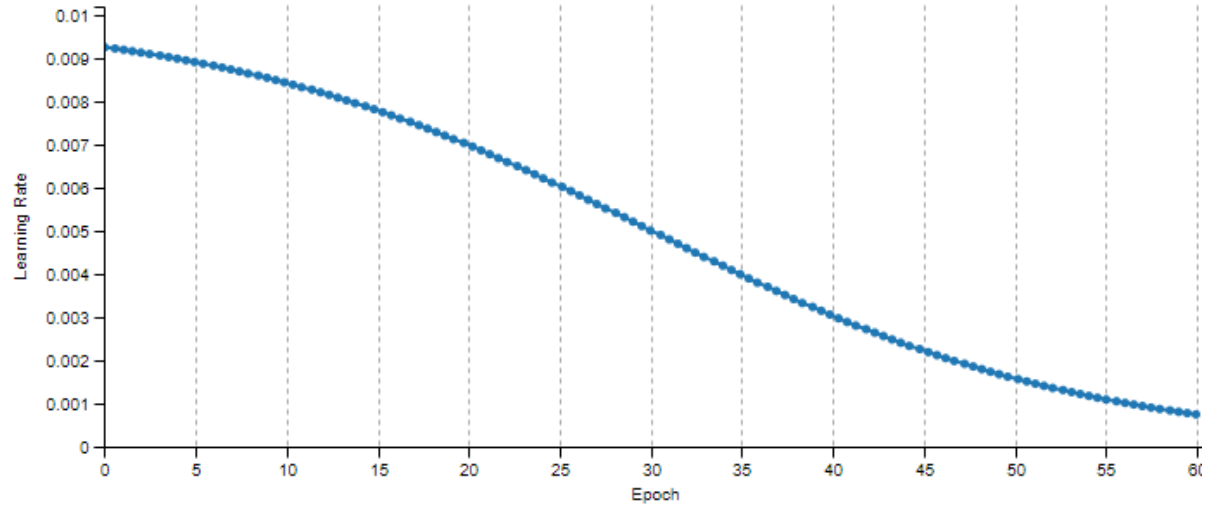
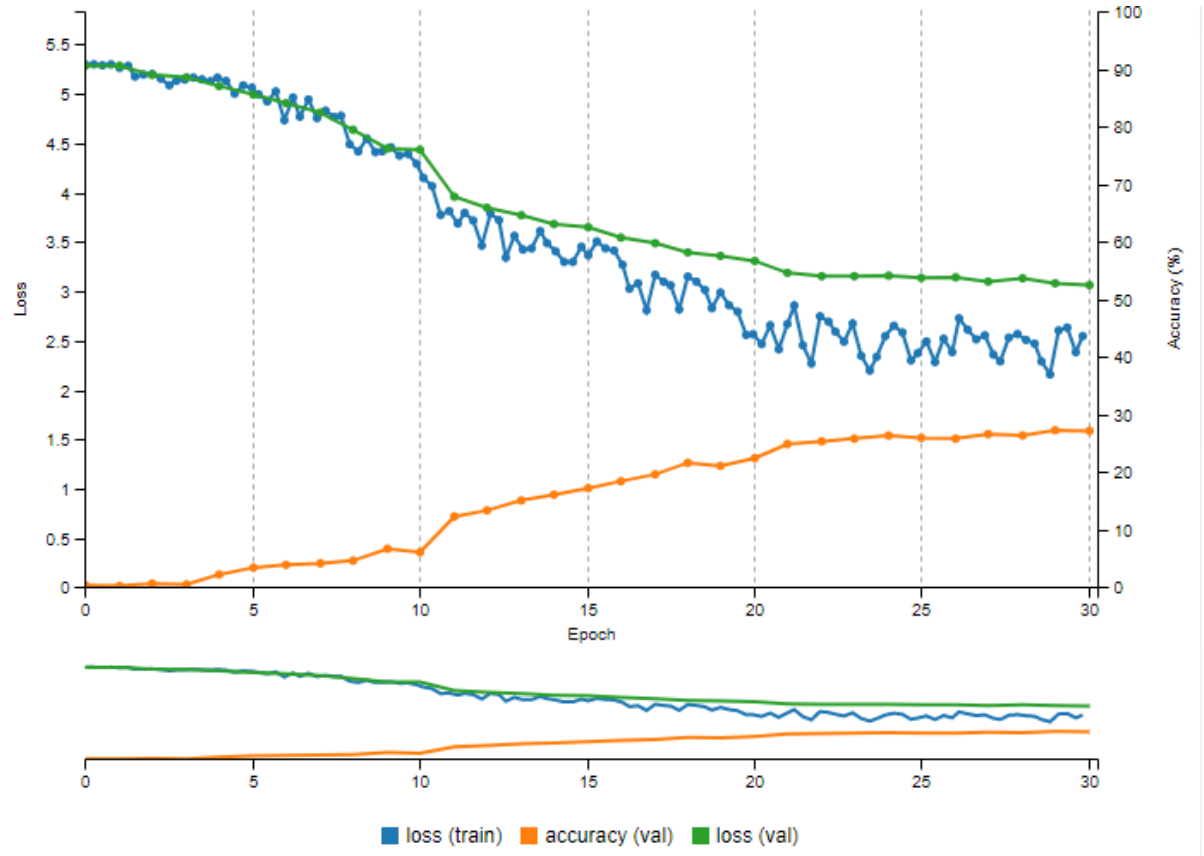


8.3.9 Treatment 21



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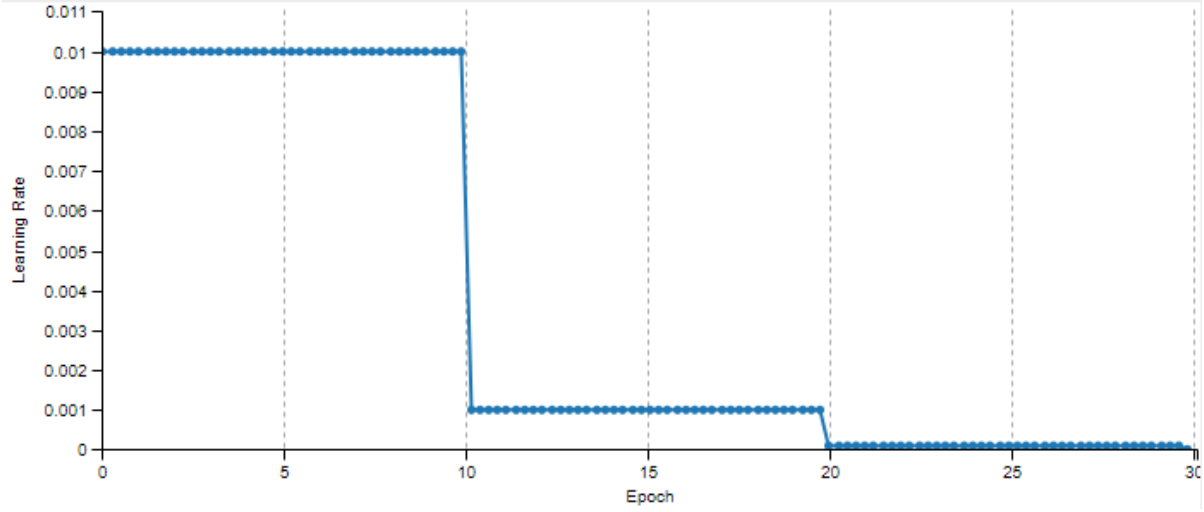
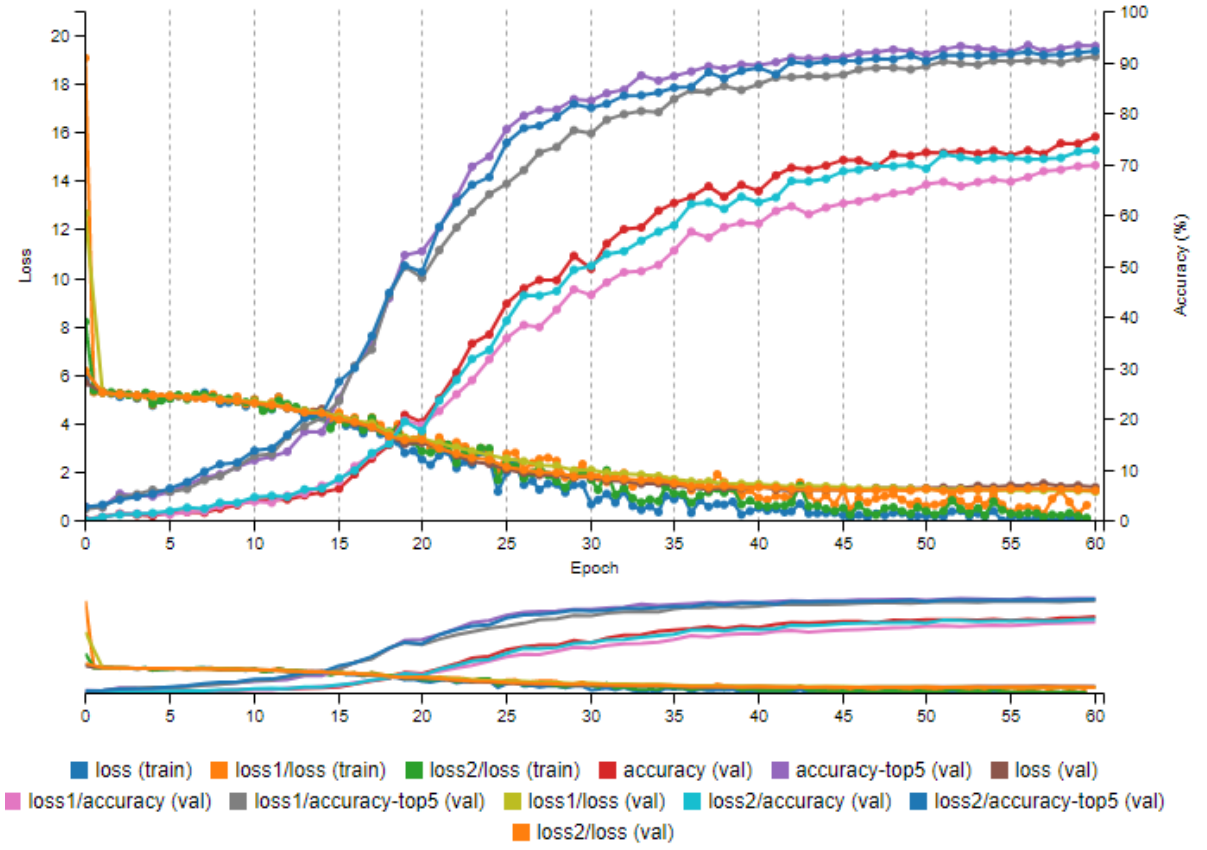


