# AER1515 Assignment 1

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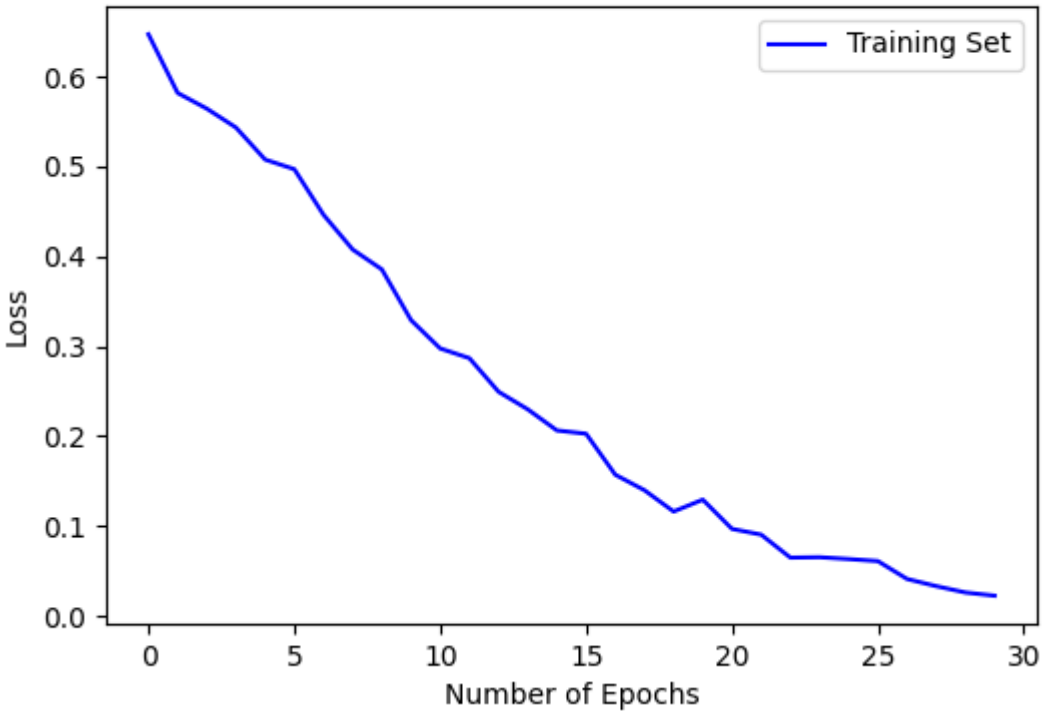
## Q1.1

Below is the plot for the loss over 30 epochs.

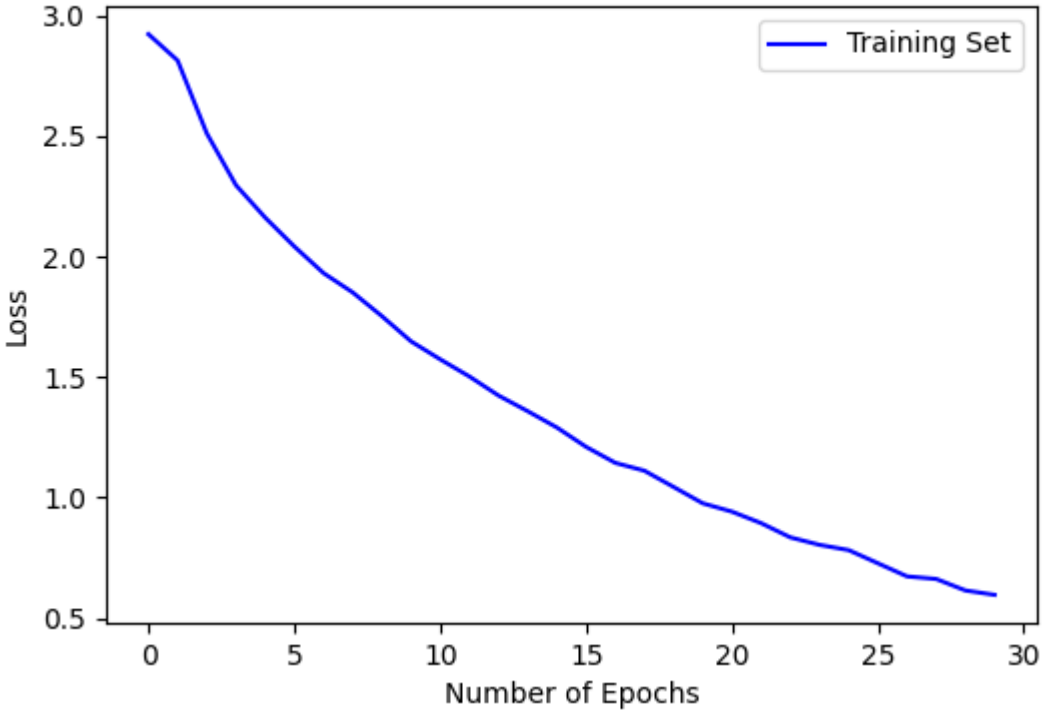



## Q1.2

The test accuracy for the binary classification on the test data was 80.0%.

