Framework-based Roguelike Game for AI/ML Education

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INTRODUCTION

Artificial intelligence (AI) and machine learning (ML) education have become popular, and several AI and ML education games have been developed. However, most games focus on coding rather than AI/ML concepts and have not been widely used or evaluated (Alam. 2022). Therefore, we propose a "Roguelike Game for AI and ML Education" (RGAME) to overcome these problems. RGAME is being developed on the basis of motivational and educational design frameworks. Users can learn ML workflow (data collection, preprocessing, training, and evaluation) through RGAME. We then introduce a method for measuring motivational and learning effects. This study focuses on K–12 education in Japan.

BACKGROUND

Learning must be motivated to provide beneficial education. According to the self-determination theory, three psychological needs should be met for the growth and well-being of people's personalities and cognitive structure: the need for competence, the need for autonomy, and the need for relatedness (Ryan and Deci. 2000). Six game-design elements produce these psychological effects: points, badges, leaderboards, performance graphs, meaningful stories, and teammates (Sailer et al. 2016). In addition, there are 14 motivators associated with educational games (Laine et al. 2020). Therefore, we have been developing RGAME using these elements to increase motivation.

To effectively interact with and critically evaluate AI, users need to gain 17 competencies. In addition, there are 15 design considerations to promote understanding of AI (Long and Magerko. 2020). RGAME is being developed on the basis of these considerations, and the learning goal is to acquire some of these competencies.

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PROPOSED GAME

Puzzle games are considered efficient for AI education (Eaton et al. 2018). However, once users have solved a puzzle, they tend to lose interest in playing the game again (Saito et al. 2021). In contrast to puzzle games, roguelike games feature a randomized environment and permanent death. Therefore, we propose a roguelike game that allows for iterative learning (Figure 1).

Figure 1: Battle scene in RGAME ("The attack power has been changed. Current attack power: 62. Data acquisition successful.")

ML models used in RGAME are Linear Support Vector Clustering (linear SVC), k Nearest Neighbor (KNN), SVC, and XGBoost based on the scikit-learn Python library; the target is Japanese K–12 students. The game flow diagram is shown in Figure 2.

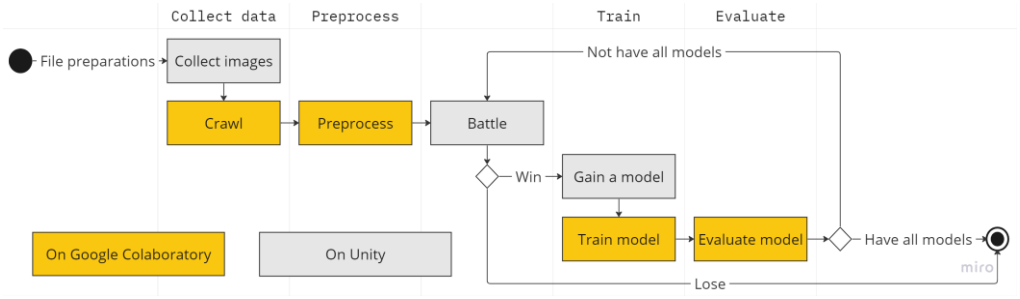

Figure 2: Game flow of RGAME.

Motivational Design Considerations

RGAME includes several game elements and motivators described in the Background section.

The game story is that the player gains four ML models and a badge for each by defeating enemies that appear. The accuracy of the acquired ML models against the

test data will be the player's attack power. Users can check the accuracy using performance graphs, which means they can obtain feedback regularly.

The motivators affected by the aforementioned game elements and the resulting psychological effects are presented in Table 1.

Game element	Motivators	Psychological need
Points	Challenge, Competence, Feedback (granular), Immersion	Need for competence
Badges	Challenge, Competence, Feedback (cumulative), Immersion	Need for competence
Performance graphs	Challenge, Competence, Competition, Feedback (sustained), Immersion	Need for competence
Meaningful stories	Challenge, Curiosity, Fantasy, Immersion	Need for autonomy

Table 1: Game elements in RGAME and their psychological effects.

Educational Design Considerations

Through RGAME, users can learn ML workflow (data collection, preprocessing, training, and evaluation) on the basis of AI education design considerations described in the Background section.

To achieve the considerations, we use Google Colaboratory and a roguelike game. Table 2 shows what learners can do with them and what AI education design considerations are met by them.

For example, the use of games lowers the learning barriers to entry into AI education. For code execution, users are required to simply copy and paste code into Google Colaboratory. By running the code, users can find that accuracy will only be achieved through the use of appropriate ML models, data, and parameters.

Tool	Action	AI education design consideration
Google Colaboratory	Run code	Embodied interactions Contextualizing data Promote transparency Critical thinking New perspectives
	Copy and paste code	Unveil gradually Opportunities to program
	Read graph	Explainability
Roguelike game	Play game	Milestones Leverage learners' interests Low barrier to entry

Table 2: Tools and corresponding AI education design considerations.

METHODOLOGY

The research questions (RQs) are as follows.

- RQ1. Can RGAME motivate learning as a serious game?
- RQ2. Is RGAME effective for learning as an AI learning tool?

To answer these RQs, we plan to conduct a comparison experiment between a version with game elements (FUL) and an e-learning version without game elements (ELE) using the experiments of "Arctic Economy" (Wittrin et al. 2023) as a reference. The study will be conducted according to the flow chart in Figure 3.

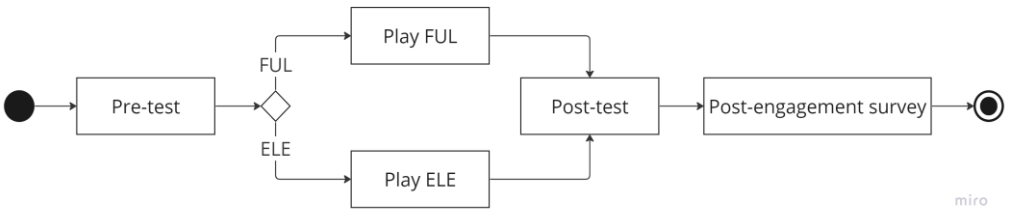

Figure 3: Experiment flow.

Data Collection

Data for the tests and the survey will be collected online using Google Forms for K–12—specifically, Japanese middle and high school students (ages 13–18).

We intend to create the tests on the basis of Five Big Ideas (Touretzky et al. 2019) to measure how much FUL improves AI competencies compared with ELE.

The survey measures individual internal learning conditions after the study subjects have used FUL or ELE. On the basis of the Serious Games Evaluation Scale (Fokides et al. 2019), we will develop questions to measure the effects of five categories: learning success, interest, motivation, attention, and associations. In addition, to assess in detail the extent to which "motivation" has improved, we will create questions based on the Ubisoft Perceived Experience Questionnaire (Azadvar and Canossa. 2018), which measures three basic psychological and intrinsic needs within self-determination theory.

CONCLUSION

We proposed RGAME, which is being developed using designs for both serious games and AI education. We will conduct tests and a survey to answer the RQs. We expect them to yield positive results and demonstrate the benefit of RGAME to AI/ML education.

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