Computer Problem-Solving by Applying Depth-First Search

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Abstract

Artificial Intelligence (AI) is the science and engineering of making intelligent machines, especially intelligent computer programs and AI is related to the similar task of using computers to understand human intelligence. One of the application of artificial intelligence is in expert system (ES) or knowledge-based. An expert system provides advice derived from its knowledge base. This system intends to solve computer problem without any computer expert. Knowledge base is made with many inferences rules and they are entered as separate rules that use them together to draw conclusions. This system intended to solve problems for Window XP based Operating System Computer by applying depth-first search algorithm. User can get the solution for their specific problems and they can make troubleshooting steps by themselves because the system will give the advice and step by step procedure for solution.

Keywords: Expert System, Artificial Intelligence, Problem-solving strategies

1. Introduction

Expert systems [2] are computer programs that are derived from a branch of computer science research called Artificial Intelligence (AI). AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behavior. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine. AI programs that achieve expert-level competence in solving problems in task areas by bringing to bear a body of knowledge about specific tasks are called knowledge-based or expert systems. Often, expert system is reserved for programs whose knowledge base contains the knowledge used by human experts, in contrast to knowledge gathered from textbooks or non-experts. The two terms are expert systems (ES) and knowledge-based systems (KBS). Taken together, they represent the most widespread type of AI application.

The dictionary definition of a computer is an electronic device that processes data according to a list of instructions. Normally computers consist of individual electronic device units. Each device can be considered a separate unit performing certain functions.

Problem solving strategies can be vitally important anytime for computer related devices malfunctions. Information technology can be used to offer ways for solving PC's problems in a friendly and easy way. Expert systems are practically suitable for these problems and will inevitably become an essential element in it.

In all types of computer system, the electronic devices units play a critical role so any failure in them will stop our computer system from working until this failure is diagnosed and repaired. In this paper, we present a problem-solving approach for Window XP based operating system computer. We created problem solving rules in rule base file and result out how to solve these problems by applying depth-first search tree structure. The depth-first search algorithm is used to retrieve nodes from diagnosis tree. User can get the solution by making troubleshooting steps by themselves.

The rest of the paper is organized as follows. In Section 2, we reviews related work. We show the general architecture of the proposed system in Section 3. Section 4 gives depth-first search algorithm. Section 5 describes computer problem-solving model and section 6 draws some conclusion.

2. Related Work

Expert systems are basically a cluster of software routines especially organized in a computer that tends to emulate the human expertise in a certain domain. Expert systems can be developed for any problem that involves a selection from among a definable group of choices where the decision is based on logical steps. Also Expert systems can help automate anything from complex regulations to aiding customers in selecting from a group of products, or diagnosing equipment problems [6].

J.Reifman et al [4] proposed the diagnostic approach with an emphasis on the construction of the two-level function and component characteristics oriented hierarchical structure knowledge base. The diagnostic technique is showed the taxonomy tree shows how the process components are classified first by thermal-hydraulics (T-H).

J.D.Kleer et al proposed diagnosing a personal computer, the expert system must know the major functional components of the system. It could ask the operator, for instance, if the display is a monochrome or color display. The operator should, in all probability, be able to provide the correct answer. The expert system could, on the other hand, cause a test unit to be run to determine the type of display. The accuracy of the data collected by either approach in this instance probably would not be that different so the knowledge engineer could employ either approach without affecting the accuracy of the diagnosis[3].

B. Wollenberg [1] proposed a model of human problem solving that makes use of the analogy between computer processing and human information processing. This model can help to understand how AI works and what its limitations. The human information processing system consists of three subsystems are a perceptual subsystem, a cognitive subsystem, a motor subsystem, and external memory.

An expert system (ES) is a system that uses human knowledge captured in a computer to solve problems that ordinarily require human expertise. Such systems can be used by non-experts to improve their problem solving capabilities. ES can also be used by experts as knowledge assistants. Such systems could function better than any single human expert in making judgment in a specific, usually narrow area expertise.

2.1. Expert System versus Problem-Solving System

The principal distinction between expert systems and traditional problem solving programs is the way in which the problem related expertise is coded. In the expert system approach all of the problem related expertise is encoded in data structures only; no problem-specific information is encoded in the program structure. The traditional problem solving approach helps contrast with the expert system. Problem solving has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills. Heuristics search method is designed to reduce the amount of search for a solution. When a problem is presented as a search tree, this approach to reduce the size of the tree by pruning nodes.

