Emro Science and Education
International open-access scientific journal
Journal homepage: https://journal.emro.uz

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CONFERENCE PAPER OPEN ACCESS

Vol. 1 No. 1 (2023) · "Axborot oqimlari va intellektual tizimlarning ijtimoiy, iqtisodiy va texnik-texnol... DOI: 10.5281/zenodo.24318074

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INTRODUCTION OF AI EDUCATION PROGRAM AT NIT GIFU COLLEGE

Koji Tajima, PhD of Engineering, Associate Professor

The National Institute of Technology, Gifu College, Gifu, Japan

Abstract

This paper describes a Problem-based learning class conducted at the Department of Electrical and Computer Engineering, NIT Gifu College. This class is for the fifth grade, and the task is to develop AI for computer games. The games will be different each ear, but we select either original games or existing analog games. In the class, the faculty members created a server program to manage the game. The student develops a client program that communicates with the server program. There are five laboratories specializing in information engineering at our college. This class holds contest-style competitions among the five laboratories to evaluate the quality of their programs. This class will begin in April and the competition will be held twice, once in June and once in September. The international students who are on short-term study programs at the college participate in the competition. The evaluation of this class will not be based on wins or losses, but rather on planning and improvement, which will be done by the laboratory supervisor using a design ability evaluation chart. The results of this class are sometimes used for graduation research, and students have presented their AI analysis at conferences.

1. Introduction

The rapid development of computer networks and AI technologies continues, and there is an urgent need to train engineers with knowledge of AI development and use. The various AI education programs are done in the technical colleges in Japan. The technical colleges are called KOSEN or National Institute of Technology in Japan. The education program of KOSEN is five-year period for students who have graduated from junior high school. Unlike high schools, the KOSEN are specialized institutions that educates engineers with basic knowledge at the university level and practical engineering skills. This system has a learning system like polytechnics in Europe.

There are 51 campuses of KOSEN colleges throughout Japan, and while they share a core curriculum to be teaching, each has its own unique curriculum. The faculty members of technical colleges are experts in their research fields with PhD degrees, and, as in universities, students are required to conduct graduate research and to present their research at academic conferences.

The NIT, Gifu College has five departments: Mechanical Engineering, Electrical and Computer Engineering, Electronic Control Engineering, Civil Engineering, and Architecture.

Published: 10.11.2023

Cite this article: Koji Tajima (2023). Introduction of AI education program at NIT Gifu College. Emro Science and Education, 1(1). https://doi.org/10.5281/zenodo.24318074

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This paper describes the details of a problem-based learning class for game AI development. It’s done on the Department of Electrical and Computer Engineering. The Department of Electrical and Computer Engineering focuses on training AI engineers who can solve problems, and offers unique content such as data analysis, engineering design, and problem-based learning classes [1,2].

2. Proposed Method

The class for game AI development is held in the first semester of the fifth grade. The fifth-grade students have basic knowledge includes the C, Java, Python programming, data structures and algorithms, computer networks, and databases. All of topics already studied through the fourth grade.

The development of the game AI will use an electronic version of the original board game. In this paper we introduce the original board game "The Laboratory" used in 2018-2021. In 2022 and 2023, we also use with digitizing existing board games. But we are detailed analysis of these is in progress, so this reason, this paper summarizes the results of the analyzation completed.

"The Laboratory" is a worker placement board game. This genre of game is also known as action selecting. The following four points were important in the development of this board game.

1. It must be designed for two players to easily run inter-laboratory contests.
2. The randomness and noise are not a factor in determining the winners.
3. No special theme. (e.g., medical, agricultural, brewing, etc.)
4. No advantage or disadvantage depending on the turn order.

We select the graduation research for the game theme because this PBL class is done at the same time which the students begin their graduation research.

Figure 1 shows the main board of this board game. In this game, players carry out an action by placing a piece on the orange squares. In research, the most important thing is to produce research results. It’s necessity to do the discussions by the seminar and basic experiments. The research results will also be obtained by presenting at conferences and writing papers. To carry out these actions, the player has to collect the money. The player can receive some money if achievements meet specific goals or to share research results with companies.

