

# Implements a Diagnostic Intelligent Agent for Problem Solving in Instructional Systems

Janie Chang, Maiga Chang, Jeng-Lun Lin , Jai-Sheng Heh  
 Dept. of Info & Comp. Eng., Chung Yuan Christian Univ., Chung Li,320, Taiwan  
[aptjanie@ms29.hinet.net](mailto:aptjanie@ms29.hinet.net), [maiga@ms2.hinet.net](mailto:maiga@ms2.hinet.net),  
[s8527165@ice.cycu.edu.tw](mailto:s8527165@ice.cycu.edu.tw), [jshieh@cycs01.ice.cycu.edu.tw](mailto:jshieh@cycs01.ice.cycu.edu.tw)

## Abstract

*Problem solving is one way to present thinking style of human beings. Most problems should be solved in some particular sequences. However, no matter how smart learners may possibly make mistakes while solving a problem. In order to decrease the mistakes making and increase the learning efficiency, a diagnostic intelligent agent is implemented in this paper to achieve the goal. Such a diagnostic intelligent agent is designed based on diagnosis PSN (DPSN), which modified from PSN.*

*This paper takes one-variable linear equation (OVLE) as an example to accomplish the experiment instructional system in which a diagnostic intelligent agent, which is so-called OVLER, is involved. By analyzing the problem solving operations and representing the problem states with graph structure, a diagnosis PSN (DPSN) is designed. (Because of the page limitations, the detailed lemmas and its proofs are ignored here.) According to the DPSN, a diagnostic intelligent agent - OVLER is finally implemented in the IVC (Internet Virtual Classroom) for demonstration purpose. From the problem solving states solved by learner, OVLER will detect the factors that cause errors and lead the learners to find the truly answer.*

## 1. Analysis and Designation of Diagnosis PSN

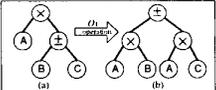
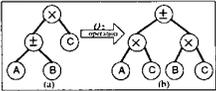
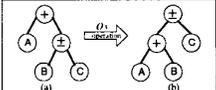
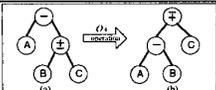
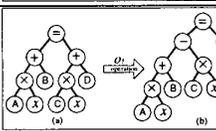
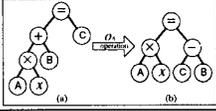
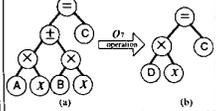
Problem solving is a way to represent the thinking style of human beings. In solving process, a problem has many characteristics: the given, the goals and obstacles.[1] Most researchers define a *problem-solving path* (PS path) as a sequence of operators leading from one state to another.[2] Since different learners will generate different PS paths, the whole problem solving process can be saw as a graph, a Problem Solving Graph (PSG). Furthermore, PS paths can be described by one more sophisticated graph, called Problem Solving Network (PSN).[3] Since PSN/PSG could not tell which PS paths is better than others, the PSN/PSG should be rearranged on a coordinate plane and formed a Coordinate PSN (CPSN).[4] According to the CPSN, all the successful paths on the plane are shown, and the performance of problem solving paths could be evaluated with the coordinate plane.[4]

However, no matter how smart or excellent learner may possibly make mistakes while they solve

problems.[5] The erroneous problem states cause the *unsuccessful PS paths*. In order to decrease the mistakes making and increase the learning efficiency, the PSN is modified as a diagnosable PSN, which is so-called diagnosis PSN (DPSN). Therefore, try to find the impact of operations to problem state and induce several types of operations in specific procedure problem, one-variable linear equation (OVLE) would be major contribution by this paper.

Firstly, one-variable linear equation (OVLE) will be taken as an example problem domain to show the Problem Graph of analyzing operations in Table 1 below. And then the erroneous operations can be caught by diagnosis PSN (DPSN). For the page limitation, some lemmas and features of DPSN are ignored in this paper.