2.2. Knowledge Base

The knowledge base an expert uses is what he learned at school, from colleagues, and from years of experience. Presumably the more experience he has, the larger his store of knowledge. Knowledge allows him to interpret the information in his databases to advantage in diagnosis, design, and analysis. Knowledge engineers, who translate the knowledge of real human experts into rules and strategies, create a knowledge base. Knowledge is represented as a set of rules and data is represented as a set of facts. These rules compare each rule in the knowledge base (rules) with the facts. Most of the systems use IF-Then rules to represent knowledge. This rule is what gives expert systems the ability to find solutions to diagnostic and problems. These rules are often represented in the following form:

IF <a set of conditions is true>

THEN <certain conclusions can be drawn>

3. Proposed System Architecture

Expert System is intended to serve in the diagnosis of loss of visions problems. A computing system is capable of representing and reasoning about some knowledge rich domain, which usually requires a human expert, with a view toward solving problems and/or giving advice. In this system, we consider that the user can get the solution from problem, which criteria are needed and which user can get or not their requirement.

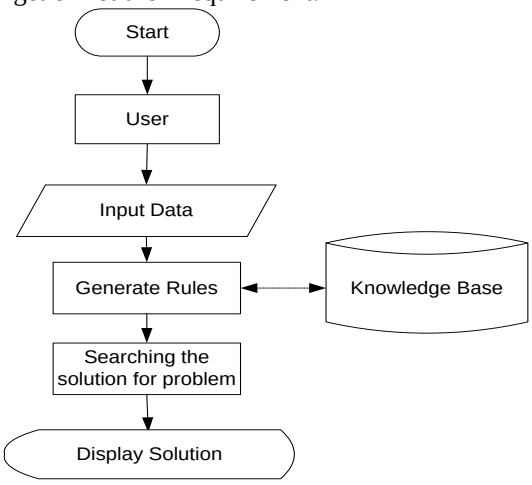

Figure 1. Proposed System Architecture

An expert system is a computer program that uses knowledge and inference procedures to

solve problems that are ordinarily solved through human expertise. It simulates the human reasoning process by applying specific knowledge and inferences. ES is possible to find specific information to guide the search process and thus reduce the amount of computation. The proposed system architecture is shown in Figure1.

4 . Depth-First Search

Depth-first search (DFS) is an algorithm for traversing or searching a tree, tree structure, or graph. One starts at the root (selecting some node as the root in the graph case) and explores as far as possible along each branch before backtracking. Formally, DFS is an uninformed search that progresses by expanding the first child node of the search tree that appears and thus going deeper and deeper until a goal node is found, or until it hits a node that has no children. Then the search backtracks, returning to the most recent node it hasn't finished exploring. In a non-recursive implementation, all freshly expanded nodes are added to a stack for exploration. The advantages of depth-first search are low space complexity, good chance of success when there are many solutions, complete if there is a solution shorter than the depth limit. Example of depth-first search tree is as shown in Figure 2.

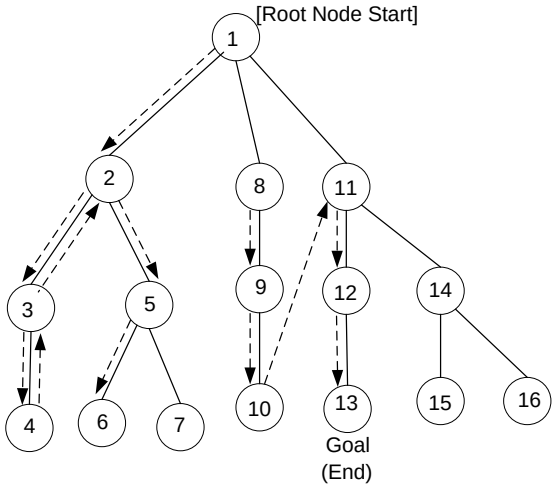

Figure 2. Example Graph for Depth-first Search Tree

4.1 Depth-First Search Tree

Depth-first search (DFS) is an algorithm for traversing or searching a tree, tree structure, or graph. One starts at the root (selecting some node as the root in the graph case) and explores as far as possible along each branch before backtracking. It searches processing in the parent-to children direction until forced to backtrack.

