Methodological Aspects of Development Logical Inference Procedures in Diagnostic Expert System

A.A.Djaylavov
Tashkent University of Information Technologies. Department of Information Technologies, 108, A.Temur str. Tashkent, Uzbekistan. 100084

A.E.Kuvnakov
Tashkent University of Information Technologies. Department of Information Technologies, 108, A.Temur str. Tashkent, Uzbekistan. 100084

ABSTRACT
In this paper the experience of creating expert systems and methodological aspects of developing logical inference procedures in diagnostic expert system of computer systems are discussed.

General Terms
Expert systems

Keywords
Expert systems, computer diagnostics, logical inference.

1. INTRODUCTION
Study of the experience of creating expert systems (ES) showed that the use of their development methodology adopted in traditional programming lead to excessive delays the process of creating the ES, or even lead to a negative result. Herewith, the use of EC is most effective in solving the problems of diagnosis, interpretation of data, forecasting, monitoring of technical conditions and ensure efficient operation of computer systems (CS).

Theoretical and practical aspects of the application of technology to solve problems of ES for diagnostics of computer systems are considered in [1-5]. Many other applications of methods and algorithms for synthesis of fuzzy-neural decision-making models have been published, where expert system in the form of fuzzy rule-based logical inference models increases model reliability and allow to solve forecasting problem in computer diagnosis problem [7-10].

It should be noted that in most cases modern ES do not meet in effective application of ES technology to solve problems of diagnostics for the following reasons:

1. Database management tools, such as, SQL-server, capable of delivering only the specific information to specific requests in the appropriate language and they cannot make a conclusions and train themselves.

2. Searching tools on the Internet cannot guarantee success, because they do not use the semantics of the subject area.

3. The system should be Internet oriented. On each of the servers involved in the organization of distributed knowledge bases and data must be installed on kernel. Knowledge Base (KB) of each server stores information about a particular area of human activity or natural science. The users have an access on the local computer that connects to the server. Suppose the user asks a question, and server in own turn could not find the answer in own database. In this case, the machine sends a network request to other servers. Demand is generated by a special algorithm and transmitted through a special transport protocol. There is another option - the server asked for clarification of the question, by doing this, server fulfills tasks to fill his knowledge base during in dialogue process.

2. METHODOLOGY
It is known that, to determine the causes and troubleshooting symptoms of CS, instability of personal computers (PCs) connected to the server of local area network is widely described in [6]. According this to determine the causes and troubleshooting symptoms of CS followings should be performed:

1. Fulfillment a complex diagnostics of system unit. After fault isolation of PC, recommendations should be given to eliminate them. Since the system unit consists of a large number of blocks, the functioning of this is closely dependent on each other, so testing PC requires some experience in this field. For example, the failure of the system that boot from the hard drive can be called as a failure of the hard drive and the fault in the controller unit on the motherboard, or improper configuration of the system. Therefore, in any fault of PCs, successive tests should detect that a component of which is the primary cause.
2. Verifying power supply unit (PSU) to clarify its fundamental performance on the phase "switching-on". PSU is also being tested in operation mode for compliance actual output parameters displayed on the stability characteristics at different levels of the ultimate load. It should be noted that a normal and stable operation of the PC in general, and for individual functional units (FU) directly depends on the quality of output power, obtained from PSU. Faulty PSU often leads to failure of the other expensive parts of your PC.
3. Conducting a complex inspection of the motherboard for the stable operation of all peripheral devices with special diagnostics software. The process of testing the motherboard may take a long time because of the complexity of the motherboard device itself, and the compatibility with other components of the PC units. The motherboard testing may involve other components

to determine the causes and not correctness of operation in this configuration.

4. Memory is being tested in the normal mode (on standard frequencies) by using specialized software to check random access memory. Herewith, the process of memory test can take a long time, so must be checked each logic cell memory for serviceability. Performed testing of each memory module separately, and only then collaborative operation with other memory modules. Having compatibility issues fully functional memory module may not work in conjunction with other modules or specific motherboards and CPUs.
5. Checking the performance of the processor in the normal mode (standard frequencies) by using specialized software testing processors are performed. The check processors can be affected together with the motherboard and on the test platform with a known working component: motherboard, memory, etc.
6. Identifying possible causes of incorrect booting of operating system (OS): The system is not fully loaded, with errors; the boot process is terminated at any stage. In this case, attempts to diagnose hardware or software reasons that cause a problem with loading the OS are performed. In the case of hardware suspicions, further testing of separate FB are required. In case of software problems, an additional integrity check of OS, their component parts and installed drivers and programs should be checked.
7. Identifying possible causes of improper operation of the OS, booting the OS, which took place without problems and errors: during operation PC freezes, appear warnings about the errors in the OS, errors during running any programs, occurrences of spontaneous shutdown or reboot of PC, etc. In this case, attempts to diagnose hardware or software reasons that causes malfunctioning of the OS are performed. In the case of hardware suspicion in the future, required testing of individual FB, In case of software problems, an additional integrity check of OS, their component parts and installed drivers and programs should be checked.