8.3.10 Treatment 23



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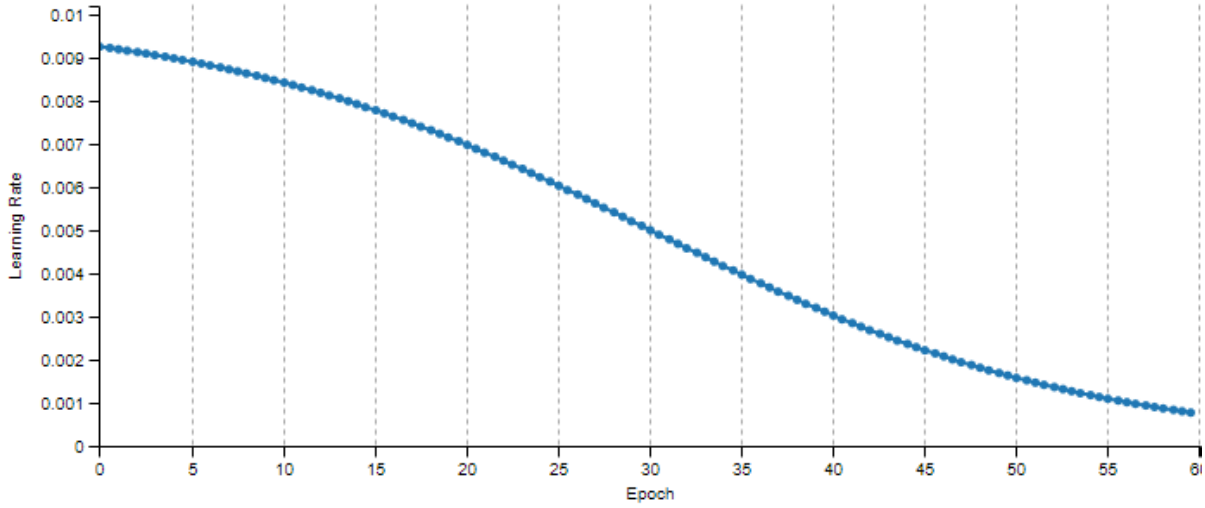
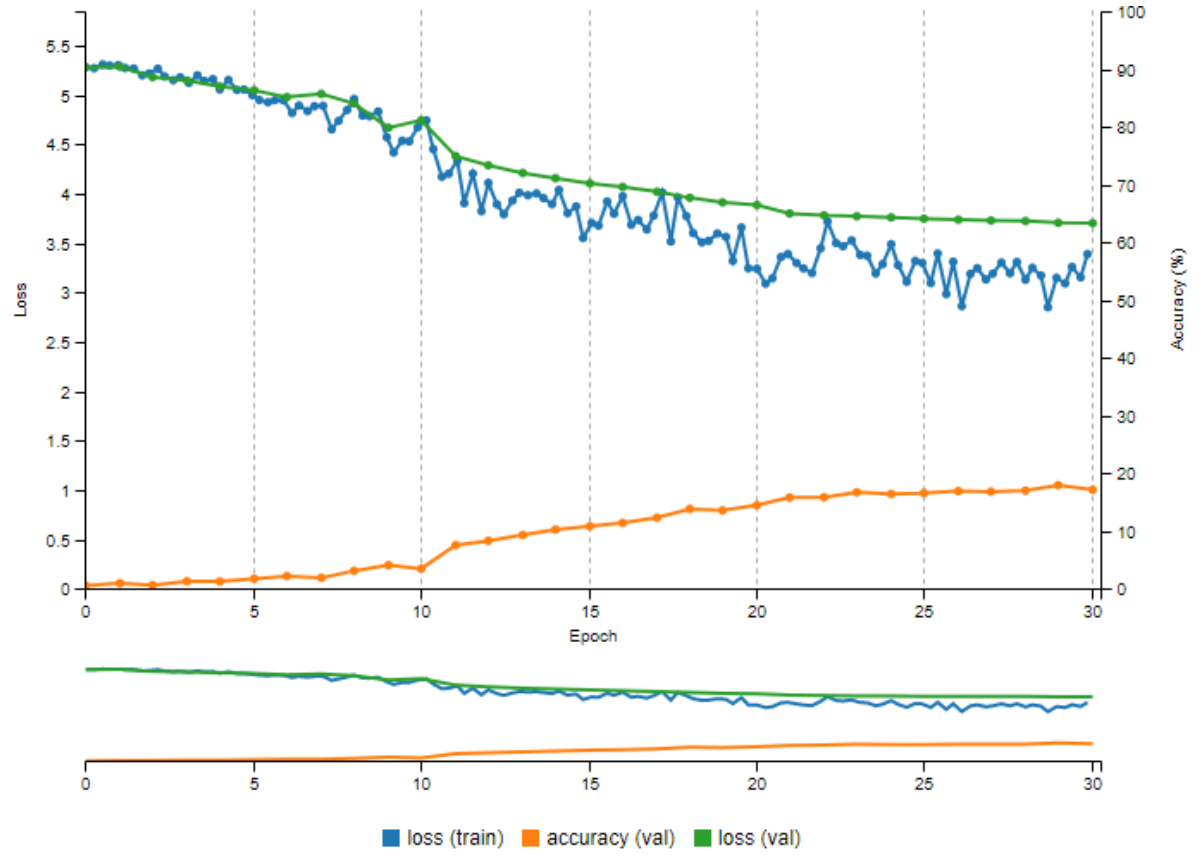


8.3.11 Treatment 25



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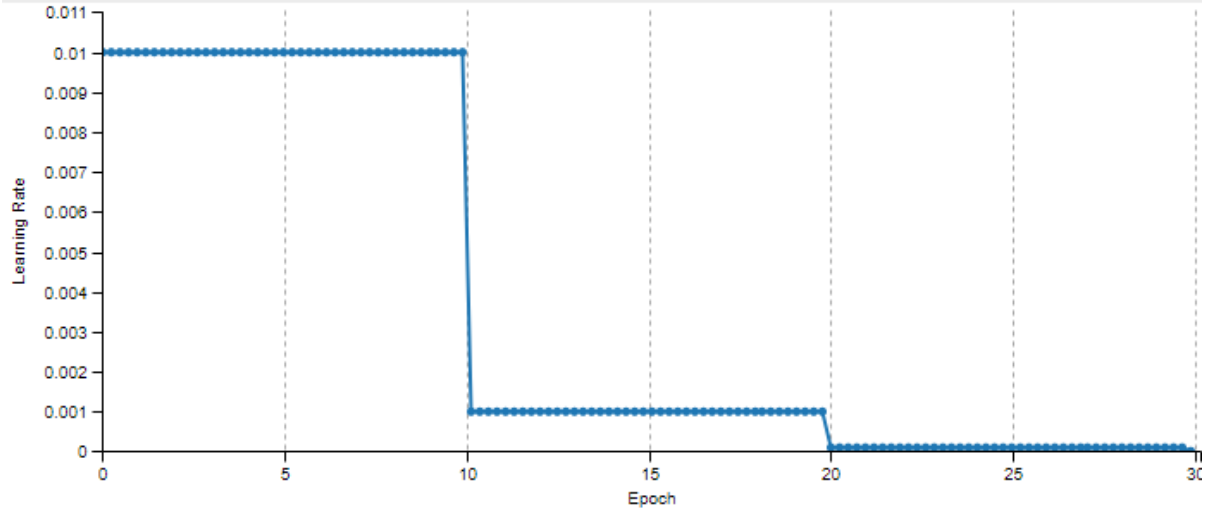
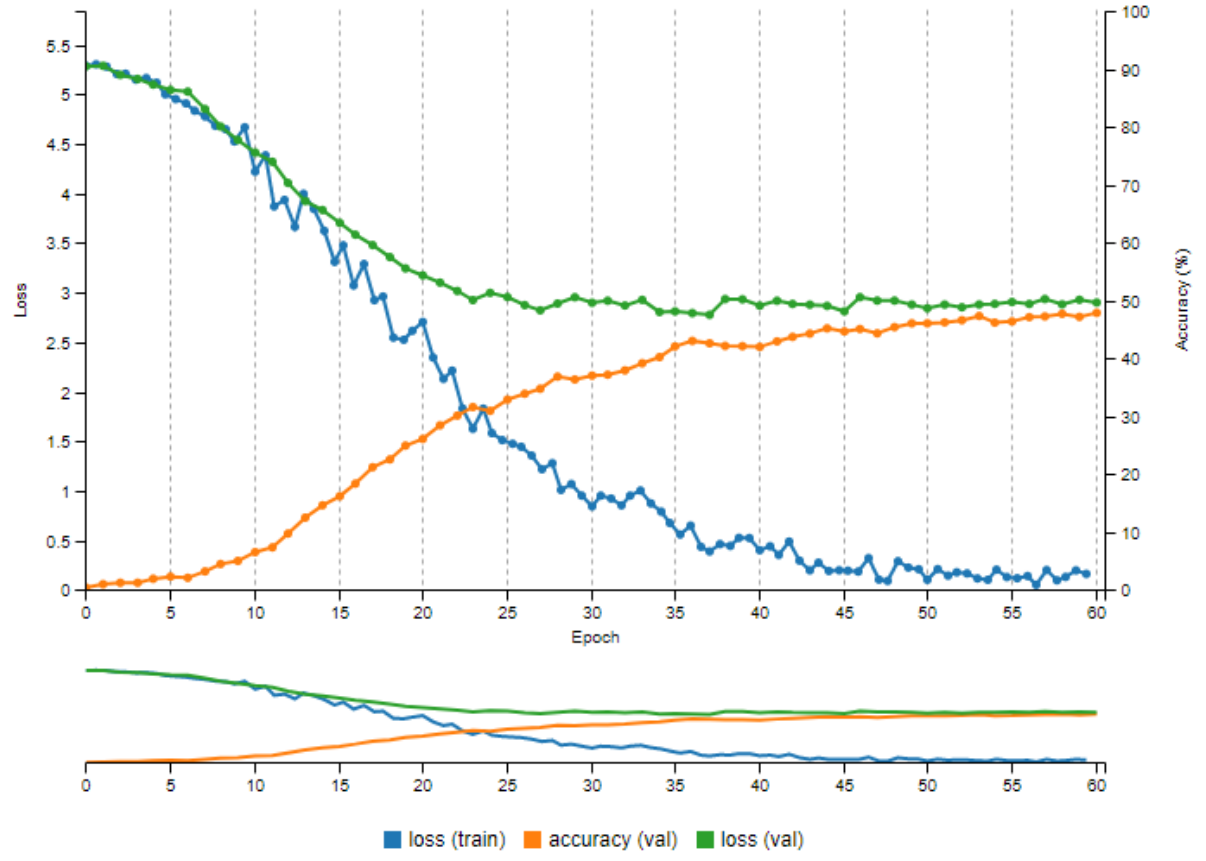


