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TECHNOLOGY DEVELOPMENT OF THE EXPERT SYSTEM

Abstract. Expert systems (ES) arose as a significant practical result in the application and development of methods of artificial intelligence (AI) - a set of scientific disciplines that study methods for solving intellectual (creative) problems using computers.During the last few years so many of these tools have become available that the choice of an appropriate tool has become an issue on its own.

The field of AI has more than forty-year history of development. From the very beginning, it examined a number of very complex problems, which, among others, are still the subject of research: automatic proofs of theorems, machine translation (automatic translation from one natural language to another), image recognition and scene analysis, action planning robots, algorithms and strategy games.

Key words: expert system, artificial intelegence , inference machine, diagnostic.

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Аңдатпа: Эксперттік жүйелер (ЭС) жасанды интеллект әдістерін қолдану және дамытуда маңызды тәжірибелік нәтижеретінде пайда болды. Жасанды интелект (ЖИ) – компьютерлерді пайдалана отырып зияткерлік (шығармашылық) проблемаларды шешу әдістерін зерттейтін ғылыми пәндер жиынтығы. Соңғы бірнеше жыл ішінде осы құралдардыңішіндеқолайлықұралдытаңдауөзіндік ерекшемәселеболыптабылады.

Жасанды интеллект өрісі қырық жылдан астам даму тарихы бар. Ең алғашқы кездерден бастап ол көптеген күрделі мәселелерді қарады, ол мәселелер әлі де зерттеулердің тақырыбы болып қалады, бір қатар теориялық мәселелерді қарастырды: теоремаларды автоматты түрде дәлелдеу, машиналық аударма (бір табиғи тілден екіншісіне автоматты түрде аудару), бейненітану және сахналық талдау, әрекет жоспарлау роботтары, алгоритмдер және стратегиялық ойындар.

Кілт сөздер: сараптамалық жүйе, жасанды интеллект, инерциялық машиналар, диагностика.

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Аннотация. Экспертные системы (ЭС) возникли как значительный практический результат в применении и разработке методов искусственного интеллекта (ИИ) – набора научных дисциплин, изучающих методы решения интеллектуальных (творческих) проблем с использованием компьютеров. В течение последних нескольких лет многие из этих инструментов стали доступными, так что выбор подходящего инструмента стал проблемой самостоятельной.

Область искусственного интеллекта имеет более чем сорокалетнюю историю развития. С самого начала был рассмотрен ряд очень сложных проблем, которые, среди прочего, все еще остаются предметом исследований, такие как: автоматические доказательства теорем, машинный перевод (автоматический перевод с одного естественного языка на другой), распознавание образов и анализ сцены, роботы планирования действий, алгоритмы и стратегические игры.

Ключевые слова: экспертная система, искусственная интуиция, машина вывода, диагностика.

Introduction

Expert systems (ES) arose as a significant practical result in the application and development of methods of artificial intelligence (AI) - a set of scientific disciplines that study methods for solving intellectual (creative) problems using computers.

The field of AI has more than forty-year history of development. From the very beginning, it examined a number of very complex problems, which, among others, are still the subject of research: automatic proofs of theorems, machine translation (automatic translation from one natural language to another), image recognition and scene analysis, action planning robots, algorithms and strategy games.

ES is a set of programs that performs the functions of an expert in solving problems from a certain subject area. ES give advice, conduct analysis, give advice, make a diagnosis. Practical application of ES in enterprises contributes to the efficiency of work and professional development of specialists.

The main advantage of expert systems is the possibility of accumulating knowledge and preserving them for a long time. Unlike the person to any information, expert systems are suitable objectively, which improves the quality of the examination. When solving problems requiring the processing of a large amount of knowledge, the possibility of an error in the search is very small.

The expert system consists of a knowledge base (part of the system in which the facts are contained), the output subsystem (the set of rules for

solving the problem), the explanatory subsystem, the knowledge acquisition subsystem, and the interactive processor.

When constructing subsystems of output, methods of solving problems of artificial intelligence are used.

So, the purpose of our research is the analysis of expert systems.
In the course of the work, a number of tasks should be performed, namely:

- the concept of expert systems;
- history of development of expert systems
- characteristics of expert systems
- criteria for using ES for solving problems
- areas of application of expert systems
- Expert systems for modeling processes in the technosphere

What are expert systems ?

Expert systems (ES) - is a bright and rapidly progressing direction in the field of artificial intelligence (AI) /1, c. 88/. The reason for the increased interest that ES causes to itself throughout its existence is the possibility of their application to the solution of problems from the most diverse areas of human activity. Perhaps, there is no such problem area in which no ES would have been created, or at least such attempts would not have been made.