## Q1.3

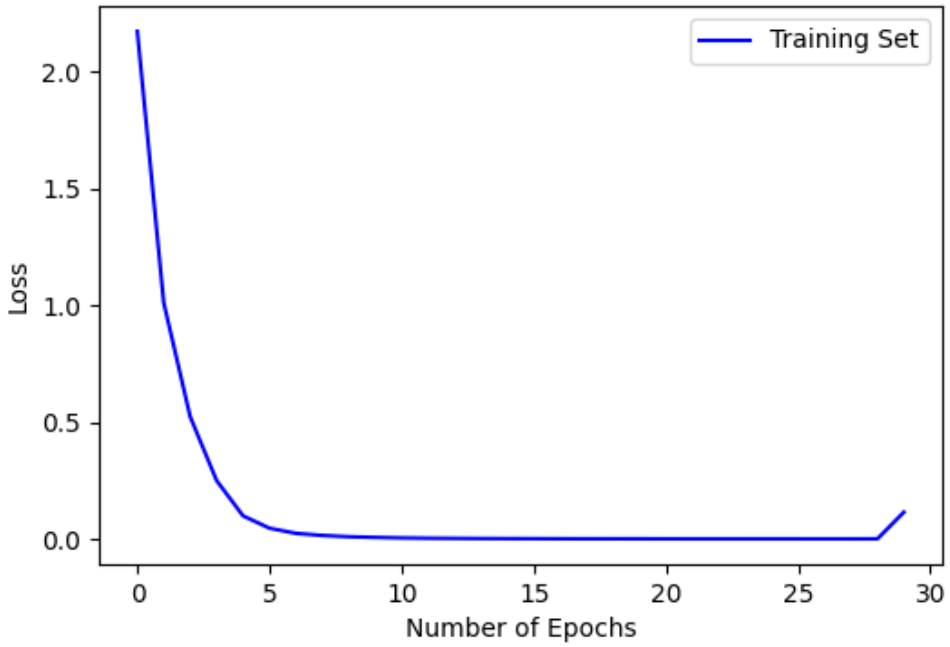
The following is the plot when the model was adjusted to a multi-class classification for all 20 classes.




Test accuracy: 64.0%

## Q2.1

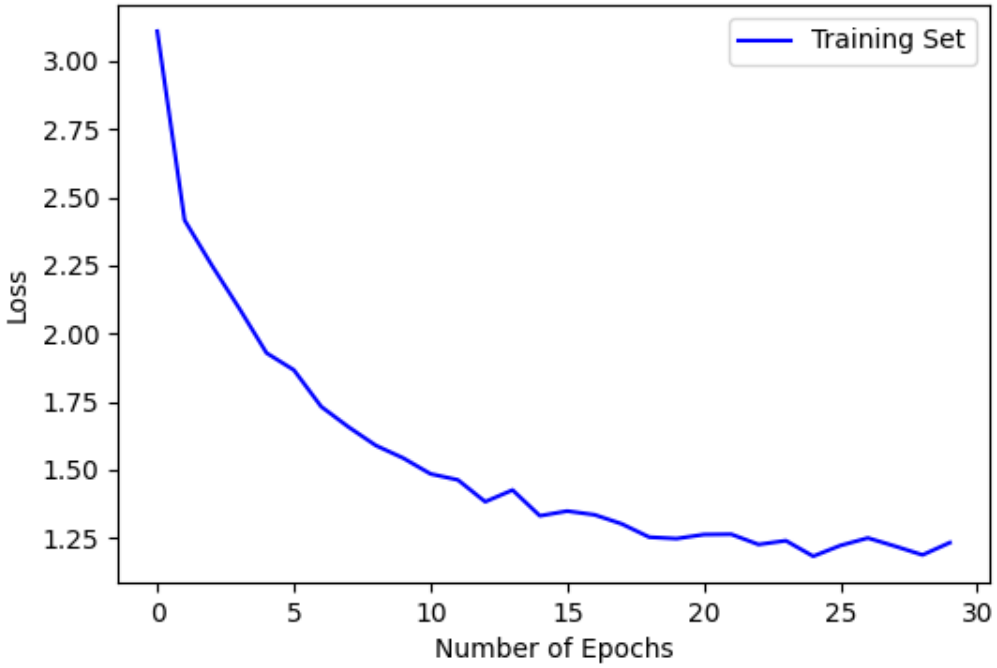
The following is the plot for the case where batch normalization layers were added to the model after the 2nd, 3rd, and 4th convolution layer.




