A Problem-solving System utilized Human Solving Strategy and Its Design

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Abstract

Many technologies developed in the study of artificial intelligence (AI) are central techniques for the construction of intelligent systems. Especially, " problem-solving " in AI is a study for constructing a system which carries out various tasks (e.g., diagnostics, design, proof corroboration and decision making) instead of human experts. By now, many problem-solving systems based on production rules have been constructed as " expert systems ", and are contributing in many fields.

At present, numerous research projects for new-age problem-solving systems have already been launched in order to realize the high-speed processing and addition of learning functions. The SOAR project is typical of these. However, in most current systems, even the newest hardware won't be able to achieve a remarkable improvement in its problem-solving ability, because they use methods with huge computation costs such as traditional searching methods and retrieval from large-scale databases etc. In the future, with the maturity of social foundations, the size of problems stemming from society will continue to grow. Therefore, it is important to computation costs. Recently, new approaches, such as content-oriented information processing, soft information processing, human-oriented information processing, and so on, have gathered attention as ways to solve an ideas to break many issues (computation cost, etc.) in conventional approaches that depend on the throughput of the computer.

This paper proposes a problem-solving method to effectively utilize the problem-solving knowledge which human beings have. In this point, the standpoint of this research is the same as the above mentioned research trends. As a matter of fact, in many cases, human beings perform problem-solving by using knowledge of a specific solving process as a kind of template. This is one of the reasons why human beings are able to perform problem-solving in real-time. The problem-solving model in this research is based on this aspect of human beings. Generally, when constructing a problem-solving system, it is difficult to encode the enormous solving processes for all inputs assumed in the target problem by a procedural language.

So I have proposed a new problem-solving concept, called " phase flow "in this research. It is a series of sub-problems which each have certain conditions to reach a final solution (a target state).

The outline of the procedure for constructing the problem-solving system is as follows. Firstly, the developers need to divide the solving process of the target problem into a series of small sub-problems linked by a causal relation with each other. Secondly, the developers pick up the following three kinds of parameters in each sub-problem and implement them into the system.

1. Conditions which represent each sub-problem,
2. Operators which change any state in each sub-problem into a new state in the next sub-problem
3. Evaluation functions to select the best operator in each sub-problem

These are the constituent elements of the " phase flow ". In actual problem-solving, the system can solve a whole problem by solving each small sub-problem one by one using the above kinds of parameters.

I constructed a problem-solving system based on this concept and performed the following three experiments to determine the its validity.

1. Application to the " $N^2 - 1$ puzzle "
2. Application to a " pursuit game "
3. Application to a practical problem , " the control of an aircraft "

I confirmed that the performance of the proposed system is remarkably better than typical rule-base systems in each experiment. In conclusion, the proposed method turned out to show the potential for application in various fields.

Key Words: **problem-solving, real-time search, problem space, $N^2 - 1$ puzzle, game programming, aircraft control**