8.3.12 Treatment 29



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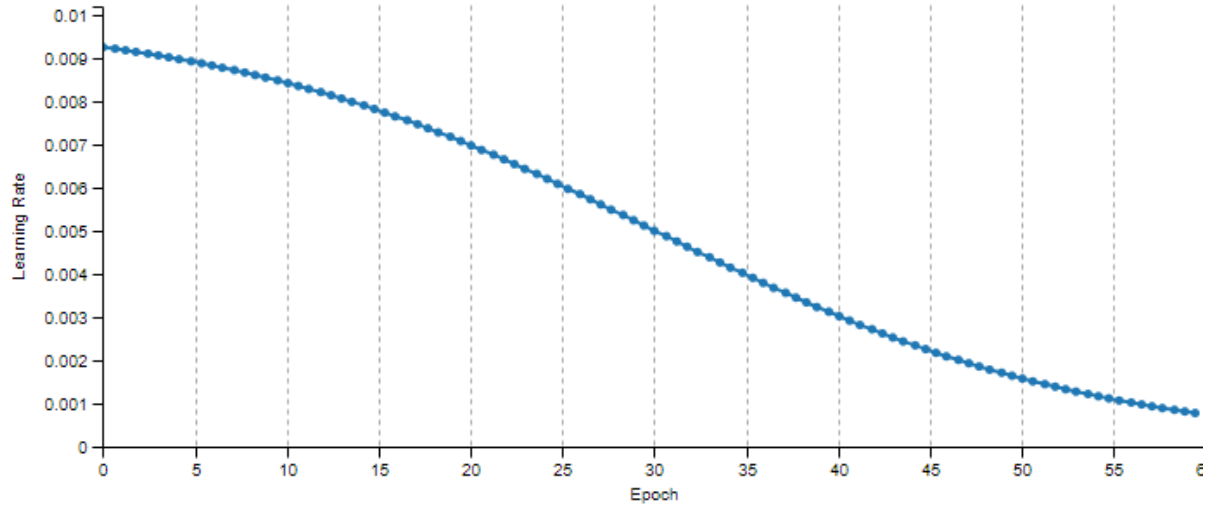
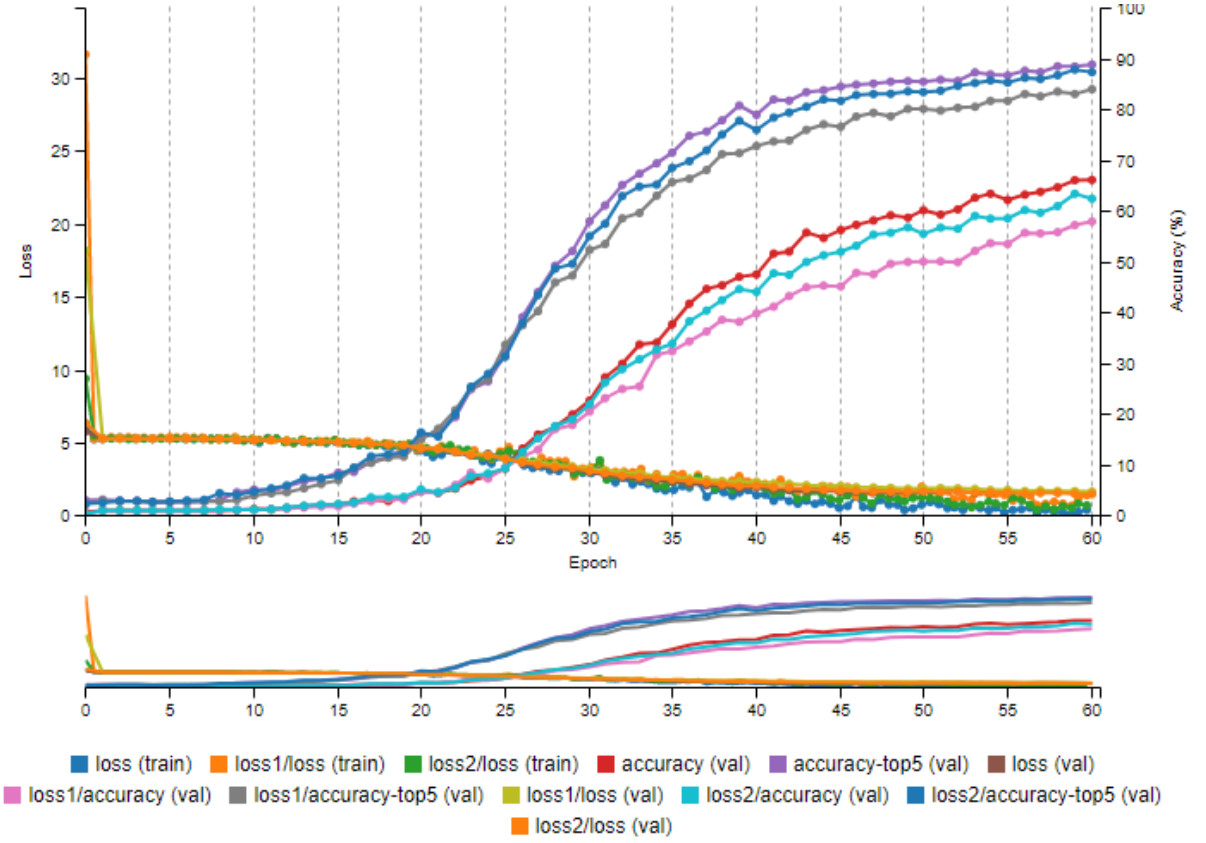


8.3.13 Treatment 30



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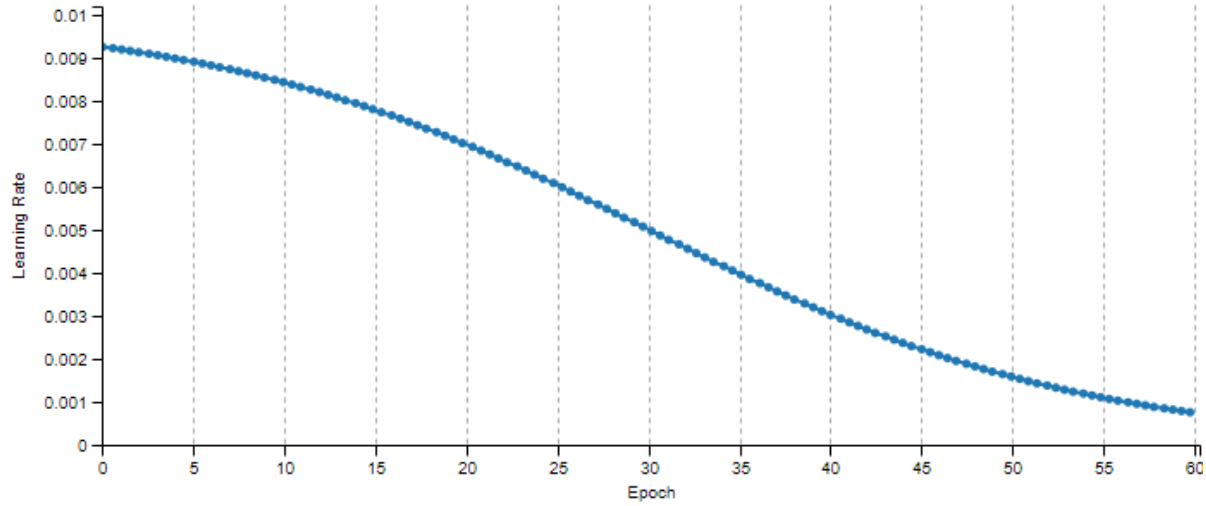
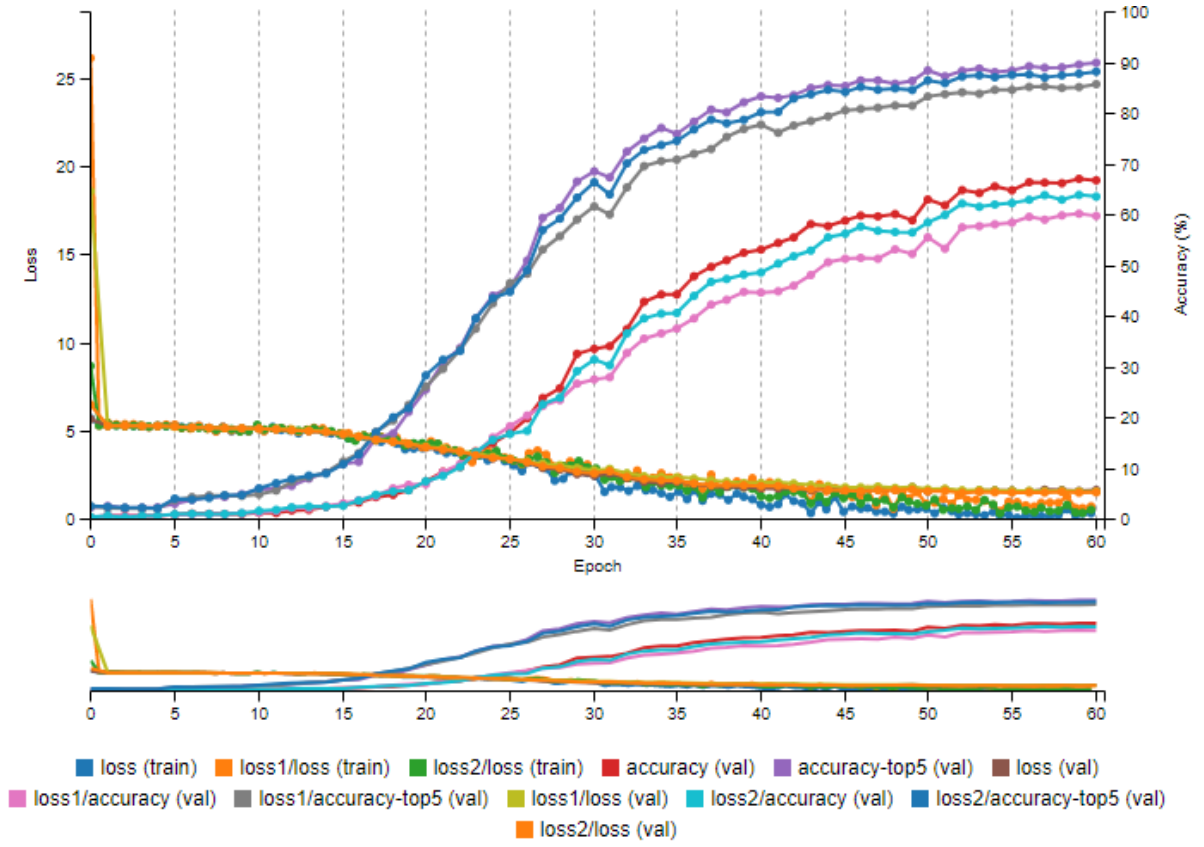
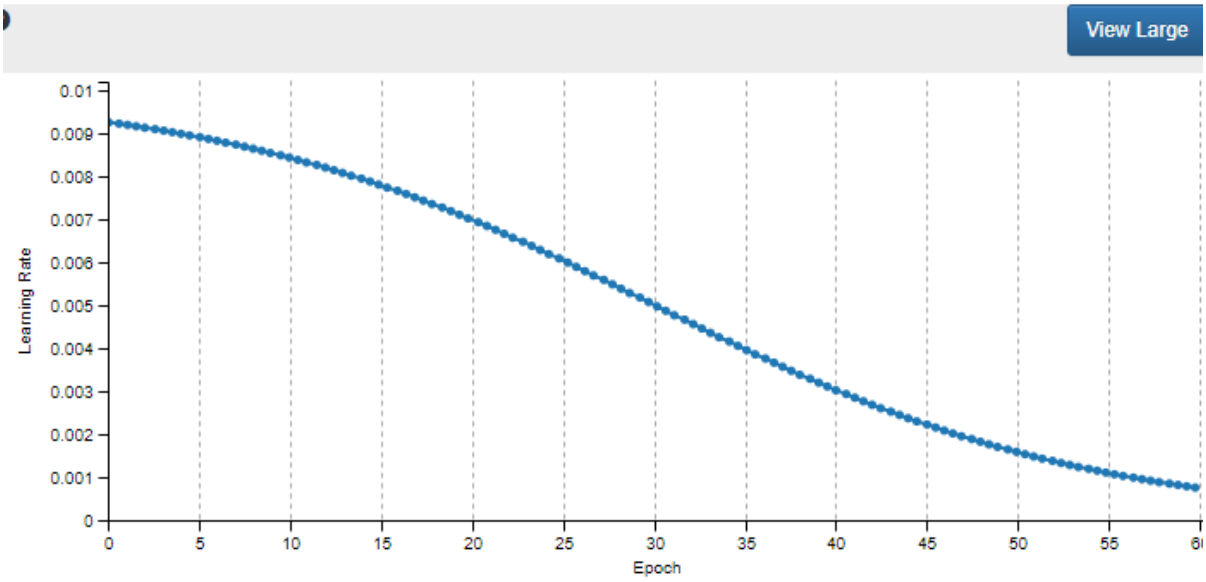
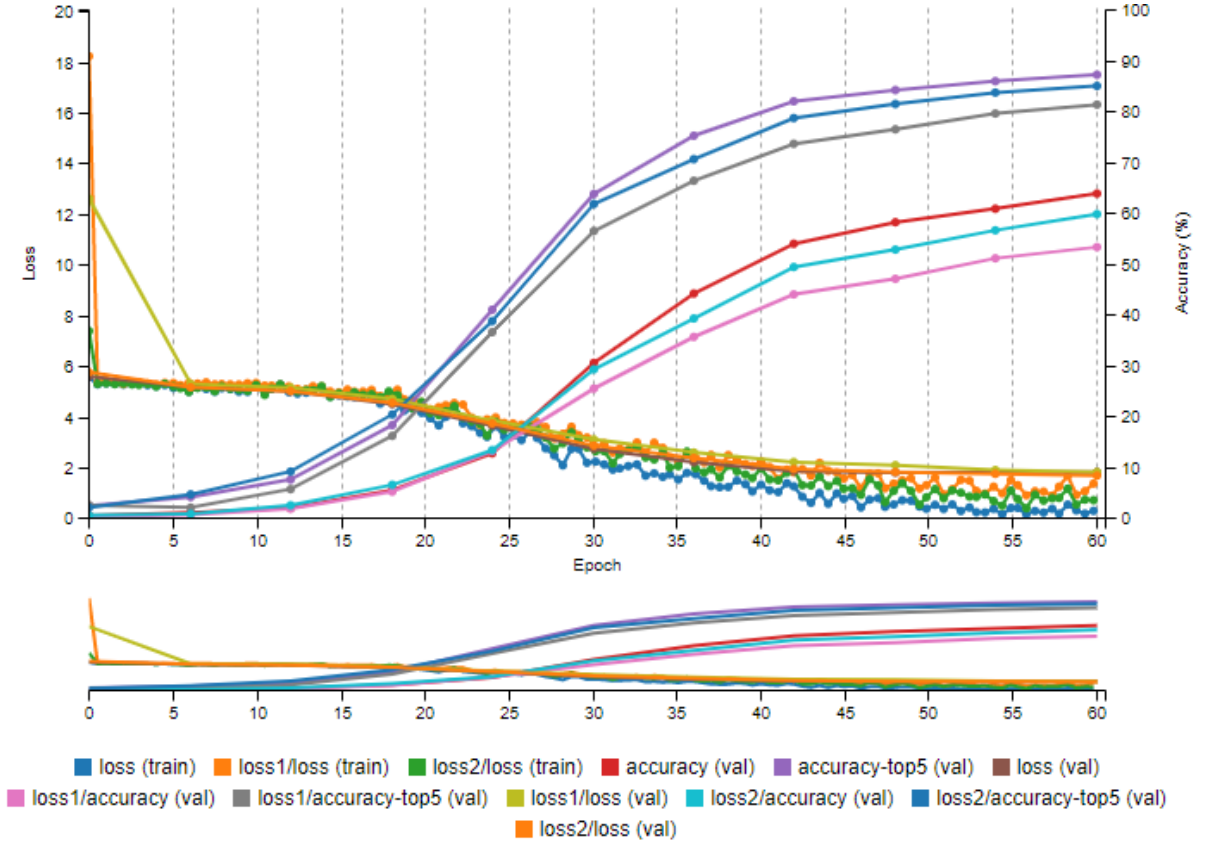