Test accuracy: 57.0%

## Q2.2

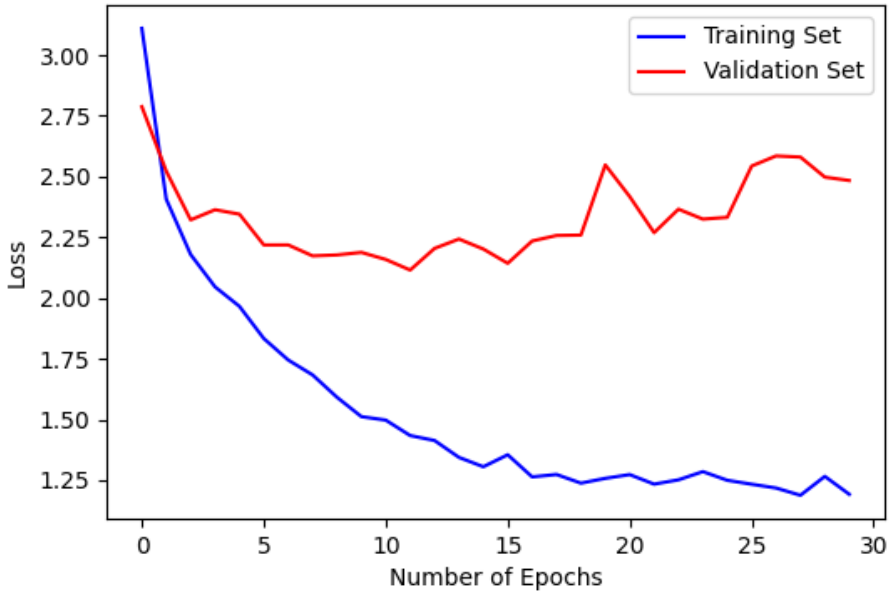
When dropout layers were added to the CNN after the 2 fully connected layers, the following error loss occurred.




Test accuracy: 64.0%

## Q3.1

The following plot demonstrates the error on the training set (blue), and the error on the validation set (red) over 30 epochs.

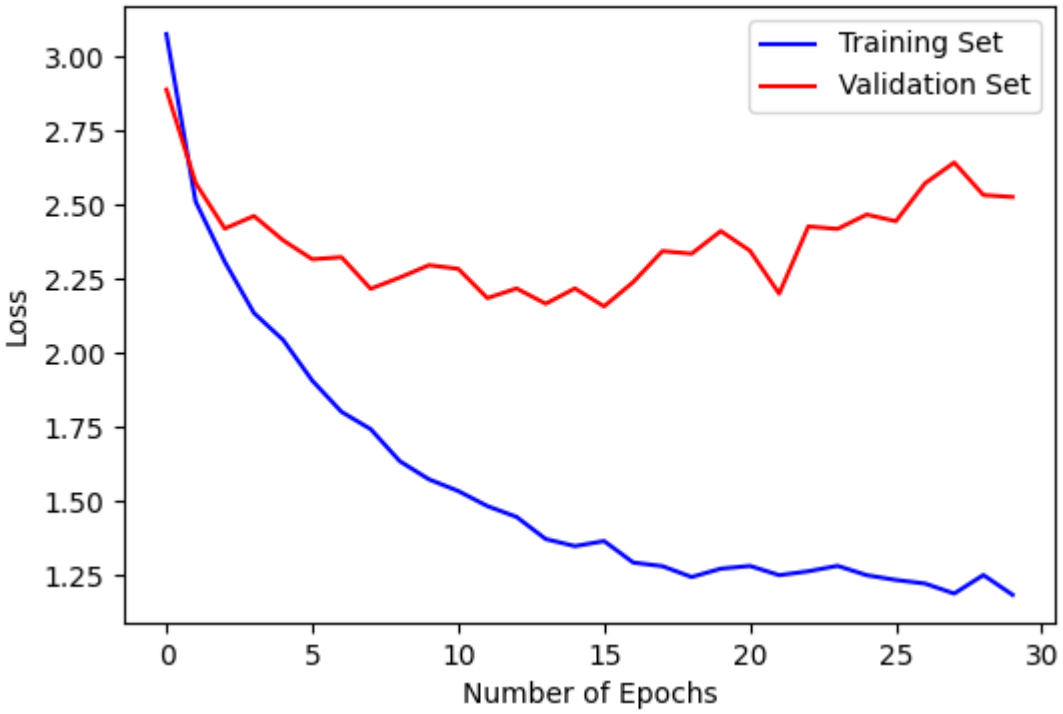


## Q3.2

The test accuracy was 63.0% when the model was saved at the epoch that yielded the lowest validation error. When the model is saved at the 30th epoch, the test accuracy is 64%. This is a relatively small difference in test accuracy and demonstrates that in this specific model configuration, choosing the model at the lowest validation error yielded a marginally lower test accuracy.

