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An example of developing a knowledge-based system

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Abstract:
A possible way to gain an understanding of how a knowledge system works is to imagine an expert-client situation. We are all experts in our fields, but in daily life, we need assistance from an expert in an area that we do not know. This paper describes a knowledge-based system on *Computer hardware diagnosis*. Intermediate computer users can diagnose their hardware using the knowledge base in the system when facing some hardware problems with desktop computers. The main purpose of this paper is to include a real-time example of how a knowledge system can be built.

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1. Introduction

We have built a knowledge-based system on computer hardware diagnosis**.** The width of the domain knowledge includes all the major issues in diagnosing computer hardware. The depth of the domain knowledge is to deal with each specific phenomenon of computer disease and to find out the potential causes for it by prioritizing some factors. We have divided the domain problem into some sub-problems based on the different parts of hardware like, for this system, monitor, motherboard, power supply, speakers, mouse, keyboard, graphical adapter, sound card, CPU fan, hard disk drive and RAM memory (Fulton, 2002). Desktop computer hardware are component devices which are typically installed into or peripheral to a computer case to create a desktop computer upon which system software is installed including a firmware interface such as a BIOS and an operating system supporting application software that performs the operator's desired functions ("Computer Hardware," 2020). Computer diagnosis is a process designed to determine whether the components of a computer are operating properly. By intermediate users, it is meant that those who have some basic knowledge about the different desktop computer hardware components so that they are able to recognize and know each part in order to be able to use this knowledge base system.

Scenario1: There is an intermediate user who is facing a certain problem with a computer, for example, no audio sound output can be heard; in that case, the user can use this knowledge-based system to find which component causing the problem. The system will help identify one component which, for example, could be the motherboard, audio card, or speakers.

Scenario2: There is an IT expert who needs to deal with many issues in the computer field. Sometimes it is hard for him/her to identify the causes of the issues. The system will give him/her an ordered list of causes based on the given input to make his/her work more efficient and less time-consuming.

2. Methodology

We had two interviews with a hardware expert. In the first meeting with the expert, we asked the expert about the major hardware problems in desktop computers and how to diagnose these hardware issues in a priority order. And in the second meeting, we introduce the progress of our system to him and asked his opinion and suggestions for the betterment and further development of our knowledge-based systems. After finishing the system development, we met the expert again. This time he tested the system functionalities and evaluated the performance. With his valuable comments, we modified our system a little bit and made small changes in subparts where it needs more accurate output.

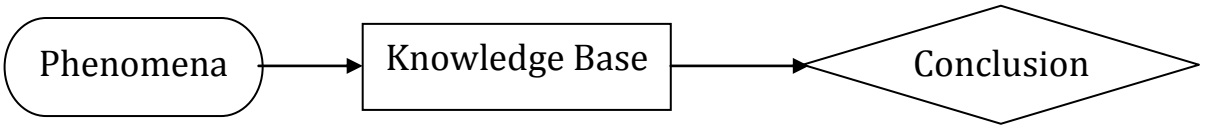

Figure 1: Main workflow of the system

3. System description

As we are dealing with diagnosing computer hardware problems, we have decided to write *rules* based on the symptoms occurring to computer hardware. We will separate the rules for different hardware parts, for instance, there will be different rules for graphics adapter and

Motherboard; but there may be more than one rule for a single part of computer hardware, like graphics adapter. In a rule, we will make some investigation of the symptoms shown for a single hardware problem. Rules descriptions of our system in *natural language* are as below:

When there is a monitor issue with picture, if the whole monitor is black but there is a message in the monitor, and the speed of fan is normal (judging by hearing), the possibility of graphical adapter being broken is high.

When there is a monitor issue with picture, if the whole monitor is black but there is a message in the monitor, and the speed of fan is slower than normal (judging by hearing), the possibility of motherboard being broken is high.

When there is a monitor issue with freezing picture measure the graphical adapter and estimate the temperature, if the temperature is higher than forty degrees Celsius, the possibility of graphics adapter being broken is high.

When there is a monitor issue with freezing picture measure the graphical adapter and estimate the temperature, if the temperature is lower than forty degrees Celsius, the possibility of CPU fan being broken is high.

When there is a sound issue, if speaker power is on, and other functions run normally, then there may be some issues with sound card.

When there is a sound issue, if speaker power is on, the sound card is built-in and other functions run normally, then there may be some issues with motherboard.

