

# Applying Knowledge Map to Intelligent Agents in Problem Solving Systems

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**Abstract:** According to the four steps of problem solving proposed by Marshall in 1995, a knowledge structure is designed based on the Concept Map and the Concept Schema, which is so-called Knowledge Map. Knowledge Hierarchy derived from Hierarchy Map of Concept Map can be used to indicate the relationships among concepts, whereas Concept Schema represents the information of the corresponding concept. After the Knowledge Map is well analyzed and designed, three functions for manipulating knowledge in problem-solving systems, such as matching operation, locating operation and loading operation are considered. And finally an intelligent agent within Knowledge Map to accomplish problem-solving steps is implemented to providing assistances for students in distance learning environment.

## Introduction

After the invention of computer, some interactive programs, called CAI Systems (Computer-Assisted Instruction Systems), are developed for help students learning. There are many previous researches from building a proper problem-solving system for students to solving a common problem by using computer system (Mayer 1992), such as four steps for solving mathematic problems (Polya 1965), seven stages of problem solving for science experiments (AUP 86), and so on. Another interesting research issue in CAI Systems is Intelligent Agent. Some Intelligent Agents are used for helping students doing science experiments in V.E.E. (Virtual Experiment Environment) (Huang et al. 1999; Kuo et al. 2001); the others are used to diagnose students' learning status in problem solving systems (Chang et al. 1999; Heh 1999; Chang et al. 2000). In this paper, an Intelligent Agent is designed with a kind of knowledge structure, Knowledge Map, to help student solving problems.

## Using Knowledge Map for Solving Problems in Intelligent Agent

This paper proposes a new knowledge structure used for problem solving called *Knowledge Map*. The idea of *Knowledge Map* comes from Concept Map and Concept Schema. An example of *Knowledge Map* for partial domain of Physics is shown in (Fig. 1). The gray blocks are the original Concept Map and are drawn as a *Concept Hierarchy*, which comes from the idea of hierarchical *Concept Map*. For example, the concept, "Motion with Constant Velocity," is one type of "1-Dimensional Motion." The correspondence of white block to the gray one is the *Concept Schema*, which comes from the definition of schema in (Gagné et al. 1993) for presenting natural categories, events and text of a concept. Take "Motion with Constant Acceleration" for example, it has its own definition "acceleration is constant" and the physics formula "rule  $v_t = v_0 + at$ ".

After constructing the *Knowledge Map*, some operations for manipulating knowledge in problem solving systems have to be designed in an Intelligent Agent: 1. *Search-Operation*; 2. *Locate-Operation*: finding what concepts should be accessed; 3. *Load-Operation*: loading contents in concept schema into the short-term memory. To use the Knowledge Map for Solving Problem, this paper follows four problem-solving steps extended by four types of knowledge schemas (Marshall 1995; Cheng et al. 2001). In (Fig. 2), a problem loaded into a Problem Solving system. This problem is processed through four steps:

1. problem identification: loading problem into problem solving system and using knowledge map to construct *Knowledge Object Schema (KOS)*.

2. problem elaboration: elaborating the *KOS*.
  3. problem planning: translating *KOS* to *Problem-Planning Schema (PPS)* and using knowledge map to do problem solving plan.
  4. problem execution: using *PPS* to get the answer and produce results.
- All these steps get knowledge from knowledge base in long-term memory and produce different schemas stored in short-term memory.

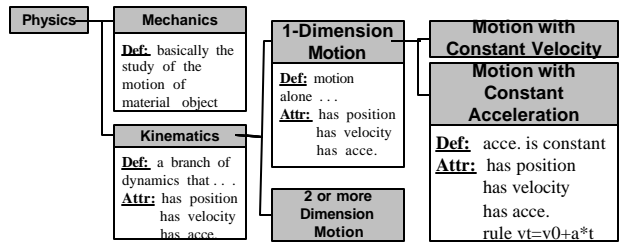


Fig. 1 Knowledge Structure - Knowledge Map

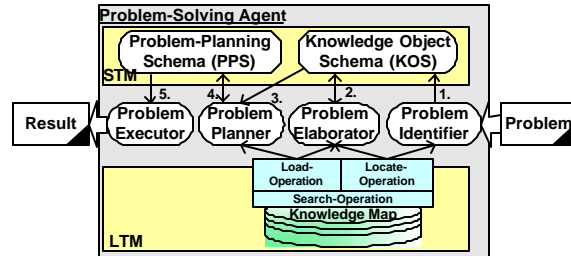


Fig. 2 Flow Chart of Problem Solving Agent

## Conclusion

This paper proposes a new knowledge structure for problem solving called *Knowledge Map* constructed by *Concept Hierarchy* and *Concept Schema*. *Concept Hierarchy* indicates the relations between concepts and *Concept Schema* stores concept-related information. This paper also shows the four steps of problem-solving and designs three operations for manipulating knowledge on *Knowledge Map*. With these operations, *Knowledge Object Schema* and *Problem-Planning Schema* are created to complete the whole problem solving process and help Problem Executor to generate results. The feature work of this paper is to change *Knowledge Map* to reticular one, increase (or insert) knowledge automatically, and construct *Knowledge Map* from natural language.

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