Applications of Expert Systems in Engineering: Russian Experience

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Abstract[1]

The article is devoted to the analysis of the ES applications in the researches of russian developers.

1. Introduction

Expert systems (ES) belong to the most widespread class of intelligent systems focused on the duplicating of experience of highly qualified experts in areas where the quality of decision-making traditionally depends on the level of professional appraisal [3].

In modern understanding [3], an expert system is a computer-based system realizing the features and means of artificial intelligence, containing a base of knowledge with a set of rules for solving a certain range of tasks, and program-technical means that make it possible on the basis of the data entered into it on the current condition of the object of management or the analyzed situation to diagnose and to formulate an offer or an option of alternative offers (recommendations) for the choice of the decision of the system user.

Expert systems are capable to receive, accumulate and correct the knowledge provided by the experts, to deduce new knowledge from some subject domain, to solve a problem on the basis of this knowledge and to explain the course of their decision. They have found application in different areas of human activities, including management, economy, designing of complex technical objects, medicine (for example, diagnostics and treatment of diseases), meteorology, mechanical engineering, education, military science, robotics, etc. [10-36].

From the point of view of software developers, an expert system represents a program for the computer which operates the knowledge in a certain subject domain with the purpose of developing recommendations or the solution of problems [3, 4, 6, 7].

Therefore false expert systems in the form of numerous dialogue systems and interactive packages of programs which discredit this direction in the user's opinion are becoming widespread. An expert system creation process demands participation of highly qualified experts in the field of artificial intelligence who have been trained in small amounts by higher educational institutions in our country so far [4].

Proceedings of the 8th International Workshop on Computer Science and Information Technologies CSIT'2006
Karlsruhe, Germany, 2006

Expert systems were separated from artificial intelligence systems into independent direction by the mid seventies of the last century when the idea of modelling concrete knowledge of experts has come to replace the searches for the universal algorithm of thinking. Universities and research centres, whose task consisted in the creation of the theory and research of possibilities of the ES practical application in different areas, were involved in development at the initial stage. The first commercial systems based on knowledge appeared in the USA. They became the first intelligent systems.

In Russia the works by D.A.Pospelov (founder of the Russian association of artificial intelligence and its first president), E.V.Popov, V.F.Horoshevsky, V.L.Stefanjuk, G.S.Osipov, V.K.Finn, V.L.Vagin, V.I.Gorodetsky have made a great contribution into the research and ES development [4].

The article is devoted to the analysis of the ES applications in the researches of russian developers.

2. Expert Systems, Developed by Russian Researches

Expert systems, developed in RF are characterized by a variety of methods and means of the development and representation of knowledge. Rules of production, frames, semantic networks are applied to represent knowledge. Various programming languages (C ++, Java with application of XML standards, Delphi, PDC-Prolog, Turbo-Pascal 7.0) and tools (COPM-Pascal, Flops, Java Universal Library for Intelligent Applications, SIMER+MIR) are used. The authors single out the following fields from the area of applications: medicine; education, training; industry, engineering; finance, trade; psychology; network services; ecology; regional management.

- expert system for knowledge quality estimation in the system of open education (developers: Moiseev V.B., Andreev A.B., Usachev Y.E., Penza Technology Institute); knowledge is represented in declarative and procedural forms; the basis of the deductive mechanism of making a conclusion is a return chain of reasoning [1, 2, 17]
- expert system "Estimation of activities" (developers: Ivanov Y.K., Kovrigin S.N., Polovnikov O.V. etc., Gagarin Centre of cosmonauts training, 2001) is a real time ES for the estimation of cosmonaut performance during training. Knowledge is stored as rules of production. A direct method of argumentation is used. Expert component is realized in COMP-Pascal 1.0 [18].
- expert system for the estimation of operation-repair service of turbogenerators (developer: Grechenkov N.V., DGIES RAO "Unified Energy System of Russia", 2000); ES is intended for the periodic complex estimation of all the normative requirements observance in the organization of turbogenerators repair service [27];
- expert system of fuzzy decision making on the choice of methods increasing oil extraction in the oil deposits (developers: Anikin I.V., Shagiahmetov M.R., Kazan, KSTU, 2001); rules are of fuzzy production; expert system knowledge base contains 153 rules; the result of expert system work is the list of the techniques recommended for the application with a degree of decision-making reliability being indicated; the analysis of ES work in real wells has shown correctness of its work in 92 % cases [8, 28].
- expert analytical system "Analysis of banking and financial information (ABFI)" (developers: Company "Vestona", 1996-2004) allows a wide range of financial problems to be solved. ES ABFI is developed in two versions: local (one-user) and network (multi-user). ABFI works on the basis of different control systems of databases including Oracle, MS SQL and Informix [19, 20].
- expert system for distant consultations by methods of Internet – advertisement (developers: Krasteleva I.E., Soshnikov D. V., Moscow State Technical University, 2001) is intended for planning an advertising campaign of a website in the Internet and functions as an expert in Internet-advertisement. As a tool for ES creation the library of Java-classes Julia (Java Universal Library for Intelligent Applications), supporting a production-frame model of knowledge representation with direct and return mechanisms of making a conclusion was used; the knowledge base is organized as hierarchy of frames; the ES has been used for the development of advertising campaigns of a number of Internet – resources [5, 31];
- expert system for customs payments "eXponent Customs Payments" (developers: firm eXponent, St.-Petersburg, last version 2.01.1 from 08.08.2003) can prepare a legally proved conclusion which will specify available mistakes in charging payments and will offer correct decisions. Besides, ES allows optimizing the taxation of a foreign trade transaction [32].
- psycholinguistic expert system VAAL (developers: Belyanin V.P., Dymshits M., Shalak V.I.) allows predicting the effect of unrecognizable influence of texts on a mass audience, analyzing texts from the point of view of such an influence, making texts with the set vector of influence, revealing personal and psychological qualities of the text authors, etc. Areas of possible application: drawing up the reports with preset characteristics of influence on the potential audience; search for the most successful names and trade marks, etc. [33];
- expert systems for personnel control "Personnel Service " (1995-2003) and "Personnel Consulting " (2000-2003) (NPO "Etalon", Moscow) allow

