

MERIT Internship (Domestic) Report

Graduate School of Science, Department of Physics, Oka Laboratory

Doctoral Program, 1st Year MERIT 12th

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Internship Overview

- Implementation Period:
November 4, 2024 - December 6, 2024
- Host Organization:
Murata Manufacturing Co., Ltd. Minatomirai Innovation Center
- Theme:
Optimization of Scheduling Using Reinforcement Learning

Background

Production scheduling in factories is a problem that needs to be solved for efficient machine operation, and it is also known as an NP-hard problem. Schedules must be created under various constraints, which can be too complex for humans to solve manually. While optimal solvers can find optimal solutions, setting detailed conditions and accurately formulating problems is not easy.

On the other hand, reinforcement learning offers a method for solving optimization problems. In reinforcement learning, an agent observes the state of its environment and takes actions based on these observations. As a result of its actions, new states are obtained, and rewards (either positive or negative) are received based on these states. By repeatedly performing the same process, the agent learns to take actions that maximize rewards. Recent advancements in deep learning and parallel processing technology have made efficient learning through reinforcement learning possible.

During this internship, I tackled actual production scheduling problems that needed to be addressed at Murata Manufacturing using a reinforcement learning approach. I evaluated whether this approach was more effective compared to traditional optimization methods.

Content

The specific details are omitted, but the content of this internship is presented in order.

Week 1:

I reproduced prior research [1]. I learned how to use OpenAI Gym, which provides the environment necessary for reinforcement learning, and conducted a tutorial-like reinforcement learning session.

Week 2:

Using the OpenAI Gym framework, I created an environment for the production scheduling problem.

Week 3:

I developed code that added detailed constraints such as leveling. Additionally, I visited the headquarters in Nagaokakyo City, Kyoto Prefecture, and the Yasu plant in Yasu City, Shiga Prefecture.

Weeks 4 and 5:

I conducted reinforcement learning using actual data and achieved certain results. While some optimization could be achieved to a certain extent, it became clear that it is difficult to satisfy all conditions when considering detailed constraints.

[1] P. Tassel, M. Gebser and K. Schekotihin, “A Reinforcement Learning Environment For Job-Shop Scheduling,” arXiv:2104.03760

Impressions

During this internship, I worked in a field that is entirely different from what I usually research. Personally, my theme was to determine whether my mathematical skills could be useful in a corporate setting as I consider my future career. As a conclusion, from this one-month experience, I felt that these skills can indeed be somewhat beneficial in a corporate environment.

The department at Murata Manufacturing's Minatomirai Innovation Center that hosted me had many members with graduate degrees and several PhD holders. Therefore, I felt that the office environment was quite similar to a university research lab. Additionally, I had opportunities to learn about various business-related activities and gained insight into research and development in an actual company.

Wednesdays were designated as no-overtime days, and it seemed there was an emphasis on not working overtime (although this did not apply directly to interns). On Wednesdays and Fridays, I was often invited to social gatherings such as dinners or board game sessions after work. There was a clear distinction between work and personal time; people did not stay late at the office or work on weekends. Thanks to such practices, I could focus on advancing my tasks during working hours on

weekdays. This experience made me want to maintain a balanced lifestyle even in my graduate research activities.

Acknowledgments

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