## Q4.1

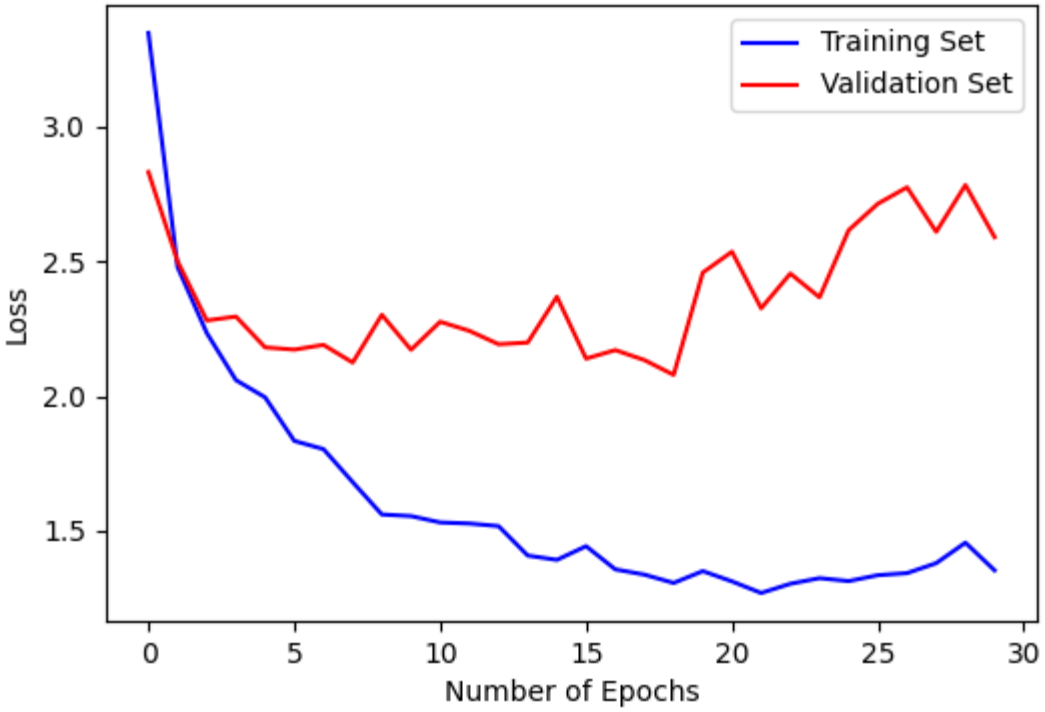
The following graph demonstrates the error over the 30 epochs when the Adam Optimizer was implemented.



