Parallelization of Automatic Tuning by Executing Machine Learning Programs in Multiple Jobs

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1. INTRODUCTION

We are working on research to optimize hyperparameters by automatic tuning [1]. The machine learning program to be tuned takes several hours for one training, and it takes an enormous number of days for tuning. The purpose of this study is to parallelize the actual measurements required for automatic tuning and reduce the execution time.

2. Automatic tuning method

2.1 The Iterative one-dimensional search

We have proposed a method called iterative one-dimensional search. In the parameter space which consists of n kinds of parameters, the followings are repeated. First is the direction search to find the points around a certain point. Second is the one-dimensional search to find the optimal point in the one-dimensional direction line. The number of search patterns in the entire parameter space is enormous. Therefore, start with narrow search direction and add the search direction sequentially.

2.2 Parallelization method

Hyperparameter estimation of a machine learning program takes a long time to do training, such as 35 days. Therefore, the execution time is reduced by parallelizing the actual measurement of the direction search and the one-dimensional search. We use “Flow” Type II subsystem, which is a supercomputer of Nagoya University, for execution environment.

3. Program to be evaluated

The program targeted for automatic tuning is a pedestrian route prediction application using machine learning [2]. This application predicts the future route and arrival point of the pedestrian from the past movement trajectory data of the target person. For evaluation, we used FDE (Final Displacement Error) which is the error between the actual pedestrian's arrival point and the estimated arrival point. The smaller the FDE, the better the accuracy.

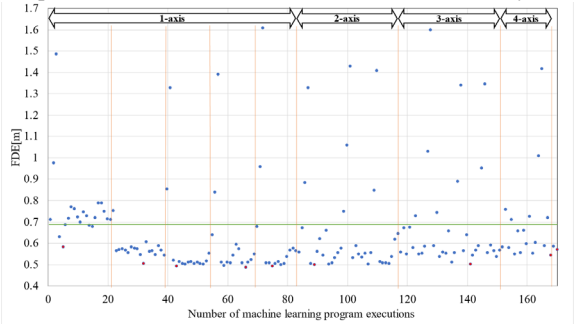

Figure 1. Transition of search during parallel execution

4. Hyperparameter estimation result

4.1 Issue setting

We conducted an experiment and analyzed using the data of "bookstore". This data requires about 5.5 hours for one training. There are 5 types of hyperparameters to be tuned in total, and 5 patterns of possible values are set for each. Therefore, the combination of hyperparameters is 3125 patterns in total.

4.2 Estimated result

170 trainings were performed, and the execution time was 2.4 days. The estimated execution time for sequential execution is 35 days. Execution time is reduced to 1/14 by parallelization.

Figure 1 shows the transition of the search during parallel execution. In the figure, each blue dot is the FDE obtained as a result of executing the machine learning program. The area between the orange vertical lines is the range of simultaneous executions in parallel. The red dot is a point that becomes the smallest FDE found in that range. The notations for 1 to 4-axes are the number of axes used for search. The green line is the FDE value of the parameters at the start of search. It can be seen that 75% of the points searched this time have better FDE than green line.

5. Conclusion

In this research, an automatic tuning mechanism was made possible to measure in parallel by submitting multiple jobs at the same time. The conclusions of this report are that the time required for hyperparameter estimation of the target machine learning program was reduced from 35 days to 2.4 days by parallelization.

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REFERENCES

[1] M. Mochizuki, A. Fujii, T. Tanaka, T. Katagiri, Fast Multidimensional Performance Parameter Estimation with Multiple One-dimensional d-Spline Parameter Search, International Workshop on Automatic Performance Tuning (iWAPT2017), (2017).

[2] R Akabane, Y Kato, Pedestrian Trajectory Prediction Based on Transfer Learning for Human-Following Mobile Robots, IEEE ACCESS, Vol.9, pp.126172-126185 (2021).