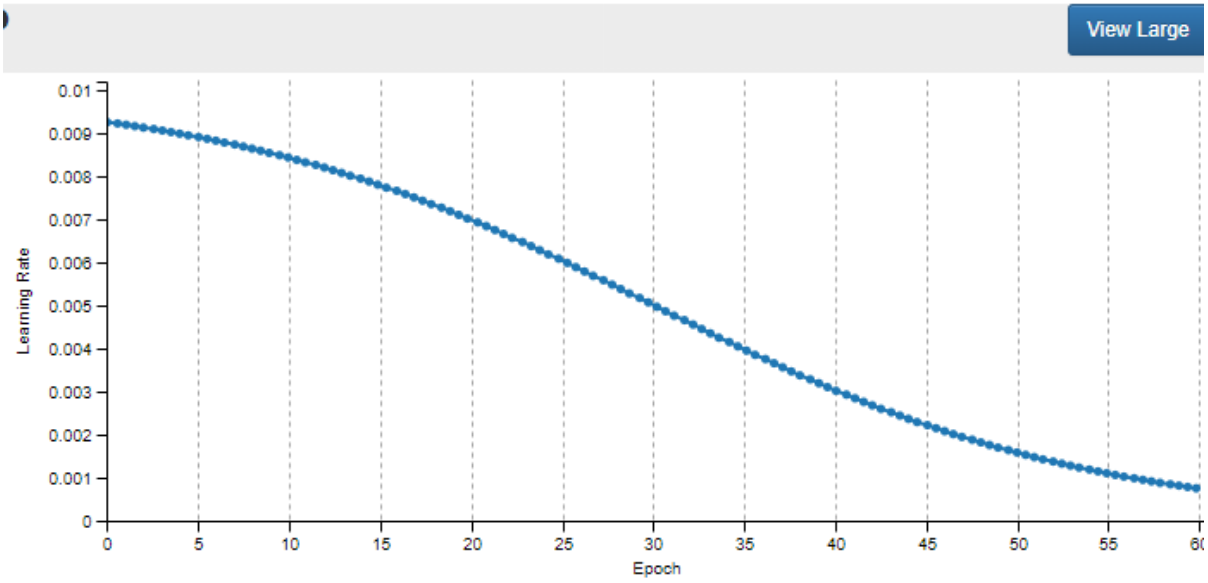
8.3.14 Treatment 39



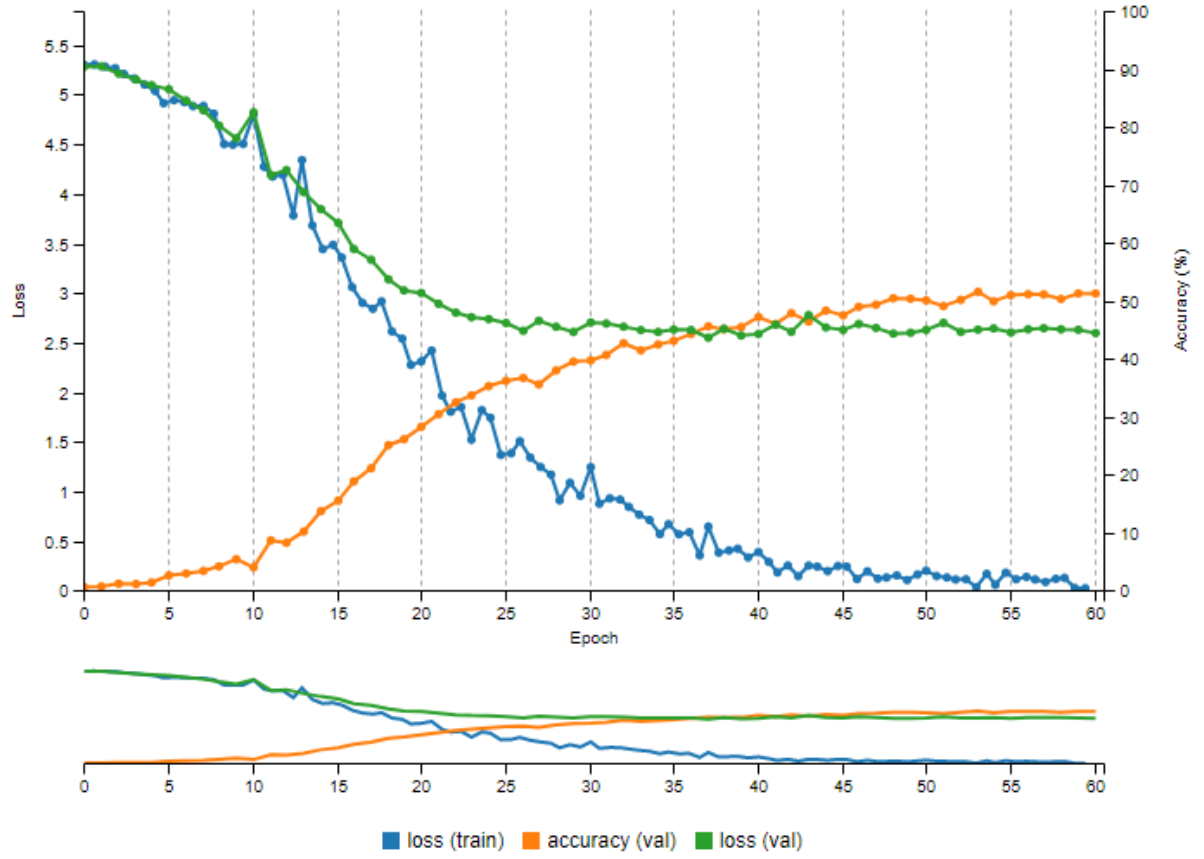


8.3.15 Treatment 40





8.3.16 Treatment 41



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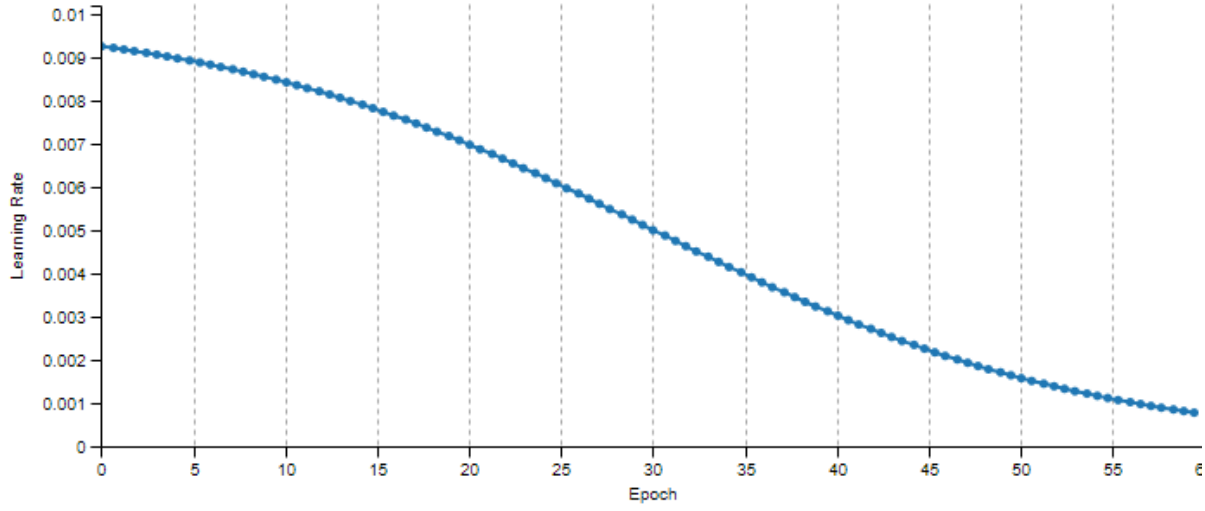