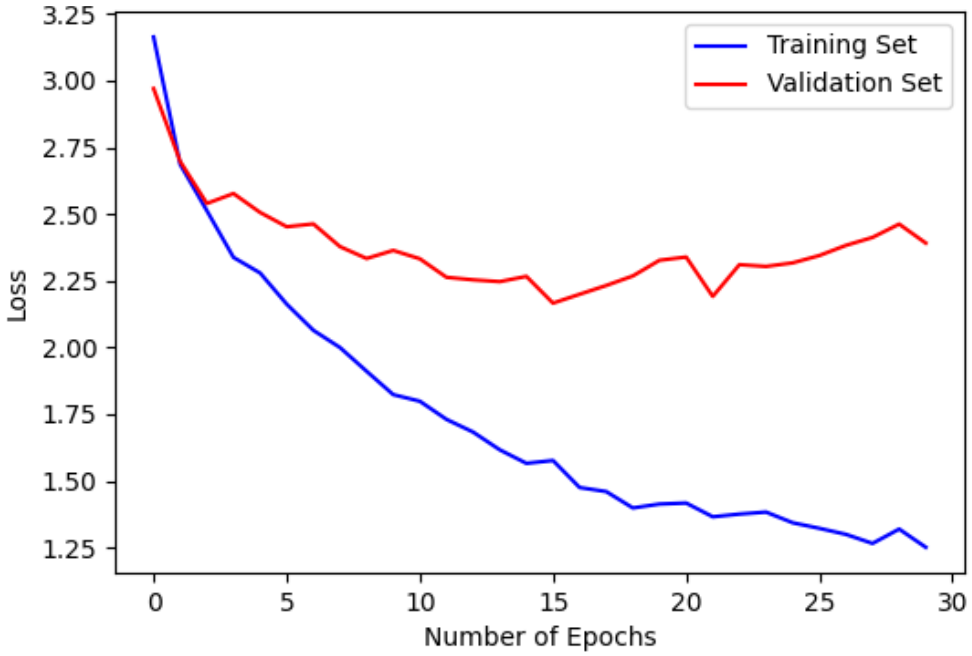

Test accuracy: 67.0%

# Q4.2

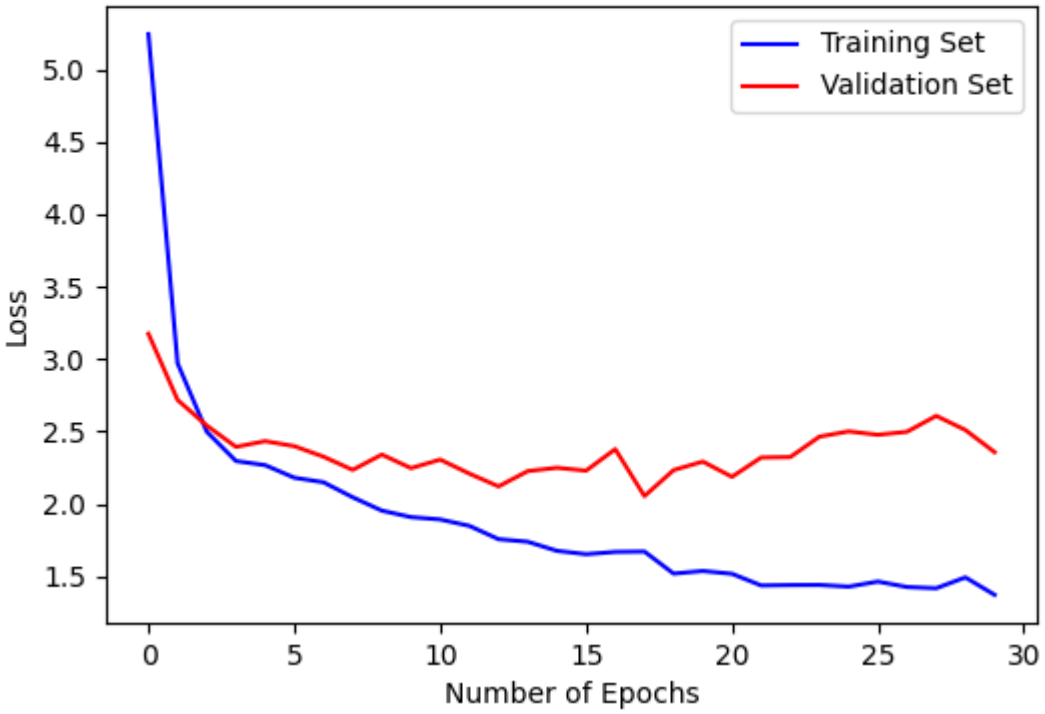
The following are the sets of error graphs, the tuned learning rate, and the corresponding classification accuracy. From the resulting test accuracies, it would appear that the optimal learning rate for the given hyperparameters is 1e-3. It was found that other learning rates higher or lower than this value yielded worse test accuracies. This is indicative that the learning rate's impact on test accuracy acts like a convex function, and a local minima was found at this specific learning rate.



