Learning Assistance Expert System Based on Java Production System with a Self-adaptive Function

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Abstract

This paper proposes a new production system (PS) with a self-adaptive function based on the Java language, in order to realize a knowledge-base (KB) development environment featuring platform independence and no requirement for special software tools. This new PS, called Adaptive Java Production System (A-JPS) in this paper, also features a user profile evaluation mechanism using a Causal network(CN) allowing general DAG structures. By means of experiments using an experimental learning assistance KB based on A-JPS, it is demonstrated that the proposed self-adaptation method is effective.

1. Introduction

For distance learning assistance systems there is a strong requirement for a self-adaptive function allowing flexible changing of the assistance contents according to the user's characteristics of understanding, called the user profile. The authors have proposed a learning assistance expert system for use in various qualification exams[1], featuring an evaluation of the user profile by means of a Causal network (CN)[2].

In a previous paper, a production system with an adaptive function was proposed on the basis of OPS83[3], the rule-based description language for building a production system. However, the use of this language is not necessarily guaranteed on every kind of operating system (it is platform dependent). Therefore this approach imposes some restrictions on the user relating to the necessary software and usable machines. Further in this approach, the structure of the CN used as the user profile evaluator, was limited to a tree structure, while there are some cases in real world applications, in which more general DAG structures should be incorporated.

In this paper, our previous work is extended with a view to establishing of a more practical method. Firstly a new production system is proposed which uses a self-adaptive function using Java, the general purpose programming language with platform independent characteristics, in order to solve the first of the problems described above. Secondly, a more general mechanism allowing arbitrary DAG structures is realized for calculating the user profile in order to solve the latter problem.

2. Experiments on the learning assistance system using A-JPS

(1) New production system with self-adaptive function based on Java

A new production system with a self-adaptation function, called the Adaptive Java Production System (A-JPS), is realized by combination of Java Production System (JPS) and the CN. The structure of A-JPS is shown in Figure 1. Using JPS an action space for a learning assistance knowledge-base (KB) is described, where the behavior of each action node is expressed using a single if-then rule. A reaction space corresponding to the action space is organized as a Causal network allowing arbitrary DAG structures [2]. The behavior of the CN is implemented as an ordinary Java program.

(2) Experimental KB and its corresponding CN

A learning assistance KB with a hierarchical structure was implemented using A-JPS. The contents of the KB were taken from a book of comments and exercises for a qualification examination of the first category information processing engineers of Japan. Although the original contents of the book contain nine chapters, only three of them, Chapters 2, 3 and 4, were used, in order that the time for each user's experiment should be shorter than two hours. Then a CN representing the reaction space was produced by a human expert who is an engineer qualified in this examination. Figure 2 shows the structure of the CN. In Figure 2, chapters other than Chapters 2, 3 and 4, were used only to

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prepare links for the probability propagations between different chapters. The structure of Figure 2 shows a general DAG structure allowing multiple chains between different nodes.

The conditional probabilities between nodes and the degree of difficulty of each question were given by the human expert.

(3) Experimental procedure and results

The flow of the experiments is shown in Figure 3. In the level test of Figure 3 sample questions taken from each chapter are executed to get the initial probability states of the CN (initial user profile). In the level test all the sections are not necessarily selected. In Figure 3 all the questions belonging to the chosen section are executed. Then the results of the executions of the questions are fed back to the CN to update the user profile.

Three people were chosen as users of the experimental KB and experiments were undertaken according to the flow of Figure 3. Figure 4 shows the relationships between the degree of understanding of the various sections and the number of times the assistance paths were executed, for a specific user.

It can be said from Figure 4 that the self-adaptation method, in which the highest priority value was given to the learning of the weakest subject, works appropriately to improve the understanding of the user.

3. Conclusion

A new production system, called A-JPS has been proposed in this paper. It features a user profile evaluation mechanism using a Causal network allowing general DAG structures, as well as platform independence through use of Java. An evaluation of the self-adaptation method was undertaken using an experimental learning assistance KB for the qualification examination of the first category information processing engineers of Japan. It was demonstrated that the self-adaptation method, featuring the selection strategy of determining the most appropriate assistance path, was effective.

References

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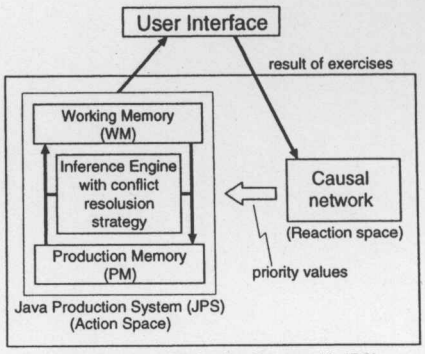

Figure 1. Structure of the Adaptive Java Production System (A-JPS) with self adaptive function

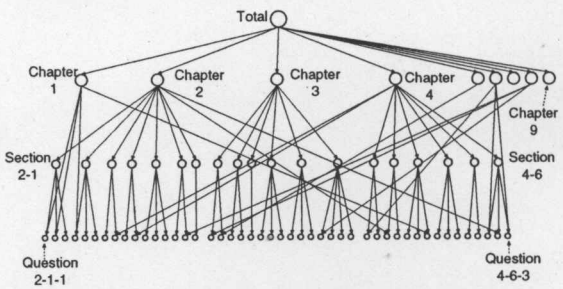

Figure 2. Structure of the CN used in the experiment

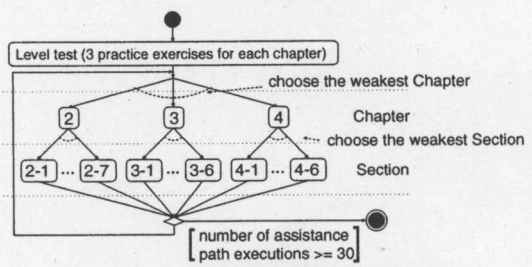

Figure 3. Flow of the experiment

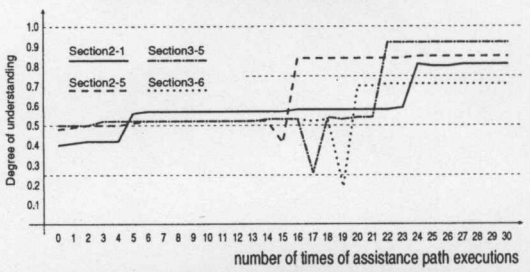

Figure 4. An example of the relationships between the degree of understanding of a section and the number of assistance path executions