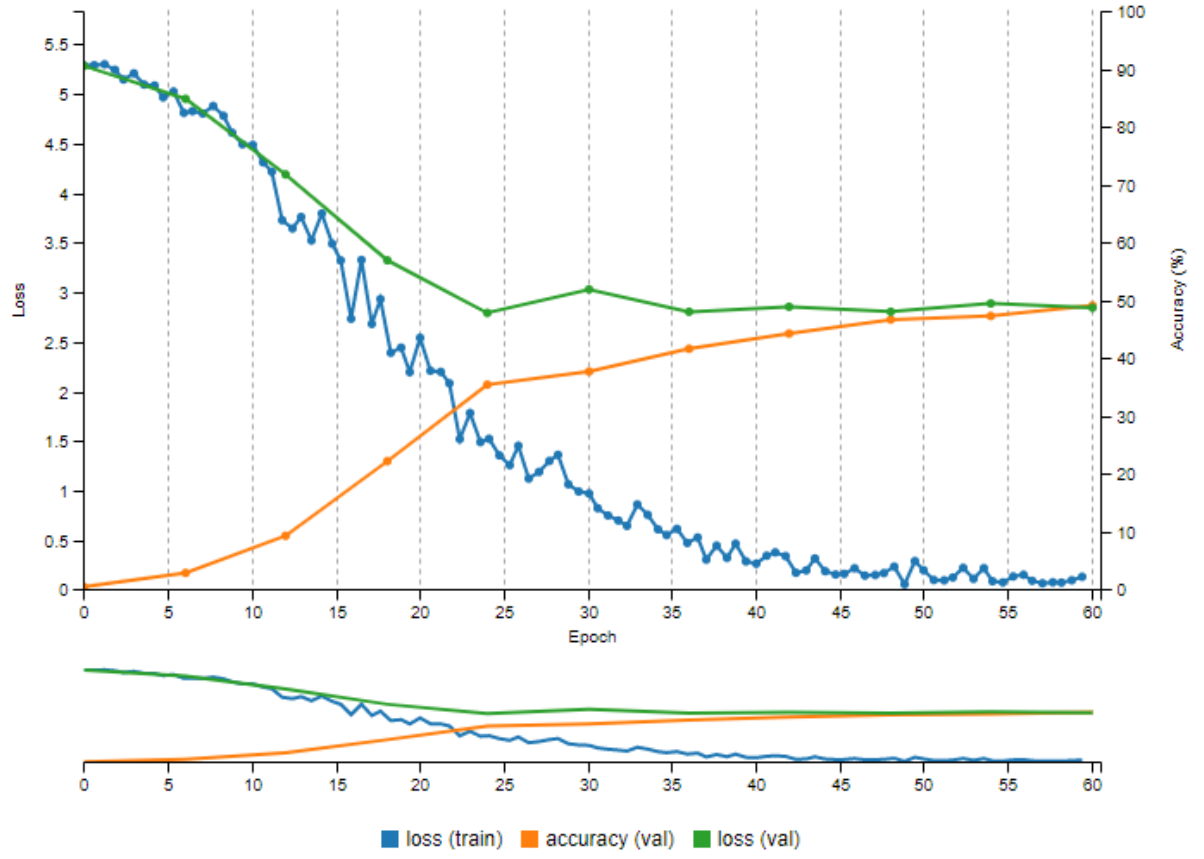


8.3.17 Treatment 42



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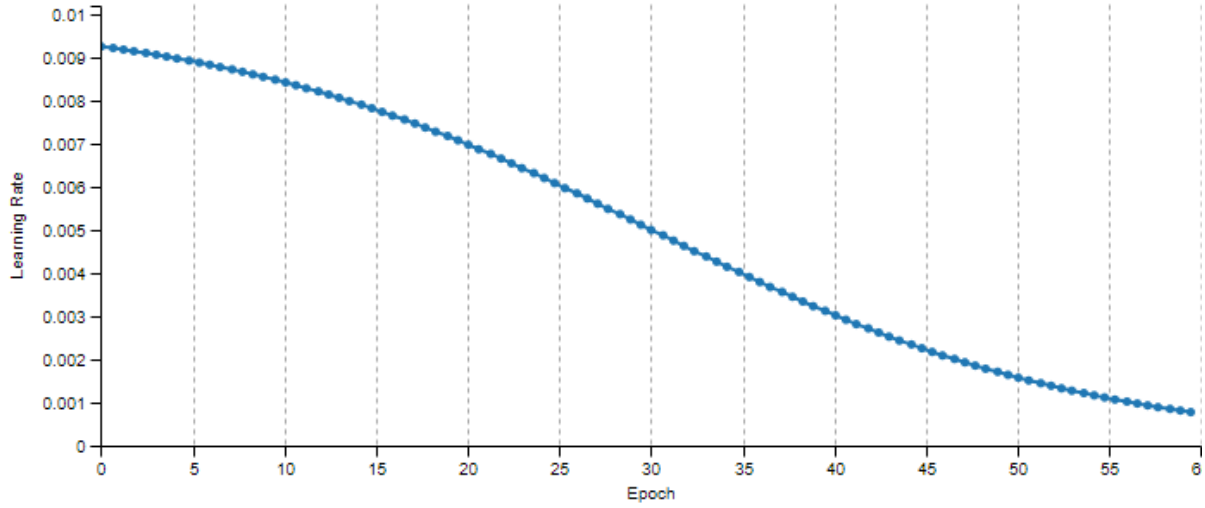
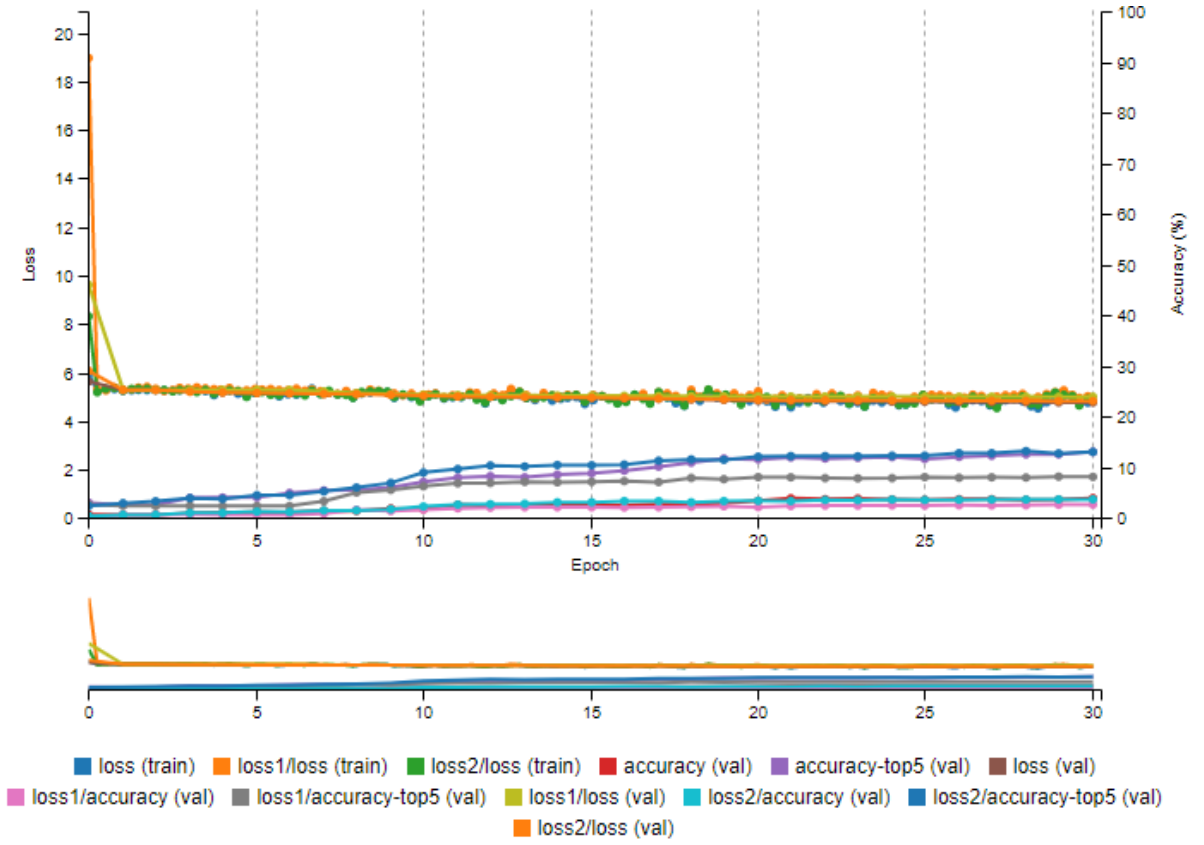
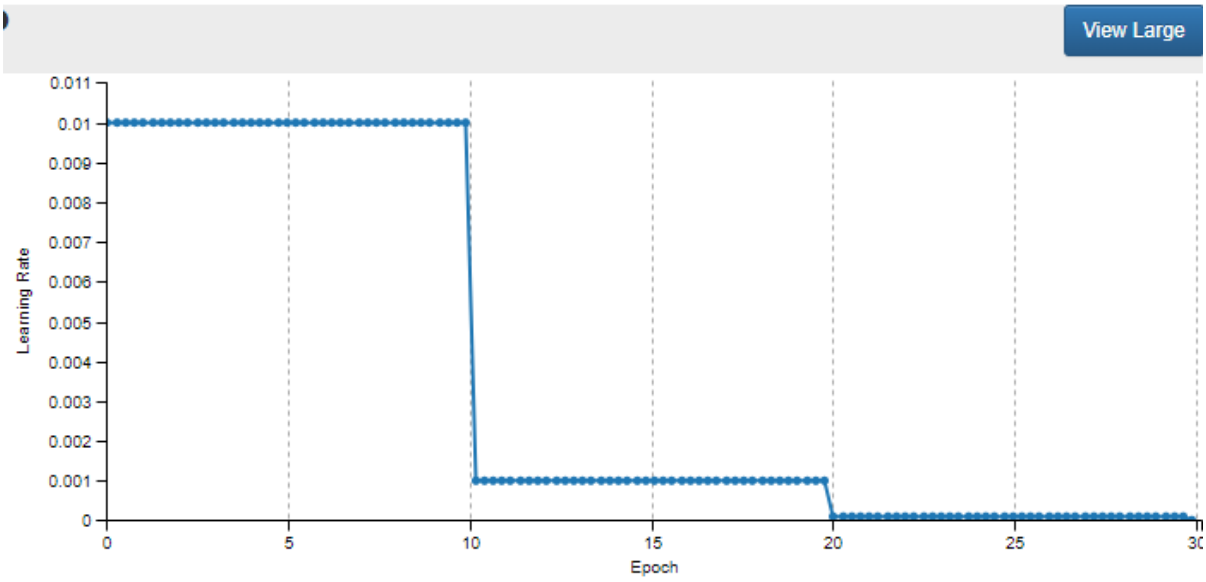