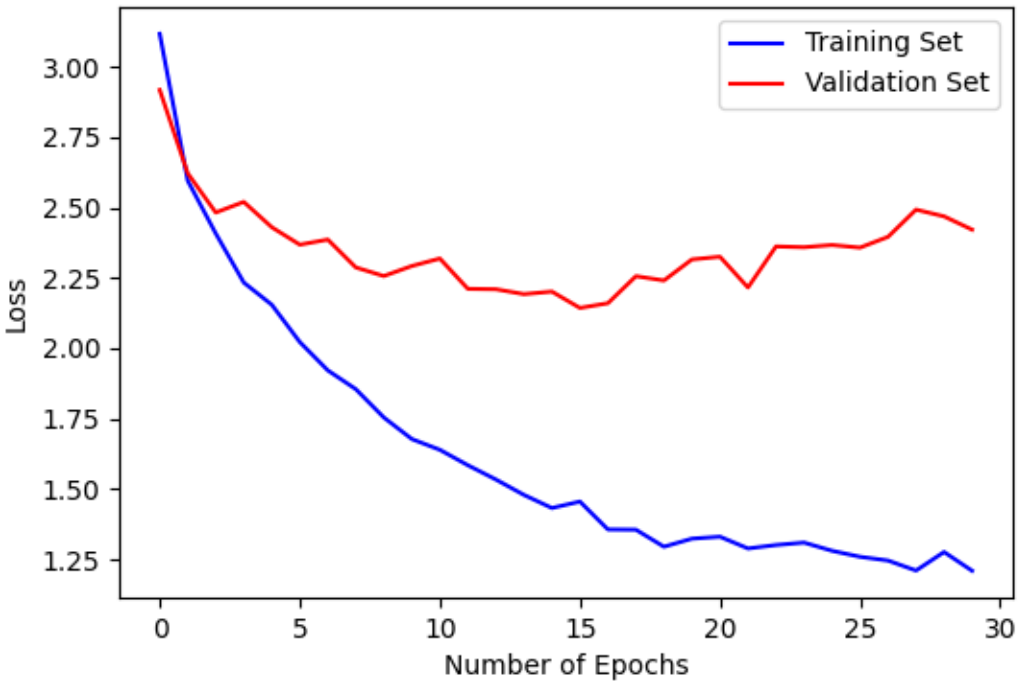

**Learning rate: 1e-3, Test accuracy: 70.0% (best)**



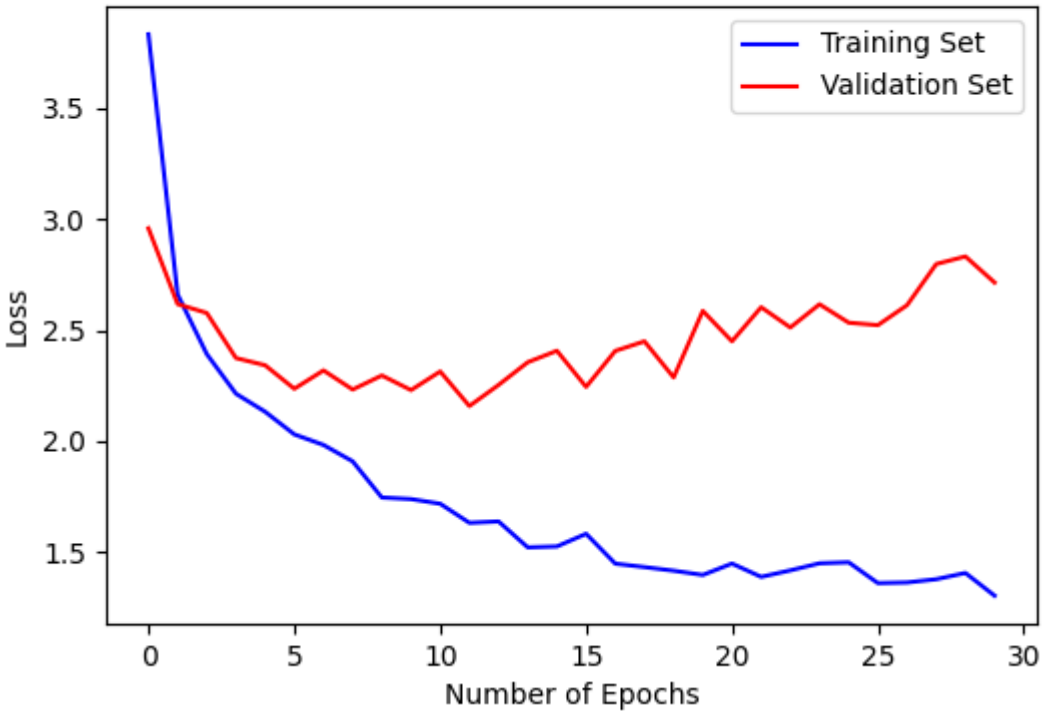

Learning rate: 5e-5, Test accuracy: 58.0%



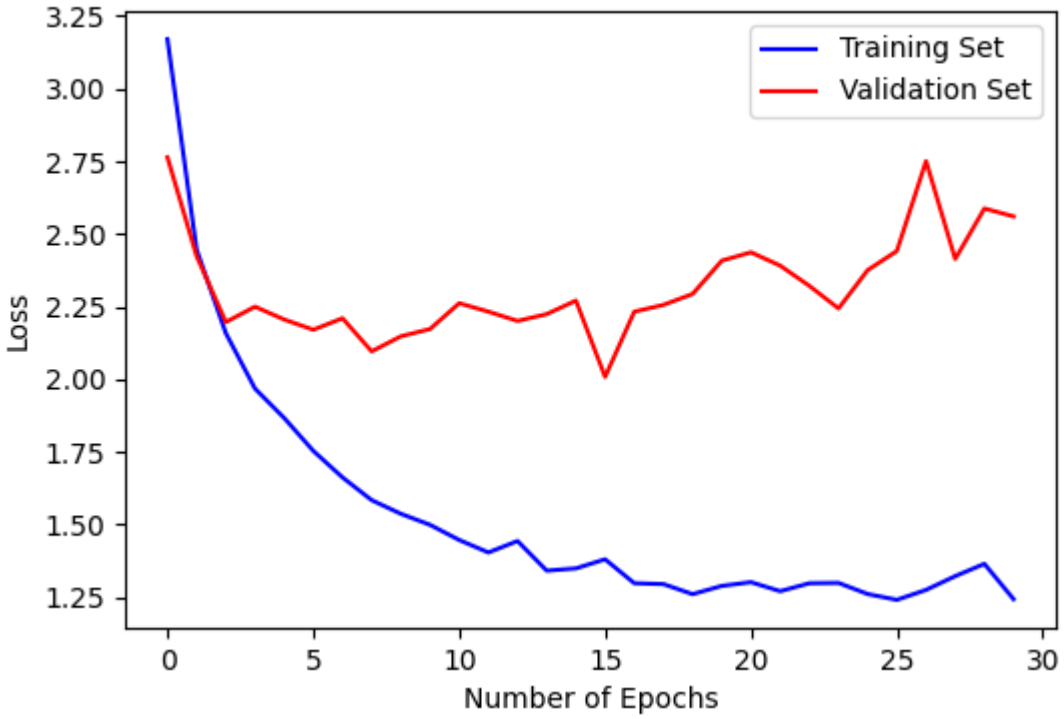

Learning rate: 4e-3, Test accuracy: 68%




Learning rate: 7e-5, Test accuracy: 66.0%



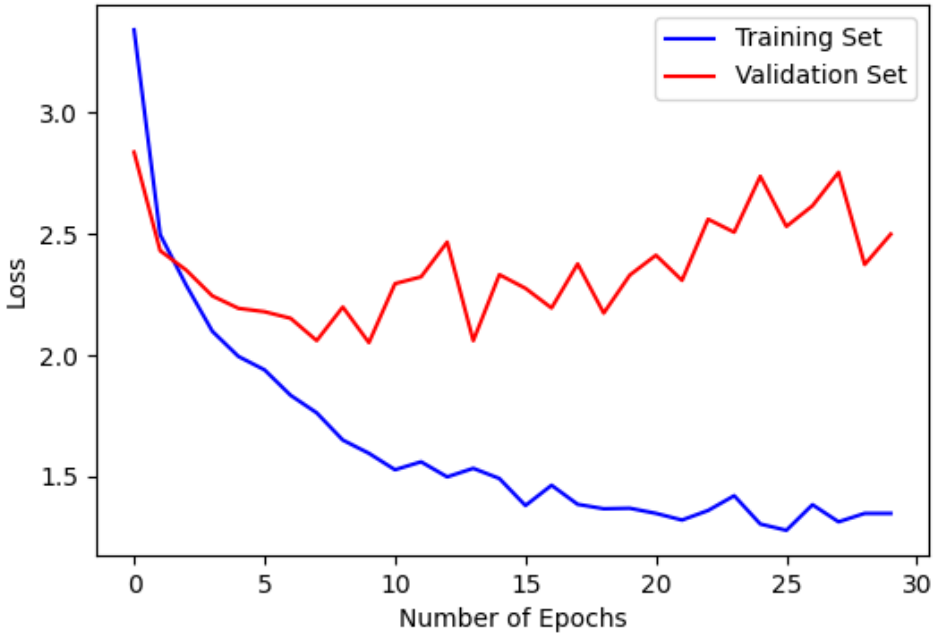

Learning rate: 2e-3, Test accuracy: 68.0%



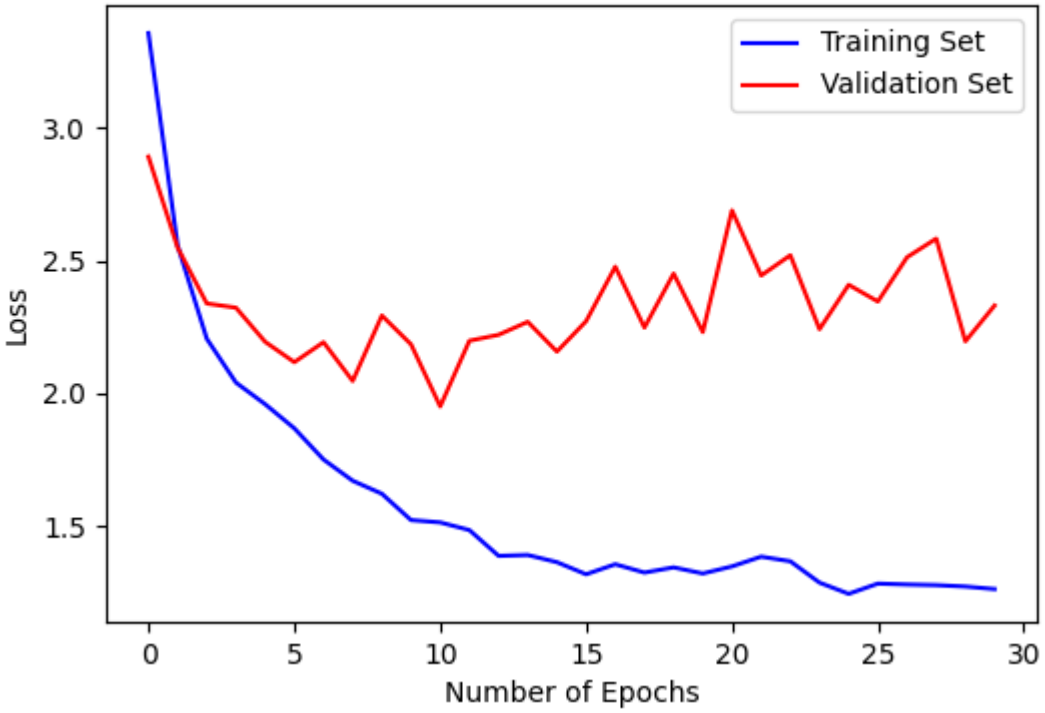

Learning rate: 5e-4, Test accuracy: 67.0%

## Q4.3

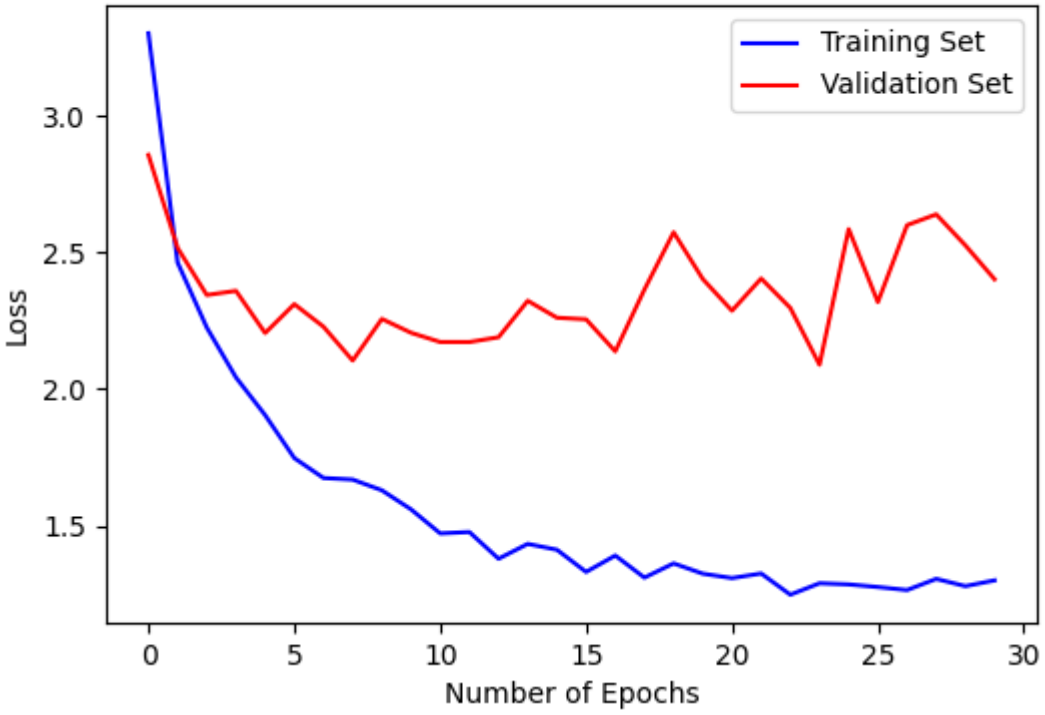