In our case, the knowledge base (KB) is formed as a collection of the following relational database in the format of database management system (DBMS) of SQL-servers, which is running on computer networks: a database with descriptions of malfunctions; database with descriptions of symptoms, table of correspondences symptoms and faults, weights table of symptoms for troubleshooting.

To make a decision and to show a final result, usually the systems use familiar concepts such as weight symptoms - the probability of a fault in percentage; underdetermined specification - a set of data on which it is impossible to make a final decision; the factor of confidence - confidence in the reliability of the system which made logical conclusions and the threshold of confidence - a number predetermined by the user - maximum weight of a fault and below it the hypothesis simply rejected.

The work of the prototype of diagnostic ES begins with an initialization function that is responsible for assigning initial value to data. Then takes control procedure named "Main Menu." Furthermore, depending on the user choice, it calls one of the following procedures: work with knowledge bases, work with database of faults; directly initiate a prototype of diagnostic ES, customized context-sensitive help system.

In our case we consider the processing of the following items:

Work with the current knowledge base: read data from files on disk, and use the information available in accordance with the following description, processing of incoming information, decision-making and delivery of the final result.

At each step of the algorithm, the system has the possibility for the user if he forgot something, go back to the previous state by pressing the button "Back". If he wants to start all over again, he should click "Cancel" button, after that the system returns to its original state. The input to the system (data, entered by the user from the keyboard) initially received incomplete information, so the system cannot uniquely diagnose.

To solve this problem, the following algorithm should be used:

1) Collection of initial information.

When log in, the user sees a list of all symptoms that are available in the database. In front of listed items symptoms, user puts a "tick" (these symptoms that he was discovered during work). By clicking "Next" the system moves to the next item.

2) Preparation of the initial list of faults, which fits to discovered set of symptoms.

After entering the initial symptoms, the system analyzes faults belonging to the specific symptoms and based on following algorithm determines the initial list of faults:

1) Open a table of correspondences.

2) For all *k=1* up to the maximum number of symptoms:

3) Take *k-th* symptom from the original list;

4) Refer to the table of correspondences: simple cyclic do a full search of all faults, standing in the column of the symptom;

5) Checking:

5.1) If the fault is already in the list, go to step 6;

5.2) If the tables = 0, then the fault is not in the list;

6) Increasing *k* by *1;*

7) If all the symptoms of (*k*) iterated, the original list of faults formed;

8) Close the mapping table.

Each symptom can belong to several faults, so the original list of faults is not the same as the symptoms. It should also be noted that the symptoms can be significant and insignificant; also, weight in relation to the symptom of a fault can be large

or small. This process is regulated by the system, so does not depend on the user.

With an initial list of faults, the system performs their differentiation. Next, the system begins to conduct "reasoning" to clarify information. The most common methods of inference -it is a direct chain of reasoning (direct conclusion) and reverse the chain of reasoning (the opposite conclusion). In the developed system implemented the mechanism of mixed conclusion, which allows both direct conclusions from facts to conclusions, and vice versa - to confirm or reject the hypothesis.

In the process of clarifying information system by asking the user, conducts "screening" unnecessary hypotheses with low weight. For calculation of weight of hypotheses system opens the data from the file, namely the table of weights. Weight table size [Number of faults] to [No. of symptoms] is at the intersection of cell number, equal to the weight of the symptom for this problem; confidence threshold should be given during initial setup an advance.

If the user is not able to answer some questions during the initial interview, the system makes recommendations, how to collect this data (check the power, continuity test signals or testing ....) and on the basis of these collect additional data. Recommendation system gives only for hypothesis, having a higher weight (to confirm their weight and the expert should not have to carry out unnecessary diagnostic procedures again).

In the process of the previous steps, should be identified several versions of the final result, where systems distributes the order of increasing probability of faults. Probability of failure is also considered in the table of weights, i.e., the algorithm that calculates weight, implementing the following procedures:

1) Select fault from the list generated in the previous stages.

2) System looks at what symptoms from a list of symptoms are related to this problem.

3) Performed the sum of weights of all symptoms related to the fault (again, according to the table of weights).

4) Memorizing the final weight of the problem.

After calculation the weights of all the faults, should be selected that fault, which has the maximum weight, and the weights are normalized.

Next, the system selects the failure, that probabilities are in some part, predefined by system programmer (so-called "confidence threshold"). The threshold of confidence can be set in the program settings.