- A node is designed as the initial state
- Each node represents a possible state
- One or more nodes represent goal states, states in which the goal is considered accomplished
- Each edge represents a state transaction caused by a specific action

The inference in the system is done by a tree structure which indicates the rules or logic which mimics human reasoning. The nodes of these trees are called rule nodes. There are several different types of rule nodes. The rule based comprises a forest of many trees. The top node of the tree is called the goal node, in that it contains the conclusion. Each tree in the forest has a different goal node. The leaves of the tree are also referred to as rule nodes, or one of the types of rule nodes.

4.2. Depth-First Search Algorithm

Depth-first search (DFS) is a general technique for traversing graph. Algorithm starts at a specific vertex S in G, which becomes current vertex. Then algorithm traverse graph by any edge (u, v) incident to the current vertex u. If the edge (u, v) leads to an already visited vertex v, then we backtrack to current vertex u. If edge (u, v) leads to an unvisited vertex v, then we go to v and v becomes our current vertex until we reach to "dead-end". At this point we start back tracking. The process terminates when backtracking leads back to the start vertex. Edges leads to new vertex are called discovery or tree edges and edges lead to already visited are called back edges. Figure 3 is the depth-first search algorithm.

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DEPTH FIRST SEARCH (G, v)
Input:  A graph G and a vertex v.
Output: Edges labeled as discovery and back edges in the connected component.
For all edges e incident on v do
   If edge e is unexplored then
      w ← opposite (v, e)
// return the end point of e distant to v
      If vertex w is unexplained then
         - mark e as a discovery edge
         - Recursively call DSF (G, w)
      else
            - mark e as a back edge
```

Figure 3. Depth-first Search Algorithm

5. Computer Problem-Solving Model

In Figure 3, this system is diagnosis error system. The user load the rule based file from any

selected directory. The user starts process for this diagnosis system. The user checks one of the problems from the problem list. If not check the problem, it shows "error message". This system match the user's problem into the rule base file by calculating the IF-THEN clause. If the rule based file has that problem, this system shows the sub-problems under the previous problem. The user checks one of the problems from the problem list until the solution recursively. Finally this system displays the solution for that problem.

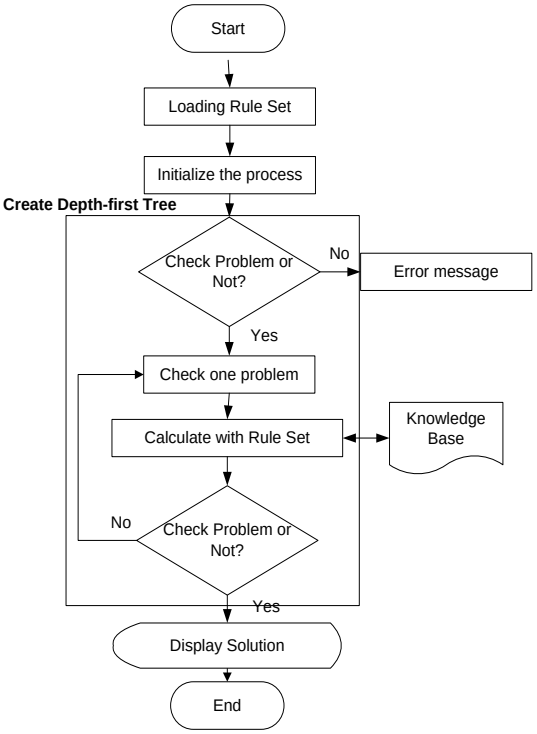

Figure 4. System Flow Diagram

5.1. Tree Structure of Sound Card Problem

In Figure 5, this Sound card problem has five sub-problems such as sound appears to play but do not hear, receive a sound-related error message, when a sound plays computer stops responding, do not hear sound from speakers and when a sound play computer restarts. "Receive a sound-related error message" sub-problem has three sub-problems.

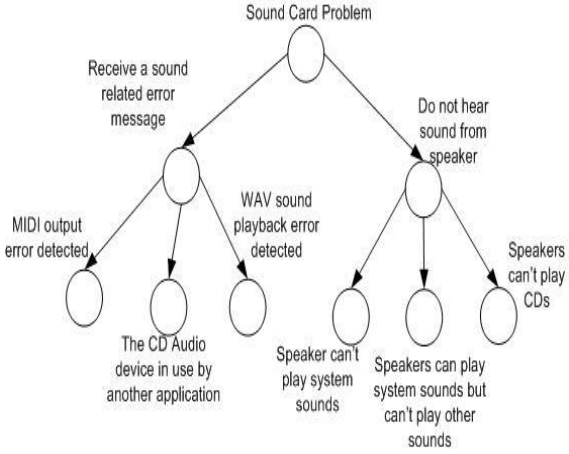

Figure 5. Sound Card Tree Structure

In Figure 6 problem reduction approach, when the user wants to know the sound card problem, the user goes to the "Receiver a sound related error message", it has three problems. This user goes to the "MIDI output error detected" problem but this solution is not the goal, the user goes back to the "The CD Audio device in use by another application" again. This solution is the goal.

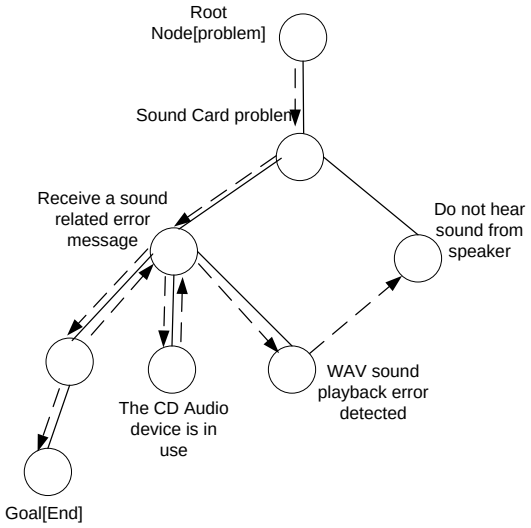

Figure 6. Problem Reduction Approach to Searching Sound Card Solution