The following are the sets of error graphs, the batch sizes, and the corresponding classification accuracy. Very similar to the learning rate, an optimal batch size was also found for the given hyperparameters. This batch size was found to be 64. The tested sizes larger and smaller than this size both yielded marginally worse test accuracies. Although size 64 was found to be optimal, this did not significantly impact the accuracy.




Batch size: 16, Test accuracy: 67.0%



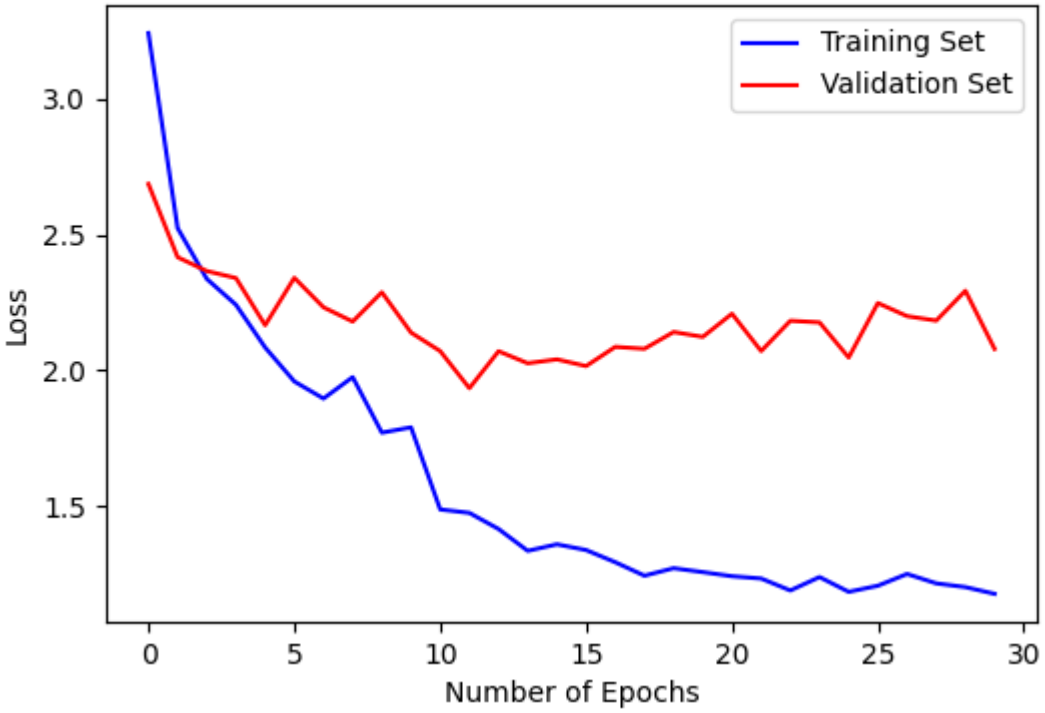

**Batch size: 64, Test accuracy: 69.0% (best)**




Batch size: 128, Test accuracy: 67.0%

## Q4.4

The following plot demonstrates the highest classification accuracy achieved. For this model, there was 1 dropout layer added after the last convolution layer, the batch size was 16, the optimizer used was Adam, and the learning rate was initially set to 1e-3, but was reduced by a factor of 0.2 at both the 10 and 20 epoch milestones. This resulted in a test accuracy of 77.0%.




Test accuracy: 77.0%