*Table 1. Analysis of operations for OVLE*

Operations	Causal Diagrams
Left Distribution( $O_1$ ) $A \times (B \pm C) = A \times B \pm A \times C$	
Right Distribution( $O_2$ ) $(A \pm B) \times C = (A \times C) \pm (B \times C)$	
Eliminate the bracket behind the sign of plus( $O_3$ ) $A + (B \pm C) = A + B \pm C$	
Eliminate the bracket behind the sign of minus( $O_4$ ) $A - (B \pm C) = A - B \mp C$	
First-order term located on the left side of equality( $O_5$ ) $A \times x + B = C \times x + D \Rightarrow A \times x + B - C \times x = D$	
Constant term located on the right side of equality( $O_6$ ) $A \times x + B = C \Rightarrow A \times x = C - B$	
Combine first-order terms( $O_7$ ) $A \times x \pm B \times x = C \Rightarrow D \times x = C$	

Combine constant terms( $o_8$ ) $A \times x = B \pm C \Rightarrow A \times x = D$	
Multiple two constant terms( $o_9$ ) $A \times x = B \times C \Rightarrow A \times x = D$	
Divide the final constant term by coefficient( $o_{10}$ ) $A \times x = B \Rightarrow x = C$	

## 2. System Implementation

The objective of this paper is to construct an instructional system. In this system, the intelligent agent OVLER is designed for diagnosing the OVLE problem and implemented based on the architecture of IVC (Internet Virtual Classroom)[6][7], which can detect errors caused by learners and try to provide the learner a convincing hint for learning. Follow is the diagnosing flowchart of the intelligent agent OVLER as Figure 1 shown. Through this figure, successful PS paths could be evaluated by CPSN, and the convincing hint given by intelligent agent is provided by DPSN, which is used to diagnose unsuccessful PS paths.

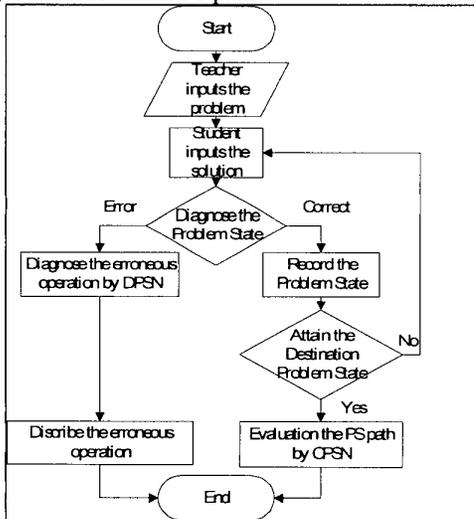


Figure 1. Flowchart of Problem Solving

Figure 2 to 3 are the snapshots of OVLER and its hints for the problem learner currently solves.

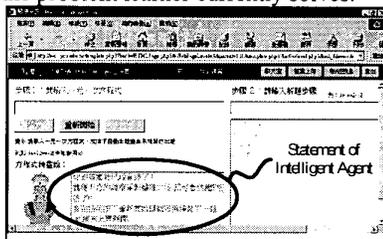


Figure 2. The snapshot of agent statement

In Figure 2 show the operation panel, which used by teacher on the left topside to give the problem or used by student on the right side to input the solution step by step. At the left bottom side of Figure 2 is the intelligent agent, which will check solutions provided by learner, and then post all the problem states and his diagnostic result automatically. Figure 3 is the diagnostic result posted by intelligent agent to help learner understand the cause of error and learn more efficiently.

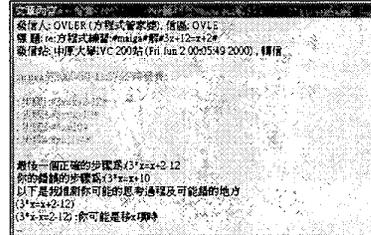


Figure 3. Diagnostic result posted by intelligent agent

## 3. Conclusion

In order to decrease mistake making and increase the learning efficiency, a diagnostic intelligent agent, OVLER, is implemented for a specific problem OVLE in this paper. According to the graph of PSN, a modified diagnosis PSN (DPSN) is proposed. Taking one-variable linear equation as an example, the concept of DPSN and Problem Graph of operations is analyzed. Finally, a diagnostic intelligent agent is realized on the IVC platform (a WebBBS system).

Many problems in other fields, which are procedural as one-variable linear equation in the mathematics, may also be diagnosed by diagnosis PSN (DPSN). Try to improve the diagnosis PSN to provide more specific error detection and recognition in other areas and provide this system an international version this summer would be our next and quit important works in the near future.

## 4. References

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