A System that Generates Word Problems Using Problem Generation Episodes

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1. Introduction

In mathematical learning, it is important to give learners a number of problems that have various features in both of surface problem situations and deep mathematical structures. In the research of educational systems, the focus is on the development of frameworks and mechanisms to support learning, but the production of learning data is also crucial. In this study, we implement a system that generates various word problems by using problem-generation episodes, which is regarded as a past case of problem generation. Our system generates various problems by applying the problem-generation episodes to initial problems stored in the system. In the problem generation, our system interacts with a teacher as a user to acquires common knowledge. And we perform experimental evaluation to verify whether our system can appropriately expand the variety of problems.

2. Problem generation by using problem generation episodes

Each problem generation episode is knowledge comprised of a single base example problem (*base*) and a single new analogical instance (*new instance*), which is regarded as a past case where a *new instance* was generated from a *base*. A relationship between a *base* and a *new instance* is used to generate new problems. In problem generation, a new output problem (*output*) is generated from given *input* example problem (input) by mapping a relationship between a *base* and a *new instance* in an episode.

Figure 1 shows the basic idea of problem generation using an episode. In Figure 1, the horizontal axis represents the features in solutions of problems and the vertical axis represents the features in problem texts. Suppose that an episode is formed, comprised of a problem that has Solution 1 and Problem Text 1 as a *base* and another problem that has Solution 2 and Problem Text 1 as a *new instance*. When a problem that has Solution 1 and Problem Text 3 is given as *input*, the episode enables the generation of a new problem that has Solution 2 and Problem Text 3 as *output*. With this basic idea, our system increases the number of problems and expands their variety using episodes. Our system expands the variety of problems by applying the problem-generation episodes to initial problems stored in the system.
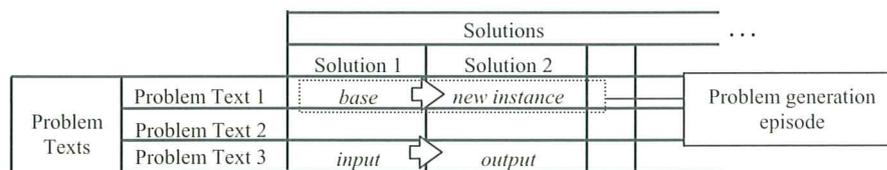

Figure 1. Basic Problem Generation Idea Using an Episode

3. Experimental Evaluation of our System

We conducted experimental evaluation to verify whether our system can appropriately expand the variety of problems. The experiments were performed in three steps: (1) storing initial problem data in our system, (2) having our system generate problem generation episodes and problems automatically, and (3) verifying the problem generation by evaluating appropriateness and the variety of the generated problems. The results of the experiments indicated that our system could generate appropriate problems and successfully expand the variety of problems. And we found that our system needs a knowledgeable teacher as a user to generate problems appropriately.

4. Conclusion

In this study, we implemented a system that generates mathematical word problems by using problem generation episodes. In the generation, our system acquires knowledge through interactions with teachers as users. We performed experimental evaluation and verified that our system can successfully expand the variety of problems.