8.3.18 Treatment 43





8.4 PREDICTIONS SNAPSHOT FOR TREATMENTS TESTED WITH "CLASSIFY MANY"

8.4.1 Treatment 3

All classifications

	Path	Ground truth	Top predictions									
1	/scratch/Teaching/cars/car_ims/007753.jpg	Dodge Durango SUV 2007	Dodge Durango SUV 2007	95.36%	Dodge Caliber Wagon 2007	3.08%	Dodge Dakota Club Cab 2007	0.46%	Dodge Caliber Wagon 2012	0.37%	GMC Acadia SUV 2012	0.23%
2	/scratch/Teaching/cars/car_ims/001926.jpg	Audi S4 Sedan 2007	Mercedes-Benz E-Class Sedan 2012	93.23%	Chevrolet Sonic Sedan 2012	1.63%	Mercedes-Benz C-Class Sedan 2012	1.49%	Mercedes-Benz S-Class Sedan 2012	0.77%	smart fortwo Convertible 2012	0.68%
3	/scratch/Teaching/cars/car_ims/002409.jpg	BMW 3 Series Wagon 2012	BMW 3 Series Sedan 2012	65.02%	BMW 3 Series Wagon 2012	25.04%	Audi S6 Sedan 2011	3.06%	Hyundai Genesis Sedan 2012	2.44%	Audi S5 Convertible 2012	1.56%
4	/scratch/Teaching/cars/car_ims/000646.jpg	Aston Martin V8 Vantage Convertible 2012	Aston Martin V8 Vantage Convertible 2012	93.5%	Aston Martin Virage Convertible 2012	5.34%	Aston Martin V8 Vantage Coupe 2012	0.44%	Fisker Karma Sedan 2012	0.19%	BMW 6 Series Convertible 2007	0.17%
5	/scratch/Teaching/cars/car_ims/011943.jpg	Jeep Wrangler SUV 2012	Ford F-150 Regular Cab 2007	27.91%	AM General Hummer SUV 2000	27.27%	Dodge Dakota Crew Cab 2010	18.43%	HUMMER H2 SUT Crew Cab 2009	8.93%	Jeep Liberty SUV 2012	2.91%
6	/scratch/Teaching/cars/car_ims/013830.jpg	Nissan Leaf Hatchback 2012	Nissan Leaf Hatchback 2012	49.95%	Porsche Panamera Sedan 2012	43.06%	Nissan Juke Hatchback 2012	3.72%	Jaguar XK XKR 2012	1.77%	Chevrolet Corvette ZR1 2012	0.58%
7	/scratch/Teaching/cars/car_ims/000126.jpg	Acura RL Sedan 2012	Acura RL Sedan 2012	64.37%	Acura TL Sedan 2012	9.45%	Chevrolet Impala Sedan 2007	8.39%	Suzuki Aerio Sedan 2007	3.77%	Volkswagen Golf Hatchback 2012	2.63%
8	/scratch/Teaching/cars/car_ims/013149.jpg	Mercedes-Benz 300-Class Convertible 1993	BMW M6 Convertible 2010	69.22%	Mercedes-Benz 300-Class Convertible 1993	8.71%	Acura TL Type-S 2008	7.5%	BMW 6 Series Convertible 2007	3.04%	BMW ActiveHybrid 5 Sedan 2012	1.61%
9	/scratch/Teaching/cars/car_ims/011360.jpg	Hyundai Sonata Sedan 2012	Hyundai Sonata Sedan 2012	41.29%	Hyundai Genesis Sedan 2012	27.09%	Hyundai Azera Sedan 2012	14.17%	Mercedes-Benz C-Class Sedan	8.84%	Mercedes-Benz S-Class Sedan 2012	2.06%

8.4.2 Treatment 4

All classifications

	Path	Ground truth	Top predictions									
1	/scratch/Teaching/cars/car_ims/007753.jpg	Dodge Durango SUV 2007	Dodge Durango SUV 2007	65.86%	Volvo XC90 SUV 2007	7.37%	Chrysler Aspen SUV 2009	6.22%	Dodge Ram Pickup 3500 Quad Cab 2009	5.67%	GMC Acadia SUV 2012	5.13%
2	/scratch/Teaching/cars/car_ims/001926.jpg	Audi S4 Sedan 2007	Nissan Juke Hatchback 2012	51.16%	Dodge Journey SUV 2012	11.65%	Chevrolet Sonic Sedan 2012	5.74%	Dodge Charger Sedan 2012	5.51%	Cadillac CTS-V Sedan 2012	2.14%
3	/scratch/Teaching/cars/car_ims/002409.jpg	BMW 3 Series Wagon 2012	Lamborghini Reventon Coupe 2008	23.58%	Hyundai Genesis Sedan 2012	20.41%	Bentley Arnage Sedan 2009	17.04%	BMW 3 Series Wagon 2012	7.17%	Daewoo Nubira Wagon 2002	6.12%
4	/scratch/Teaching/cars/car_ims/000646.jpg	Aston Martin V8 Vantage Convertible 2012	Aston Martin V8 Vantage Convertible 2012	76.63%	Aston Martin Virage Convertible 2012	17.94%	Aston Martin V8 Vantage Coupe 2012	2.46%	Jaguar XK XKR 2012	1.08%	Spyker C8 Convertible 2009	0.6%
5	/scratch/Teaching/cars/car_ims/011943.jpg	Jeep Wrangler SUV 2012	AM General Hummer SUV 2000	76.24%	Dodge Dakota Crew Cab 2010	5.84%	Ford Ranger SuperCab 2011	4.34%	Ford F-150 Regular Cab 2007	1.77%	Dodge Ram Pickup 3500 Quad Cab 2009	1.34%
6	/scratch/Teaching/cars/car_ims/013830.jpg	Nissan Leaf Hatchback 2012	Jaguar XK XKR 2012	34.91%	Chevrolet Corvette ZR1 2012	27.6%	Nissan Leaf Hatchback 2012	16.3%	Volvo C30 Hatchback 2012	5.53%	Ford Fiesta Sedan 2012	5.51%
7	/scratch/Teaching/cars/car_ims/000126.jpg	Acura RL Sedan 2012	Volkswagen Golf Hatchback 2012	26.29%	Hyundai Elantra Touring Hatchback 2012	12.54%	Chevrolet Impala Sedan 2007	8.11%	Suzuki Aerio Sedan 2007	7.76%	Acura RL Sedan 2012	7.53%
8	/scratch/Teaching/cars/car_ims/013149.jpg	Mercedes-Benz 300-Class Convertible 1993	BMW M6 Convertible 2010	54.95%	Acura TL Type-S 2008	16.65%	Rolls-Royce Phantom Drophead Coupe Convertible 2012	3.81%	Spyker C8 Convertible 2009	3.37%	Lamborghini Reventon Coupe 2008	3.02%

8.4.3 Treatment 10

All classifications

	Path	Ground truth	Top predictions									
1	/scratch/Teaching/cars/car_ims/007753.jpg	Dodge Durango SUV 2007	Dodge Durango SUV 2007	91.19%	Dodge Dakota Crew Cab 2010	8.43%	Dodge Dakota Club Cab 2007	0.32%	Dodge Ram Pickup 3500 Quad Cab 2009	0.02%	Isuzu Ascender SUV 2008	0.01%
2	/scratch/Teaching/cars/car_ims/001926.jpg	Audi S4 Sedan 2007	Mitsubishi Lancer Sedan 2012	71.64%	Audi S4 Sedan 2007	12.65%	Audi S5 Convertible 2012	2.52%	Chevrolet Sonic Sedan 2012	1.83%	Mercedes-Benz E-Class Sedan 2012	1.61%
3	/scratch/Teaching/cars/car_ims/002409.jpg	BMW 3 Series Wagon 2012	BMW 3 Series Wagon 2012	37.94%	BMW 3 Series Sedan 2012	22.88%	BMW ActiveHybrid 5 Sedan 2012	9.66%	BMW 1 Series Coupe 2012	8.6%	BMW M5 Sedan 2010	4.9%
4	/scratch/Teaching/cars/car_ims/000646.jpg	Aston Martin V8 Vantage Convertible 2012	Aston Martin Virage Convertible 2012	34.78%	Aston Martin V8 Vantage Convertible 2012	21.48%	Aston Martin V8 Vantage Coupe 2012	10.29%	Fisker Karma Sedan 2012	8.25%	Jaguar XK XKR 2012	6.32%
5	/scratch/Teaching/cars/car_ims/011943.jpg	Jeep Wrangler SUV 2012	Dodge Dakota Crew Cab 2010	27.33%	Jeep Liberty SUV 2012	16.83%	Dodge Ram Pickup 3500 Quad Cab 2009	9.99%	GMC Canyon Extended Cab 2012	9.57%	Chevrolet Avalanche Crew Cab 2012	8.09%
6	/scratch/Teaching/cars/car_ims/013830.jpg	Nissan Leaf Hatchback 2012	Nissan Leaf Hatchback 2012	80.11%	Nissan Juke Hatchback 2012	6.5%	smart fortwo Convertible 2012	6.34%	Scion xD Hatchback 2012	1.8%	Ford Fiesta Sedan 2012	1.01%
7	/scratch/Teaching/cars/car_ims/000126.jpg	Acura RL Sedan 2012	Chevrolet Impala Sedan 2007	23.81%	Honda Accord Sedan 2012	17.49%	Acura RL Sedan 2012	15.21%	Honda Accord Coupe 2012	9.28%	Chevrolet Monte Carlo Coupe 2007	4.81%
8	/scratch/Teaching/cars/car_ims/013149.jpg	Mercedes-Benz 300-Class Convertible 1993	Dodge Charger SRT-8 2009	31.64%	Chrysler 300 SRT-8 2010	17.79%	Mercedes-Benz 300-Class Convertible 1993	8.95%	Chevrolet Camaro Convertible 2012	5.53%	Dodge Charger Sedan 2012	4.74%
9	/scratch/Teaching/cars/car_ims/011360.jpg	Hyundai Sonata Sedan 2012	Hyundai Genesis Sedan 2012	37.37%	Hyundai Azera Sedan 2012	29.37%	Hyundai Sonata Sedan 2012	29.01%	Acura TL Type-S 2008	1.36%	Acura RL Sedan 2012	1.34%