5.2. Rules of Sound Card Problem

The rule base stores these rules from the domain expertise and the solution that is created by the strategies from the errors. This paper provides solutions to common errors encountered throughout using computer. The user can know which problem occur the computer without computer expert.

Now, our system have sound card, DVD, AMI BIOS, IBM BIOS, memory card error, installation problem, operating system and new memory card

problems. If the user wants to add new problem, the user will create rules for this new problem in the rule base file firstly. And then the user will add solutions for those problems in the solution file.

Rule 1:
IF (Sound Card problem) **AND** (Received a sound related error message) **AND** (MIDI output error detected)
THEN (verify computer can play system sounds

- Open Sounds and Audio Devices Properties in Control Panel.
- Click the Sounds tab.
- Under Program events, pick any event, such as Asterisk.
- Under Sounds, select any sound, such as Chord.
- Click the play button to confirm whether your computer can play system sounds.

, verify computer can play MIDI files)

- Click Start, click Search, and then click Other files or folders.
- In Name of file or folder, type: *.mid
- Click Search.
- Double-click several files in the results list to confirm whether your computer can play MIDI files.

Rule 2:
IF (Sound Card Problem) **AND** (Receive a sound related error message) **AND** (The CD Audio device in use by another application)
THEN (verify that no other CD audio programs are running

- Close the program you use to play the CD.
- Check the taskbar to see if any other programs that might play CD audio are running, and close them.
- Press CTRL+ALT+DEL.
- In Windows Task Manager, on the Applications tab, click any program that might be using your CD-ROM drive, and then click End Task.)

Rule 3:
IF (Sound Card Problem) **AND** (Receive a sound related error message) **AND** (WAV sound playback error dected)
THEN (verify computer can play system sounds

- Open Sounds and Audio Devices Properties in Control Panel.
- Click the Sounds tab.
- Under Program events, pick any event, such as Asterisk.
- Under Sounds, select any sound, such as Chord.
- Click the play button to confirm whether your computer can play system sounds.

, verify computer can play MIDI files)

- Click Start, click Search, and then click Other files or folders.
- In Name of file or folder, type: *.mid
- Click Search.
- Double-click several files in the results list to confirm whether your computer can play MIDI files.

6. Conclusion

Problem solving is the process of finding a solution when the path leading to that solution is uncertain. Problem solving is of crucial importance in engineering when products or processes fail for computer system. When these rules are created from the domain expertise, the knowledge base stores the rules of the expert system. Proposed problem solving strategies involves designing an expert system which is a system that uses human knowledge captured in a computer to solve problems that ordinarily require human expertise and finding a set of rules, or a procedure, that finds satisfactory solutions to a specific computer related devices problem. Dept-first search method is applied in searching a tree structure to improve problem solving skills in this paper. Diagnostic system is build from diagnostic tree to solve computer related problems such as Sound Card problem, DVD problem, BIOS problem, Memory problem, Operating System problem. By using this system, user can reduce time consuming and can get their desire information easily.

7. References

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