Requirement 13 Report - Behavioral Cloning Hyperparameters

Overview:

In order to optimize the hyper parameters for the behavioral cloning model, I first identified the parameters we should optimize and settled on the batch size, the learning rate, and the number of epochs we train on. I then did some initial research for what ranges would be reasonable for each parameter and settled on 2 to 1024 for batch size, $1x10^{-5}$ to 1 for the learning rate, and 1 to 12 for epochs (this was mainly constrained by training time). I used the Optuna Python package to explore the search space for the best parameters using the loss value as the measure of accuracy or objective value. After some initial testing with n = 10 trials, I narrowed down the parameters a bit more, and ran Optuna for 90 trials using 8 to 128 for batch size, $1x10^{-5}$ to $1x10^{-1}$ for the learning rate, and 1 to 12 for the number of epochs.

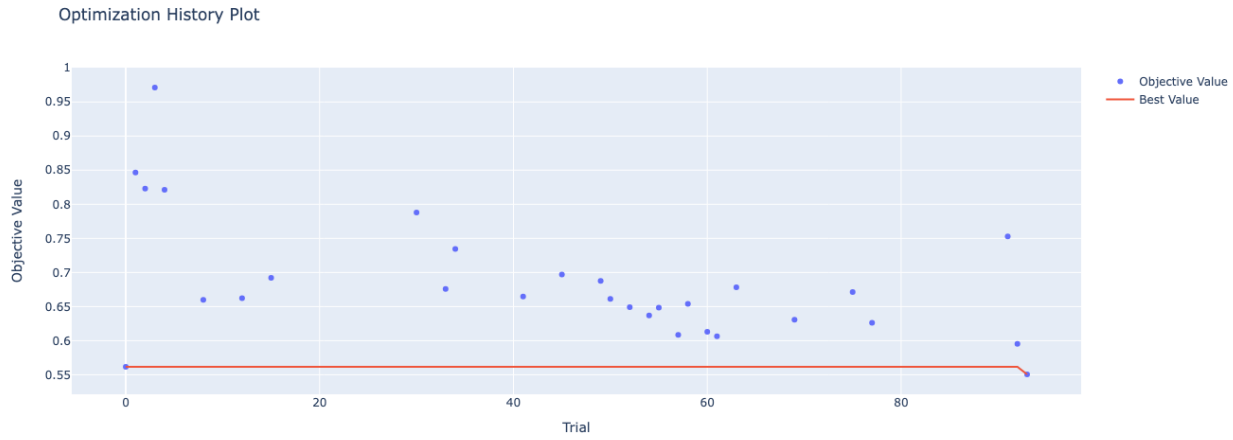

Figure 1. Optimization history plot

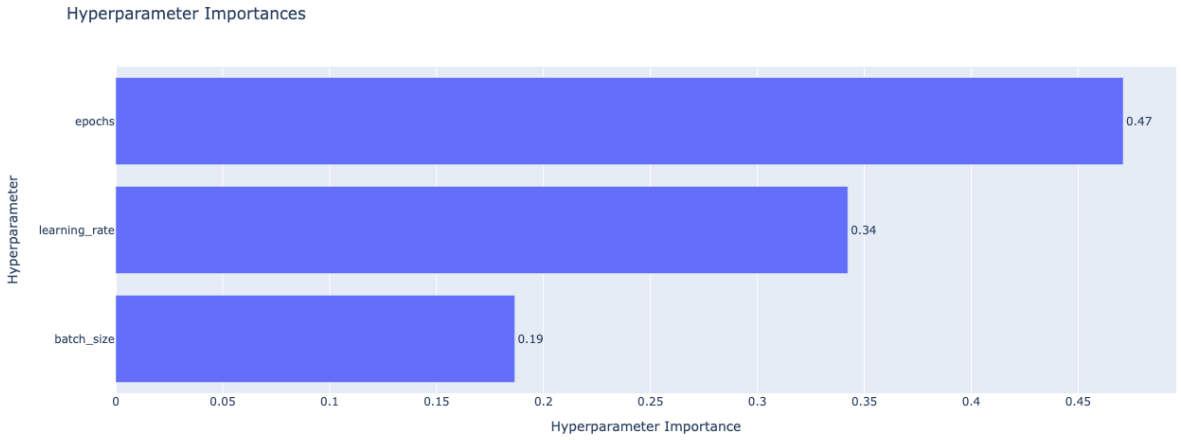

Figure 2. Hyperparameter importance

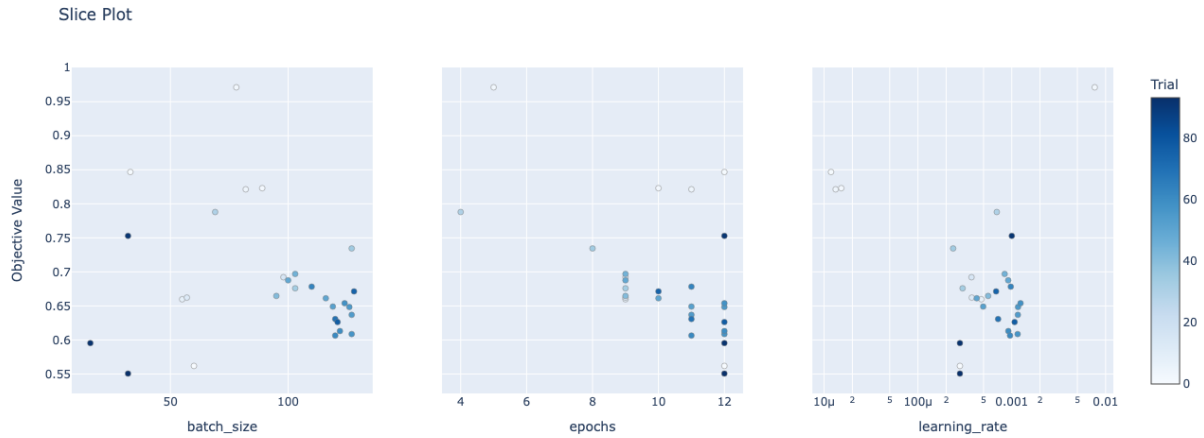

Figure 3. Hyperparameter optimization slice plot

Results:

After many trials as shown in figure 1, Optuna's progress was stalling and failed to find a better combination than the lucky guess from testing, which I manually enqueued as the first trial. I realized Optuna was limiting the search to high batch sizes because the higher batch sizes start off with lower loss values although they end up being outperformed by lower batch sizes if allowed to complete; however, these trials were getting pruned early on. Since there is no easy way to overcome this after days of optimization and conducting a random search is not possible due to its cost, I simply took the optimal epochs and learning rate from the best trials found with Optuna, and tested them with a few different batch sizes. In the end, the best parameters I found were: **{'learning_rate': 0.00028, 'epochs': 12, 'batch_size': 32}**, with a loss value of 0.55. This is an improvement of about 50% over the default values provided by the MineRL team. Since pretty much all the best trials were with 12 epochs, better performance would probably come from more epochs; however, 12 is about the maximum feasible for optimizing given it takes around an hour to train with the free Colab tier. In the event we need to improve the performance of behavioral cloning, I would customize the pruning function to avoid the bias towards high batch sizes.