8.4.4 Treatment 16

All classifications

	Path	Ground truth	Top predictions									
1	/scratch/Teaching/cars/car_ims/007753.jpg	Dodge Durango SUV 2007	**Dodge Durango SUV 2007**	99.97%	**Dodge Dakota Crew Cab 2010**	0.02%	**Dodge Dakota Club Cab 2007**	0.01%	**Dodge Caliber Wagon 2007**	0.0%	**Dodge Ram Pickup 3500 Quad Cab 2009**	0.0%
2	/scratch/Teaching/cars/car_ims/001926.jpg	Audi S4 Sedan 2007	**Hyundai Santa Fe SUV 2012**	27.94%	**Hyundai Genesis Sedan 2012**	22.44%	**Mercedes-Benz E-Class Sedan 2012**	22.31%	**Audi A5 Coupe 2012**	17.91%	**Mercedes-Benz S-Class Sedan 2012**	3.13%
3	/scratch/Teaching/cars/car_ims/002409.jpg	BMW 3 Series Wagon 2012	**BMW 3 Series Wagon 2012**	86.74%	**BMW 3 Series Sedan 2012**	13.02%	**Volvo 240 Sedan 1993**	0.07%	**BMW ActiveHybrid 5 Sedan 2012**	0.06%	**Daewoo Nubira Wagon 2002**	0.03%
4	/scratch/Teaching/cars/car_ims/000646.jpg	Aston Martin V8 Vantage Convertible 2012	**Aston Martin V8 Vantage Convertible 2012**	95.7%	**Aston Martin V8 Vantage Coupe 2012**	3.36%	**Lamborghini Reventon Coupe 2008**	0.88%	**Aston Martin Virage Convertible 2012**	0.05%	**Ferrari California Convertible 2012**	0.0%
5	/scratch/Teaching/cars/car_ims/011943.jpg	Jeep Wrangler SUV 2012	**AM General Hummer SUV 2000**	92.61%	**HUMMER H2 SUT Crew Cab 2009**	3.98%	**HUMMER H3T Crew Cab 2010**	0.89%	**Dodge Ram Pickup 3500 Quad Cab 2009**	0.52%	**Jeep Compass SUV 2012**	0.33%
6	/scratch/Teaching/cars/car_ims/013830.jpg	Nissan Leaf Hatchback 2012	**Nissan Leaf Hatchback 2012**	99.81%	**Jaguar XK XKR 2012**	0.17%	**Porsche Panamera Sedan 2012**	0.02%	**Nissan Juke Hatchback 2012**	0.0%	**Chevrolet Corvette ZR1 2012**	0.0%
7	/scratch/Teaching/cars/car_ims/000126.jpg	Acura RL Sedan 2012	**Acura RL Sedan 2012**	99.75%	**Acura TSX Sedan 2012**	0.17%	**Acura TL Type-S 2008**	0.03%	**BMW 3 Series Wagon 2012**	0.01%	**Chevrolet Impala Sedan 2007**	0.01%
8	/scratch/Teaching/cars/car_ims/013149.jpg	Mercedes-Benz 300-Class Convertible 1993	**BMW M6 Convertible 2010**	44.06%	**Mercedes-Benz 300-Class Convertible 1993**	41.27%	**Rolls-Royce Phantom Drophead Coupe Convertible 2012**	8.05%	**Aston Martin V8 Vantage Convertible 2012**	2.96%	**Audi 100 Wagon 1994**	2.11%

8.4.5 Treatment 23

1	/scratch/Teaching/cars/car_ims/007753.jpg	Dodge Durango SUV 2007	Dodge Durango SUV 2007	100.0%	Dodge Dakota Club Cab 2007	0.0%	Dodge Dakota Crew Cab 2010	0.0%	Dodge Ram Pickup 3500 Quad Cab 2009	0.0%	Isuzu Ascender SUV 2008	0.0%
2	/scratch/Teaching/cars/car_ims/001926.jpg	Audi S4 Sedan 2007	Suzuki Kizashi Sedan 2012	93.02%	Audi S4 Sedan 2007	6.62%	Audi RS 4 Convertible 2008	0.31%	Audi A5 Coupe 2012	0.04%	Mercedes-Benz C-Class Sedan 2012	0.01%
3	/scratch/Teaching/cars/car_ims/002409.jpg	BMW 3 Series Wagon 2012	BMW 3 Series Sedan 2012	95.98%	BMW 3 Series Wagon 2012	2.86%	BMW M3 Coupe 2012	0.61%	BMW 1 Series Coupe 2012	0.3%	BMW M5 Sedan 2010	0.24%
4	/scratch/Teaching/cars/car_ims/000646.jpg	Aston Martin V8 Vantage Convertible 2012	Aston Martin V8 Vantage Convertible 2012	53.89%	Aston Martin V8 Vantage Coupe 2012	35.03%	Aston Martin Virage Convertible 2012	11.03%	Aston Martin Virage Coupe 2012	0.05%	Ferrari California Convertible 2012	0.0%
5	/scratch/Teaching/cars/car_ims/011943.jpg	Jeep Wrangler SUV 2012	AM General Hummer SUV 2000	83.78%	HUMMER H2 SUT Crew Cab 2009	15.57%	Ford F-150 Regular Cab 2007	0.64%	Nissan NV Passenger Van 2012	0.01%	Jeep Wrangler SUV 2012	0.01%
6	/scratch/Teaching/cars/car_ims/013830.jpg	Nissan Leaf Hatchback 2012	Nissan Leaf Hatchback 2012	100.0%	Aston Martin V8 Vantage Convertible 2012	0.0%	Chevrolet Corvette ZR1 2012	0.0%	Jaguar XK XKR 2012	0.0%	Scion xD Hatchback 2012	0.0%
7	/scratch/Teaching/cars/car_ims/000126.jpg	Acura RL Sedan 2012	Acura RL Sedan 2012	100.0%	Acura TSX Sedan 2012	0.0%	Acura TL Sedan 2012	0.0%	Honda Accord Sedan 2012	0.0%	Chevrolet Impala Sedan 2007	0.0%
8	/scratch/Teaching/cars/car_ims/013149.jpg	Mercedes-Benz 300-Class Convertible 1993	Mercedes-Benz 300-Class Convertible 1993	100.0%	Geo Metro Convertible 1993	0.0%	Chrysler PT Cruiser Convertible 2008	0.0%	Eagle Talon Hatchback 1998	0.0%	Ford Mustang Convertible 2007	0.0%
9	/scratch/Teaching/cars/car_ims/011360.jpg	Hyundai Sonata Sedan 2012	Hyundai Sonata Sedan 2012	41.98%	Acura RL Sedan 2012	37.15%	Hyundai Azera Sedan 2012	20.52%	Hyundai Genesis Sedan 2012	0.32%	Honda Accord Sedan 2012	0.02%
10	/scratch/Teaching/cars/car_ims/012185.jpg	Jeep Grand Cherokee SUV 2012	Jeep Grand Cherokee SUV 2012	98.85%	Jeep Compass SUV 2012	1.13%	Toyota 4Runner SUV 2012	0.02%	Mazda Tribute SUV 2011	0.0%	Dodge Durango SUV 2012	0.0%
11	/scratch/Teaching/cars/car_ims/011741.jpg	Isuzu Ascender	Isuzu Ascender	99.69%	Chevrolet Silverado	0.31%	Chevrolet Silverado	0.0%	Dodge Dakota Crew	0.0%	GMC Yukon Hybrid SUV	0.0%

8.4.6 Treatment 30

1	/scratch/Teaching/cars/car_ims/011430.jpg	Hyundai Elantra Touring Hatchback 2012	**Hyundai Elantra Touring Hatchback 2012**	96.7%	**Ford Fiesta Sedan 2012**	3.16%	**Volkswagen Golf Hatchback 2012**	0.11%	**Suzuki SX4 Hatchback 2012**	0.02%	**Hyundai Accent Sedan 2012**	0.0%
2	/scratch/Teaching/cars/car_ims/014455.jpg	Rolls-Royce Ghost Sedan 2012	**Rolls-Royce Ghost Sedan 2012**	49.79%	**Rolls-Royce Phantom Sedan 2012**	49.07%	**Chrysler 300 SRT-8 2010**	0.68%	**Chrysler Crossfire Convertible 2008**	0.2%	**Rolls-Royce Phantom Drophead Coupe Convertible 2012**	0.19%
3	/scratch/Teaching/cars/car_ims/007346.jpg	Dodge Dakota Crew Cab 2010	**Dodge Dakota Crew Cab 2010**	99.81%	**Dodge Durango SUV 2012**	0.12%	**Dodge Dakota Club Cab 2007**	0.05%	**Dodge Durango SUV 2007**	0.01%	**Dodge Caliber Wagon 2007**	0.0%
4	/scratch/Teaching/cars/car_ims/010287.jpg	HUMMER H2 SUT Crew Cab 2009	**HUMMER H2 SUT Crew Cab 2009**	87.77%	**HUMMER H3T Crew Cab 2010**	12.11%	**Jeep Wrangler SUV 2012**	0.1%	**AM General Hummer SUV 2000**	0.01%	**smart fortwo Convertible 2012**	0.0%
5	/scratch/Teaching/cars/car_ims/014613.jpg	Scion xD Hatchback 2012	**Scion xD Hatchback 2012**	99.94%	**Nissan Leaf Hatchback 2012**	0.05%	**Acura ZDX Hatchback 2012**	0.0%	**Ford Fiesta Sedan 2012**	0.0%	**Hyundai Sonata Hybrid Sedan 2012**	0.0%
6	/scratch/Teaching/cars/car_ims/015765.jpg	Volkswagen Beetle Hatchback 2012	**Volkswagen Beetle Hatchback 2012**	85.79%	**Spyker C8 Convertible 2009**	11.91%	**Volkswagen Golf Hatchback 2012**	0.88%	**Porsche Panamera Sedan 2012**	0.33%	**Bugatti Veyron 16.4 Coupe 2009**	0.21%
7	/scratch/Teaching/cars/car_ims/001261.jpg	Audi V8 Sedan 1994	**Audi 100 Wagon 1994**	46.78%	**Volkswagen Golf Hatchback 1991**	32.56%	**Audi V8 Sedan 1994**	15.33%	**Plymouth Neon Coupe 1999**	4.73%	**Audi 100 Sedan 1994**	0.38%
8	/scratch/Teaching/cars/car_ims/011779.jpg	Jaguar XK XKR 2012	**Chevrolet Corvette ZR1 2012**	70.56%	**Chevrolet Corvette Convertible 2012**	20.29%	**Chevrolet Corvette Ron Fellows Edition Z06 2007**	2.66%	**Aston Martin Virage Convertible 2012**	2.66%	**Aston Martin V8 Vantage Convertible 2012**	1.11%
9	/scratch/Teaching/cars/car_ims/010037.jpg	GMC Savana Van 2012	**Chevrolet Express Cargo Van 2007**	77.88%	**Chevrolet Express Van 2007**	17.13%	**GMC Savana Van 2012**	4.78%	**Nissan Juke Hatchback 2012**	0.11%	**Bugatti Veyron 16.4 Coupe 2009**	0.02%
10	/scratch/Teaching/cars/car_ims/012471.jpg	Lamborghini Gallardo LP 570-4 Superleggera 2012	**Lamborghini Gallardo LP 570-4 Superleggera 2012**	78.59%	**Bentley Continental Supersports Conv. Convertible**	15.35%	**Dodge Challenger SRT8 2011**	1.12%	**Hyundai Veloster Hatchback 2012**	1.07%	**Lamborghini Reventon Coupe 2008**	0.79%