In addition, to provide a sense of strategy, before the game begins, the player selects a character with unique abilities, such as an engineer, leader, or manager. Depending on the character selection, it is necessary to consider in which order to carry out the actions, to carry out the actions that best suit own strengths or interfere with actions that best suit the opponent's strengths.

To develop a program, it is necessary to learn the communication protocol. The original HTTP-like communication protocol is used for communication on the

boardgame. The student needs to develop a program to successfully communicate with the server.

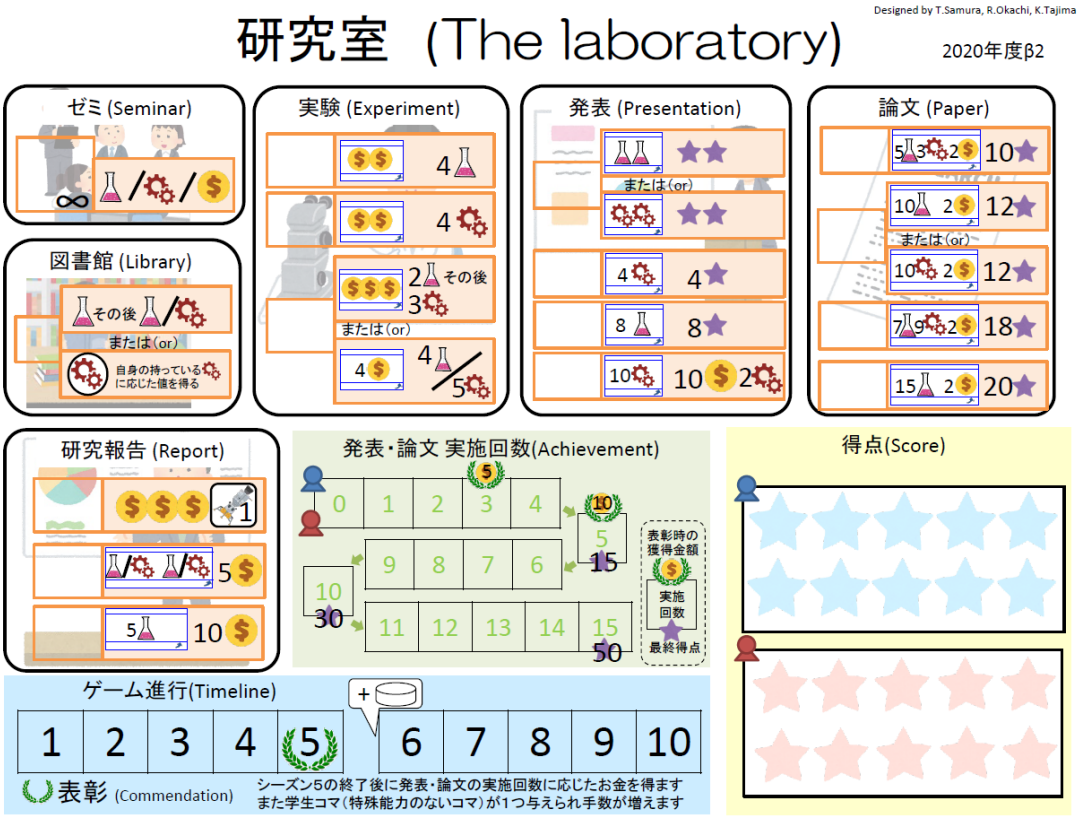


Figure 1. The Main Board of Developed Board Game

Although policies for developing AI differ from laboratory to laboratory, we generally advise that development should be carried out in the following three phases.

The first step is to understand the game and the communication protocols. In this step, the students create a program that does not consider the advantage or disadvantage of the choice of action. It is randomly AI, and it focus on the game runs until the end. For the verification, we provide a program that is randomly selected for actions. The student's goal is to create a program that performs the same operation as this program.