When there is a monitor issue with picture, if the whole monitor is black and there is no message in the monitor after disconnecting the cable between the monitor and the computer case, the possibility of monitor being broken is high.

When there is an automatically restart issue, if the CPU temperature is higher than fifty-five degrees, the possibility of CPU fan being broken is high.

When there is an automatically restart issue, if the CPU temperature is lower than fifty-five degrees, and the graphical adapter temperature is higher than forty degrees then the possibility of graphical adapter being broken is high.

When there is an automatically restart issue, if the CPU temperature is lower than fifty-five degrees, and the graphical adapter temperature is less than forty degrees, the possibility of power supply being broken is high.

When the computer can not start, if there is not any sign and sound for the whole system, the possibility of power supply being broken is high.

When the computer cannot start, if there is no beep sound and fan speed is normal, it is highly possible that there are some issues with motherboard or graphical adapter.

When the computer cannot start, if there is beep sound and there is no picture in the monitor, it is highly possible that the RAM is broken.

When the computer is running slowly, if the usage of memory is low, there may be an issue in hard disk.

When the computer is running slowly, if the usage of memory is high, there may be an issue in Ram.

When the computer is running slowly, if the usage of memory is low, and the free space in the operative system drive is less than 2GB, there may be an issue in CPU.

In our knowledge system, there is no need to give the system any new facts before a session. The input from the user during the session is enough to go to a decision needed or expected. In a new session, the user will answer some questions or gives some choices based on the symptoms occurred in his/her computer and the system will use those answers or choices to draw a conclusion, which means what type of hardware problems have occurred to the computer.

As a problem solving strategy, *Forward Chaining* is preferred for our system to draw conclusions. Forward Chaining is a data-driven technique used in constructing goals or reaching inferences derived from a set of facts (Klein, 2002). Forward chaining begins with the facts of a problem (Biondo, 1990; Elzbieta et al., 2018). Then the system proceeds by applying rules to the facts to produce new facts and continue until hopefully a solution is generated or a decision is made satisfying the goal condition. Our system uses data provided by the users and moves towards the conclusions so that data-driven is applied as a solving strategy.

The knowledge in our system is based on facts. At the beginning, the system asks the users about the main problem they are facing with their desktop computers, like regarding Picture, regarding Sound, Restarting issue, etc. We have divided and mentioned the main problems that can be occurred in a desktop machine into five different types. Then based on the selection of the users, the system will ask the users some more questions related to the certain problems, like current CPU temperature, RAM usage at present, etc. Finally, depending on the answers from the users, the knowledge base system will give the outputs about which parts of hardware may cause the problems.

At the beginning of the project, we had two different scenarios for our knowledge base system. One was for showing how an intermediate user can find out any hardware related problem in his/her desktop computer using our system. The other was showing how our system can help an IT expert to help customers in identifying hardware failures. With the development of the system, no new scenario had been concerned. So, we only considered the previous scenarios throughout the whole progress of the system.

We tested the system very well. We have considered all possible inputs that are valid for the system and observed the outputs. The outputs are right in the context of reality. More specifically, we, as users, entered some symptoms that occurred in a desktop computer and the system gave us which parts of hardware are responsible as outputs. As an example, in our system we gave the inputs that the power of speakers is on, the sound card is built-in and other functions run normally in a desktop computer, while there is still a problem in the computer regarding Sound. Based on the phenomenon our knowledge-base system gives output that there are some problems with the Motherboard in the computer.

4. Discussion and Conclusion

The system expert tested the knowledge base system along with us. He tested it in several different ways and he got the correct results from the system every time. The expert noticed that our system was built fully according to his suggestions and directions and he mentioned that the system can be used in reality. So, in the final meeting with the expert, he declared that the system building and modifying task had been finished according to the plan made in the beginning. Besides, he gave us some other ideas and opinions regarding further development and more functionality with the system in the future.

This system is mainly used to help the user diagnose the problem of the desktop computer by asking the user's phenomenon they meet with their computer. The whole system is developed in *Expert System Builder* and implemented by loading the question file. Since the system is built by Expert System builder, it does not have any online source code, instead, all information is saved in a file, which is created by the program, and the content of the file is not readable rather than coded in some way. In order to use this system, it should be used on the Expert System builder which should be installed on computers (*Download - Es-Builder*). This system covers the most common hardware problems but not all of them, and not the software related issues.

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