8.4.7 Treatment 39

1	/scratch/Teaching/cars/car_ims/011430.jpg	Hyundai Elantra Touring Hatchback 2012	**Hyundai Elantra Touring Hatchback 2012**	100.0%	**Suzuki SX4 Hatchback 2012**	0.0%	**Volkswagen Golf Hatchback 2012**	0.0%	**Suzuki Aerio Sedan 2007**	0.0%	**Toyota Corolla Sedan 2012**	0.0%
2	/scratch/Teaching/cars/car_ims/014455.jpg	Rolls-Royce Ghost Sedan 2012	**Rolls-Royce Ghost Sedan 2012**	88.53%	**Rolls-Royce Phantom Sedan 2012**	11.43%	**Rolls-Royce Phantom Drophead Coupe Convertible 2012**	0.04%	**MINI Cooper Roadster Convertible 2012**	0.0%	**Chrysler 300 SRT-8 2010**	0.0%
3	/scratch/Teaching/cars/car_ims/007346.jpg	Dodge Dakota Crew Cab 2010	**Dodge Dakota Crew Cab 2010**	99.99%	**Dodge Dakota Club Cab 2007**	0.01%	**Dodge Durango SUV 2012**	0.0%	**Chevrolet Avalanche Crew Cab 2012**	0.0%	**HUMMER H3T Crew Cab 2010**	0.0%
4	/scratch/Teaching/cars/car_ims/010287.jpg	HUMMER H2 SUT Crew Cab 2009	**HUMMER H2 SUT Crew Cab 2009**	99.93%	**HUMMER H3T Crew Cab 2010**	0.07%	**AM General Hummer SUV 2000**	0.0%	**Jeep Wrangler SUV 2012**	0.0%	**Dodge Ram Pickup 3500 Crew Cab 2010**	0.0%
5	/scratch/Teaching/cars/car_ims/014613.jpg	Scion xD Hatchback 2012	**Scion xD Hatchback 2012**	100.0%	**Nissan Leaf Hatchback 2012**	0.0%	**Ford Fiesta Sedan 2012**	0.0%	**Hyundai Tucson SUV 2012**	0.0%	**Suzuki Aerio Sedan 2007**	0.0%
6	/scratch/Teaching/cars/car_ims/015765.jpg	Volkswagen Beetle Hatchback 2012	**Volkswagen Beetle Hatchback 2012**	95.01%	**Cadillac CTS-V Sedan 2012**	4.74%	**Bentley Continental GT Coupe 2007**	0.1%	**Chevrolet Cobalt SS 2010**	0.06%	**MINI Cooper Roadster Convertible 2012**	0.04%
7	/scratch/Teaching/cars/car_ims/001261.jpg	Audi V8 Sedan 1994	**Audi V8 Sedan 1994**	70.16%	**Volkswagen Golf Hatchback 1991**	16.36%	**Volvo 240 Sedan 1993**	8.85%	**Bentley Arnage Sedan 2009**	3.7%	**Ford Mustang Convertible 2007**	0.24%
8	/scratch/Teaching/cars/car_ims/011779.jpg	Jaguar XK XKR 2012	**Jaguar XK XKR 2012**	87.81%	**Porsche Panamera Sedan 2012**	11.5%	**Fisker Karma Sedan 2012**	0.29%	**BMW Z4 Convertible 2012**	0.14%	**Spyker C8 Coupe 2009**	0.08%
9	/scratch/Teaching/cars/car_ims/010037.jpg	GMC Savana Van 2012	**GMC Savana Van 2012**	98.16%	**Chevrolet Express Cargo Van 2007**	1.18%	**Bugatti Veyron 16.4 Coupe 2009**	0.4%	**Acura Integra Type R 2001**	0.12%	**Chevrolet Express Van 2007**	0.06%
10	/scratch/Teaching/cars/car_ims/012471.jpg	Lamborghini Gallardo LP 570-4 Superleggera	**Lamborghini Gallardo LP 570-4 Superleggera**	100.0%	**Hyundai Veloster Hatchback 2012**	0.0%	**Acura Integra Type R 2001**	0.0%	**Dodge Challenger SRT8 2011**	0.0%	**Bentley Continental Supersports Conv.**	0.0%

8.4.8 Treatment 41

1	/scratch/Teaching/cars/car_ims/011430.jpg	Hyundai Elantra Touring Hatchback 2012	**Hyundai Elantra Touring Hatchback 2012**	98.76%	Ford Fiesta Sedan 2012	1.03%	smart fortwo Convertible 2012	0.15%	Hyundai Accent Sedan 2012	0.04%	Volkswagen Golf Hatchback 2012	0.01%
2	/scratch/Teaching/cars/car_ims/014455.jpg	Rolls-Royce Ghost Sedan 2012	**Rolls-Royce Ghost Sedan 2012**	92.57%	BMW Z4 Convertible 2012	2.88%	Suzuki Aerio Sedan 2007	0.66%	Acura Integra Type R 2001	0.46%	Rolls-Royce Phantom Sedan 2012	0.45%
3	/scratch/Teaching/cars/car_ims/007346.jpg	Dodge Dakota Crew Cab 2010	**Dodge Dakota Crew Cab 2010**	94.52%	Chevrolet Silverado 1500 Hybrid Crew Cab 2012	2.07%	Isuzu Ascender SUV 2008	0.44%	GMC Canyon Extended Cab 2012	0.43%	GMC Terrain SUV 2012	0.33%
4	/scratch/Teaching/cars/car_ims/010287.jpg	HUMMER H2 SUT Crew Cab 2009	**HUMMER H2 SUT Crew Cab 2009**	100.0%	HUMMER H3T Crew Cab 2010	0.0%	AM General Hummer SUV 2000	0.0%	Jeep Wrangler SUV 2012	0.0%	Spyker C8 Convertible 2009	0.0%
5	/scratch/Teaching/cars/car_ims/014613.jpg	Scion xD Hatchback 2012	**Scion xD Hatchback 2012**	99.99%	Ford Fiesta Sedan 2012	0.01%	Toyota Corolla Sedan 2012	0.0%	Toyota Camry Sedan 2012	0.0%	Hyundai Tucson SUV 2012	0.0%
6	/scratch/Teaching/cars/car_ims/015765.jpg	Volkswagen Beetle Hatchback 2012	**Volkswagen Beetle Hatchback 2012**	100.0%	Porsche Panamera Sedan 2012	0.0%	Nissan Leaf Hatchback 2012	0.0%	Cadillac CTS-V Sedan 2012	0.0%	Fisker Karma Sedan 2012	0.0%
7	/scratch/Teaching/cars/car_ims/001261.jpg	Audi V8 Sedan 1994	**Audi V8 Sedan 1994**	99.99%	Lincoln Town Car Sedan 2011	0.01%	Audi 100 Sedan 1994	0.0%	Bentley Arnage Sedan 2009	0.0%	Bentley Continental Flying Spur Sedan 2007	0.0%
8	/scratch/Teaching/cars/car_ims/011779.jpg	Jaguar XK XKR 2012	**Jaguar XK XKR 2012**	99.87%	Lamborghini Gallardo LP 570-4 Superleggera 2012	0.05%	Eagle Talon Hatchback 1998	0.02%	Chevrolet Corvette ZR1 2012	0.01%	Lamborghini Reventon Coupe 2008	0.01%
9	/scratch/Teaching/cars/car_ims/010037.jpg	GMC Savana Van 2012	**Spyker C8 Convertible 2009**	24.53%	Ford GT Coupe 2006	22.66%	Bugatti Veyron 16.4 Coupe 2009	16.59%	Ford F-150 Regular Cab 2012	10.15%	Chevrolet Corvette ZR1 2012	6.53%
10	/scratch/Teaching/cars/car_ims/012471.jpg	Lamborghini Gallardo LP 570-4 Superleggera	**Lamborghini Gallardo LP 570-4 Superleggera**	99.89%	AM General Hummer SUV 2000	0.06%	Bentley Continental Supersports Conv.	0.04%	Ford GT Coupe 2006	0.0%	Jeep Wrangler SUV 2012	0.0%

8.4.9 Treatment 42

1	/scratch/Teaching/cars/car_ims/011430.jpg	Hyundai Elantra Touring Hatchback 2012	**Hyundai Elantra Touring Hatchback 2012**	99.99%	**Volkswagen Golf Hatchback 2012**	0.01%	**Hyundai Accent Sedan 2012**	0.0%	**Ford Fiesta Sedan 2012**	0.0%	**Hyundai Veloster Hatchback 2012**	0.0%
2	/scratch/Teaching/cars/car_ims/014455.jpg	Rolls-Royce Ghost Sedan 2012	**Rolls-Royce Ghost Sedan 2012**	99.62%	**Rolls-Royce Phantom Sedan 2012**	0.11%	**Rolls-Royce Phantom Drophead Coupe Convertible 2012**	0.1%	**BMW ActiveHybrid 5 Sedan 2012**	0.07%	**BMW 6 Series Convertible 2007**	0.03%
3	/scratch/Teaching/cars/car_ims/007346.jpg	Dodge Dakota Crew Cab 2010	**Dodge Dakota Crew Cab 2010**	97.42%	**Chevrolet Silverado 1500 Regular Cab 2012**	0.91%	**GMC Canyon Extended Cab 2012**	0.46%	**Dodge Dakota Club Cab 2007**	0.34%	**Chevrolet Silverado 1500 Hybrid Crew Cab 2012**	0.29%
4	/scratch/Teaching/cars/car_ims/010287.jpg	HUMMER H2 SUT Crew Cab 2009	**HUMMER H2 SUT Crew Cab 2009**	99.85%	**HUMMER H3T Crew Cab 2010**	0.15%	**AM General Hummer SUV 2000**	0.0%	**Jeep Wrangler SUV 2012**	0.0%	**McLaren MP4-12C Coupe 2012**	0.0%
5	/scratch/Teaching/cars/car_ims/014613.jpg	Scion xD Hatchback 2012	**Scion xD Hatchback 2012**	99.99%	**Ford Fiesta Sedan 2012**	0.01%	**Hyundai Tucson SUV 2012**	0.0%	**Hyundai Veloster Hatchback 2012**	0.0%	**Toyota Camry Sedan 2012**	0.0%
6	/scratch/Teaching/cars/car_ims/015765.jpg	Volkswagen Beetle Hatchback 2012	**Volkswagen Beetle Hatchback 2012**	99.47%	**Bentley Continental Flying Spur Sedan 2007**	0.09%	**Nissan Leaf Hatchback 2012**	0.09%	**Suzuki Kizashi Sedan 2012**	0.06%	**Porsche Panamera Sedan 2012**	0.04%
7	/scratch/Teaching/cars/car_ims/001261.jpg	Audi V8 Sedan 1994	**Audi 100 Wagon 1994**	43.92%	**Lincoln Town Car Sedan 2011**	24.15%	**Volvo 240 Sedan 1993**	7.4%	**Chrysler 300 SRT-8 2010**	5.23%	**Audi 100 Sedan 1994**	3.34%
8	/scratch/Teaching/cars/car_ims/011779.jpg	Jaguar XK XKR 2012	**Jaguar XK XKR 2012**	99.75%	**Aston Martin V8 Vantage Coupe 2012**	0.08%	**Lamborghini Gallardo LP 570-4 Superleggera 2012**	0.05%	**Ford GT Coupe 2006**	0.01%	**Lamborghini Aventador Coupe 2012**	0.01%
9	/scratch/Teaching/cars/car_ims/010037.jpg	GMC Savana Van 2012	**GMC Savana Van 2012**	99.94%	**HUMMER H3T Crew Cab 2010**	0.04%	**Chevrolet Express Cargo Van 2007**	0.01%	**Chevrolet Express Van 2007**	0.0%	**Audi 100 Sedan 1994**	0.0%
10	/scratch/Teaching/cars/car_ims/012471.jpg	Lamborghini Gallardo LP 570-4	**Lamborghini Gallardo LP 570-4**	100.0%	**AM General Hummer SUV 2000**	0.0%	**Bentley Continental Supersports**	0.0%	**Chevrolet Express Van 2007**	0.0%	**Hyundai Veloster Hatchback**	0.0%