The second step is to consider the strategy and build it into the action selection algorithm. This game is extremely low scoring if the actions are carried out randomly, and even more so if the actions are carried out according to the steps, even if they are simple. The students have until June to create a program that will beat any provided program.

The final step is to build AI using the training data. The students must improve the selectivity of AIs by playing against other AIs created by themselves or against random AIs. The minimax method, neural networks, and Q-learning are often used to select actions, but each laboratory is different.

3. Results

As an example of the 2021 results, we show the analysis of the results of three AI matches conducted by the students [3]. This experiment compared the three AIs in

Table 1. Average score based on interplay between AIs.

Type	Detail of AI	Average score
AI 1	MiniMax (LE) self-learning	122
	MiniMax (LE) Learning against AI 2	127
	MiniMax (LE) Learning against A1 3	129
A1 2	Neural Networks with character E&L	104
	Neural Networks with character H&L	58
	Neural Networks with character E&M	74
	Neural Networks with character E&R	94
	Neural Networks with character G&R	50
AI 3	Heuristic Algorithms with character E&L	84
	Heuristic Algorithms with character H&R	86

compatibility and strength. The AI1 is an algorithm using only minimax, where the evaluation factor is a fixed expression using the sum of money and research results. The learning parameters are the coefficients of each element. AI2 is based on a neural network. It has a three-layer structure, with 66 board situations in the input layer, 32 intermediate layers, and 78 combinations of each action and character in the output layer, which are learned by varying the combined load. Both AI1 and AI2 use genetic algorithms to train. The learning was considered complete after several hundred generations of elite selection. AI3 is a heuristic algorithm, which does not learn, but makes fixed human-considered actions.

We played each AI against each other and obtained the average score. The results are summarized in Table 1. This experiment showed that minimax's algorithm was better and that some of the character combinations were stronger than others.

As an additional experiment, we randomized the character selection and summarized which character the AI selected. The results are shown in Figure 2. It shows that after the 50th generation, there is a significant difference in the selection rate. We were also able to analyze the differences in the strength of the characters in practice, although we considered that they should be as similar as possible during production.

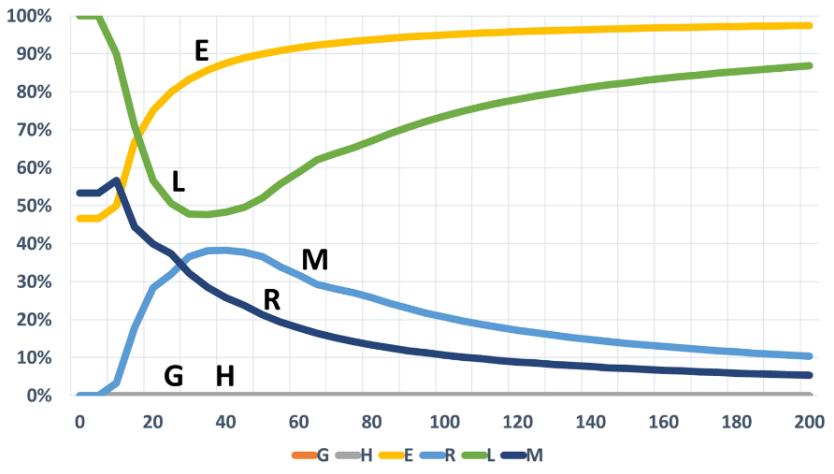


Figure 2 Changes in the selection rate of characters chosen by the AI.

4. Conclusions

This paper describes the problem-based learning classes conducted in NIT, Gifu College for AI education. By using games familiar to students as teaching materials, not only can they actively and spontaneously develop AI, but they can also empirically understand how machines learn by playing against the AI they have developed themselves. In addition, because this learning method is done in groups, the students were able to learn how to assign roles and manage a team.

This experiment is still ongoing, and this ear it is being conducted with the card-based game of fencing. We expect that students will continue to develop their problem-solving skills and AI knowledge through the creation of these game AI.

Acknowledged

I would like to thank Prof. Umida Ashurova of Kinjo Gakuin University for giving me the opportunity to present this paper.

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