professional, psychological, physiological parameters to be determined for each worker, as well as character of his behaviour in a conflict situation, compatibility, self-estimation, potential opportunities, etc; ES knowledge base contains the base of precedents the application of which has allowed the number of diagnosed parameters to be reduced; ES are developed both in local, and in network variants [25].

- expert system "GPRS Adviser" (developers: Company "TeleInCom PK", Moscow, 2001) provides the analysis of communication sessions in real time and estimates the quality parameters of GPRS (General Packet Radio Services) networks service [35];
- expert system "Expert Extension" for the diagnostics of a network (developers: Company "ProLan", Moscow, 2002) is intended for the analysis of the information contained in a line of seized packages, and on the basis of heuristic rules making conclusions on the defects available in the network. In version Observer 8.0 expert analysis is carried out for the IP-traffic [22].
- expert system "Geogracom 5W +" (main developer: Chernyavski V.N., NKF "Geogracom") is a system of decision-making support for the development of the region due to the transport network and is intended for the definition of the level and need for the provision of the population and region economy with a transport network. Geogracom 5W + may refer to the transforming expert systems which are characterized by generation of hypotheses, system of self-training "without the teacher" and some other attributes. Under uncertain conditions or absence of the data the system itself offers the missing "data-analogues" from the history of its work [29].

3. Researches in the Field of ES, Supported by RFBR

- "Research and development of tools for the creation of semiotic type expert systems" (Vagin V. N., Yeremeyev Al. P., 2002, MEI). In this project the models and methods of representing and processing incomplete, fuzzy and inconsistent knowledge in open and dynamic problem domains with the aim of constructing the semiotic type expert systems have been researched and developed. Learning procedures with a teacher and generalization methods based on the theory of rough sets used in machine learning systems and inductive concept formation have been analyzed. A semantic network has been chosen as formalism for knowledge representation. The inference algorithms on the base of analogy with and without regard for the context have been developed. Parallel inference procedures by the connection graph method have been developed.
- "Tools for speak in natural language with data base and expert system" (Kurbatov S.S., 2002, FSUC "Central SRI "Granit"). During the work performance a package of theoretical and program developments on the creation of tool software for the dialogue in a natural language (NL) with data bases and expert systems was conducted.. The developed mechanisms allow a system to put forward the suppositions about morphological and syntactical performances of any words and to confirm these suppositions through search for appropriate contexts. Mechanisms of mapping the objects of the data base with a character type in NL- objects of the standard base are realized in a minimal version.
- "Projects implementation support internet-ware for complex systems fundamental research" (Yusupova N.I., 2005, USATU). The purpose of the project is development of the specialized program-technical Internet-ware, which provided automation of project performance of joint multi-purpose fundamental researches of complex systems and also provided operative effective information interchange between collectives of developers at a level of semantics of investigated research fields.
- "The intelligent methods of multilink manipulator path search in complex environment" (Shakhmametova G.R., 2006, USATU). The genetic approach as the basis for the path search method for a multilink manipulator in complex environment is used. The expert system (ES) is developing for providing a specific purpose orientation at the stages of initial population formation and path crossing to get over the major downfalls of the genetic approach. ES is built of two modules: for forming recommendations for the initial population generation and for path crossing.

4. Conclusion

The majority of ES developers in Russia are focused on highly specialized subject domains with the purpose of developing of ES for the solution of a concrete problem in a certain subject domain.

In conclusion, the authors single out the following basic contemporary tendencies of the ES applications:

- development of neuronal network ES and expert systems with elements of fuzzy logic;
- development of network expert system;
- development of case reasoning expert systems;
- development of expert systems for the solution of a definite range of problems in a certain subject domain;
- a basic tendency of the development of expert systems is that expert systems are becoming a

component part of an actively developing area of science of knowledge engineering.

Acknowledgment

This research is supported by the grant 06-08-01180-a (2006-2008) of Russian Foundation for Basic Research.

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