A Learning Path Recommendation System for English Grammar Quiz Using Knowledge Map

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Abstract: Learning path recommendation systems assist learners in learning in an optimal sequence of knowledge items. Conventional systems do not take into account the knowledge that the learner has already acquired, and thus knowledge that has already been acquired may be included in the recommended learning path. Therefore, in this paper, we focus on English grammar and propose a system that recommends learning paths based on the learning history, excluding already acquired knowledge.

Keywords: English as a foreign language, Learning path, Knowledge Map, E-learning Recommender

1.   Introduction

Systems that provide learning paths, in which learning materials are arranged so that learners can efficiently acquire multiple pieces of knowledge, have been previously studied (Shi et al. 2020; Zheng et al. 2013). Conventional learning path systems have the problem that the learning paths provided may include knowledge that has already been acquired.
In this study, we propose a learning path recommendation system that uses a graph structure called a "knowledge map" and learning history to recommend learning paths for English grammar knowledge that has not yet been learned. A knowledge map consists of nodes describing concepts or items and links describing relationships between nodes (Shishehchi et al., 2011; Lee and Segev, 2012). The proposed system recommends learning paths based on the English grammar knowledge map created based on the CEFR-J Grammar Profile, a measure of English learning achievement for Japanese learners developed by Tono et al. (2016) and the level of proficiency of each grammar based on the answer history of quizzes answered on the existing e-book reading system BookRoll (Ogata et al. 2015).

2.   Related Research

2.1   Learning Path Recommendation Systems Using Knowledge Maps

Many previous studies have developed learning path recommendation systems, some of which use knowledge maps. However, few of them take into account whether the learner has already acquired the knowledge. The system proposed in this study recommends learning paths that take into account already acquired grammar knowledge.

2.2   Picture-book Recommendation Systems Using Vocabulary Knowledge Maps

The English Picture-book Recommender System (Takii, Flanagan, and Ogata, 2021) recommends picture books containing words that have not been learned yet that are related to previously learned words based on reading history and vocabulary knowledge maps (Flanagan et al., 2019). The system takes into account the relevance and proficiency of knowledge. The system proposed in this paper further takes into account the knowledge learning order.

3.   Overview of the recommendation system

3.1   CEFR-J Grammar Profile

CEFR-J (Ishii and Tono, 2016) is an English proficiency framework developed by Tono et al. by applying the Common European Framework of Reference for Languages (CEFR) to Japan. The CEFR-J Grammar Profile is a classification of English grammar according to the CEFR-J levels, and covers the major grammar studied in junior and senior high school. Each grammar has a regular expression, by which we can extract it from given English sentences. In this study, we use this method to link each quiz with grammar knowledge items.

3.2   Generating English Grammar Knowledge Maps

The English Grammar Knowledge Map used in this study is generated by the following method.
1.   Each item in the CEFR-J Grammar Profile is considered as a node, and the similarity between regular expression strings is calculated for each combination of two nodes. Weighted links are generated using the similarity as weights, and an undirected graph is obtained.
2.   Based on the learning order of each English grammar in junior high and high schools, the graph obtained in step 1 is transformed into a directed graph with links starting with the grammar learned first and ending with the grammar learned later.
3.   A maximum directed global tree is obtained by performing branch pruning on the graph obtained in step 2 using the minimum spanning tree algorithm.

3.3   System Configuration

Figure 1 shows an overview of the proposed quiz recommendation system. The knowledge map and links between quizzes and grammars are stored in a database. When learners answer quizzes on BookRoll, the answer logs are stored in the LRS after processing. These logs are used for quiz recommendation along with the information stored in the user's knowledge state store and the knowledge dependencies of the knowledge map.
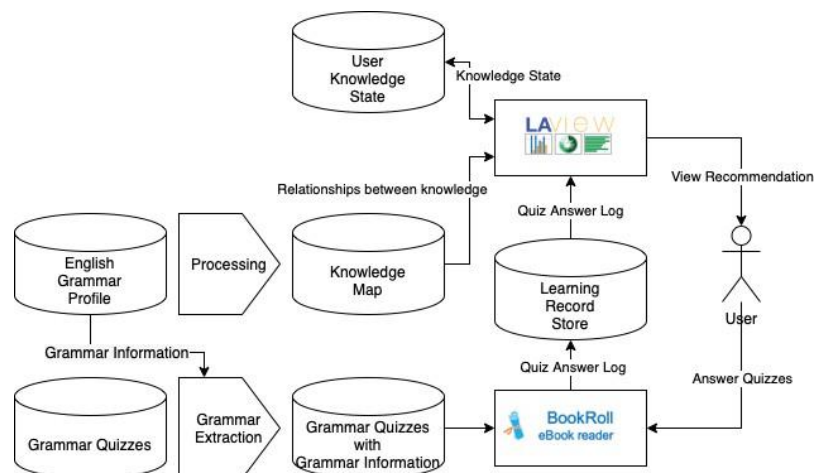

Figure 1. Structure of the English quiz recommendation system

3.4   Learning Path Recommendation Mechanism

The system generates a learning path as follows.
1.   Obtain the grammar contained in quizzes that the learner has answered incorrectly in the past from the LRS.
2.   Based on the knowledge map, search for some knowledge that should be acquired before mastering the knowledge obtained in step 1. At this time, only the knowledge that is yet to be acquired is selected with reference to the proficiency.

The system gives the quizzes corresponding to the knowledge in the learning pathway obtained in the above procedure a priority as follows, and encourages students to answer the quizzes starting with the quiz according to these priorities.

- If a quiz corresponds to one knowledge of a learning pathway, it is given the same priority as that knowledge.
- If a quiz corresponds to more than one piece of knowledge in a learning pathway, it is given the same priority as the knowledge to be learned later.

4. Conclusion and Future Work

In this paper, we proposed a quiz recommendation system for efficient English language learning in an optimal sequence. The system uses the English grammar knowledge map and the learner's proficiency level to sequence and recommend quizzes for learning based on knowledge that has yet to be learned. Compared to conventional systems, this system is expected to provide more efficient support by taking into account not only the learning order but also the learner's knowledge proficiency. We plan to conduct experiments with Japanese high school students to verify the effectiveness of the system.

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