3. PRACTICAL IMPLEMENTATION OF THE ALGORITHMS

On the basis of given algorithm and according to the weight and rated symptoms and recommendations, developed a preliminary version of an expert system to facilitate the process of identifying, verifying and locating problems and/or failure, as well as for the issuance of detailed and specific recommendations.

To create a program Php language and to store data PostgreSQL database has been used. The size of the source code: 467487 Kbytes; Database size: 23234 Kbytes.
The expert system is divided into the following databases:

1. Knowledge Base: a group of symptoms and the symptoms of the problems;
2. Database Troubleshooting: description of the problem;
3. Base decisions: recommendations for solutions to the problems;
4. Run ES: immediate start of the analysis of system, identification of problems;
5. Settings: the program settings;
6. Help: guidelines.

Base - designed for input or modify the information necessary for system selection causes of of problems and provide recommendations.

Knowledge Base - describes a group of symptoms and the symptoms themselves. In order to switch to running mode of knowledge base, must be selected from the main menu: "work with knowledge bases."

In the mode with groups of symptoms – in this mode it is possible modify the information about the groups of different variants of the problems, such as problems with power supply, OS boot, or something else.

In the mode with the symptoms – in this mode it is possible modify the description of the problems themselves, choose their weight, which affects decision-making, as well as select which group of symptoms, the problem belongs.

In the mode with databases of malfunctions can be modified the data about the actual malfunction and choose which symptoms belongs to this fault.

In the mode with the database solutions, modified the recommendations data to specific faults, symptoms of problems.

In all modes of work with databases it is possible to add a new record (in the form at the bottom of the page), edit (modify) an existing entry, or delete the record.

Launching ES- To start the system it is necessary to go to the main menu and choose the item "Run ES". Displays a list of groups of problems (symptoms), among which it is necessary to select one or more groups. After that the program goes to the selection of the symptoms that are previously selected group
After selecting the symptoms will be displayed list of faults, according to the symptoms, that previously selected. Also - can be chosen or one or more faults, according to the problem to the user.
After entering of the necessary data and selecting of the items, the program begins to analyze, in accordance with the incorporated algorithm and determines the symptoms and faults according to their weight, and produces a list of recommendations from the database solutions.

4. CONCLUSIONS

In this paper we investigate and analyze the experience of creating expert systems and the problems of developing logical inference in diagnostic expert system of computer systems. The analysis shows that, this methodology can be applied not only for the diagnosis of computer systems and computer networks, also for diagnostics including the network devices.

5. ACKNOWLEDGMENTS

Our thanks to the experts who have contributed towards development of this article.

6. REFERENCES

[1] Djaylavov A.A. 2011. Some aspects of the use of expert systems technology to solve the problems of diagnostics of computer systems. In Proceedings of the Republican Scientific and Technical Conference Current status and the development of information technologies.

[2] Mazeppa R.B., Kirzhakov V.Y. 2005. Practical aspects of the use of expert systems technology for real-time diagnosis of the design of complex technical systems. Journal of information technology in the design and production. (Feb. 2005.), 13-21.

[3] Bekmuratov T.F., Djaylavov A.A. 2007. Solution of problems of diagnosing computer systems by heuristics methods. Journal of TUIT. (Jan. 2007), 67-71.

[4] Bekmuratov T.F., 2006. Conceptual model algorithmic fuzzy inference system. J. Problems of Informatics and energy. Issue. 6 (June. 2006), 3-12.

[5] Kruglov V.V., Dli M.I. 2002. Intelligent information systems: computer support systems of fuzzy logic and fuzzy inference. M. Phizmatlit.

[6] Mueller S. 2005.Upgrading and Repairing PCs. M. Williams.

[7] Bekmuratov T.F, Mukhamedieva D.T. 2013. Methods and algorithms for synthesis of fuzzy-neural decision-making models. Publisher «Palmarium Academic Publishing». AV Akademikerverlag GmbH & Co.KG Heinrich-Böcking-Str. 6-8, 66121 Saarbrucken, Germany. 164 p.

[8] Bekmuratov T.F, Mukhamedieva D.T. 2011. Fuzzy inference system for forecasting problems // DAN Uzbekistan. - Tashkent, No.3, 23-26 p.

[9] Bekmuratov T.F, Mukhamedieva D.T 2011. Neuro synthesis algorithm for fuzzy inference systems // International Science and Technology Journal of Chemical Technology. Control and management. - Tashkent, № 6, 49-57p.

[10] Muhamedieva D.T. 2013. Clustering algorithm rules of fuzzy inference systems // Natural and engineering sciences. №2. Moscow. 248-252p.