ES is a set of programs or software that performs the functions of an expert in solving a task in the field of its competence. ES, like an expert-person, in the course of his work operates with knowledge. Knowledge of the subject area necessary for the operation of ES is in a certain way formalized and presented in computer memory as a knowledge base that can be changed and supplemented in the process of system development /2, p. 92/.

ES issues advice, analyze, classify, give advice and diagnose. They are focused on solving problems, usually requiring an expert examination by a specialist person. Unlike computer programs, using procedural analysis, ES solve problems in a narrow subject area (a specific area of expertise) on the basis of deductive reasoning. Such systems are often able to find solutions to problems that are unstructured and poorly defined. They cope with the lack of structuring by attracting heuristics, that is, rules taken from the ceiling, which can be useful in those systems where a lack of necessary knowledge or time excludes the possibility of conducting a full analysis.

The expert system can fully assume the functions, the implementation of which usually requires the involvement of a specialist or play the role of an assistant for the person making the decision. In other words, a system (technical or social) that requires a decision can be obtained directly from the program or through an intermediate link - a person who communicates with the program. The decision maker can be an expert with his own rights, in which case the program can "justify" its existence, increasing the effectiveness of its work. An alternative is that a person working in cooperation with such a

program can achieve with its help results of higher quality. Generally speaking, the correct distribution of functions between a person and a machine is one of the key conditions for the high efficiency of implementing expert systems.

The main advantage of ES is the ability to accumulate knowledge, preserve them for a long time, update and thereby ensure the relative independence of a particular organization from having qualified specialists in it /3, p. 74/. Accumulation of knowledge allows to improve the qualification of specialists working in the enterprise, using the best, proven solutions.

History of development of expert systems

The most well-known ES, developed in the 1960s and 1970s, have already become classical in their areas. By origin, subject areas and by the continuity of the ideas, methods and tools used, they can be divided into several families /4, c. 55/:

1. META-DENDRAL. The DENDRAL system allows to determine the most probable structure of a chemical compound from experimental data (mass spectrography, nuclear magnetic resonance data, etc.) M-D automates the process of acquiring knowledge for DENDRAL. It generates rules for constructing fragments of chemical structures.

2. MYCIN-EMYCIN-TEIREIAS-PUFF-NEOMYCIN. This family of medical ES and service software for their construction.

3. PROSPECTOR-KAS. PROSPECTOR- is intended for search (prediction) of deposits on the basis of geological analyzes. KAS - knowledge acquisition system for PROSPECTOR.

4. CASNET-EXPERT. CASNET-medical ES system for diagnosis of issuing recommendations for the treatment of eye diseases. Based on it, the language of knowledge engineering EXPERT was developed, with the help of which a number of other medical diagnostic systems were created.

5. HEARSAY-HEARSAY-2-HEARSAY-3-AGE. The first two systems of this series are the development of an intelligent system for recognizing a single human speech, the words of which are taken from a given dictionary. These systems are characterized by an original structure based on the use of a bulletin board-a global database containing the current results of the system. Later, on the basis of these systems, the HEARSAY-3 and AGE instrumental systems (Attempt to Generalize-attempting communication) were created to construct the ES.

6. AM (Artificial Mathematician-Artificial Mathematician) and EURISCO systems were developed at Stanford University by Dr. D. Lenat for research and training purposes. Lenat believes that the effectiveness of any ES is determined by the knowledge embedded in it. In his opinion, in order for the system to be capable of learning, about one million general information should be introduced into it. This roughly corresponds to the amount of information that a four-year-old child with average abilities has. Lenat also believes that the

way to create highly specialized ES with a reduced amount of knowledge leads to a dead end.

In the AM system, about 100 withdrawal rules and more than 200 heuristic learning algorithms were initially laid, allowing to build arbitrary mathematical theories and representations. At first the results of the system were very promising. She could formulate the notions of a natural number and prime numbers. In addition, she synthesized a variant of the Goldbach conjecture that every even number greater than two can be represented as a sum of two primes. So far, neither the evidence of this hypothesis has been found, nor can it be refuted. The further development of the system slowed down and it was noted that despite the "mathematical abilities" shown at the beginning, the system can not synthesize new heuristic rules, i.e. its capabilities are determined only by those heuristics that were originally built into it.

When developing the EURISCO system, an attempt was made to overcome these shortcomings of the AM system. As in the beginning of the AM operation, the first results obtained with the help of EURISCO were effective. It was reported that the EURISCO system can successfully participate in very complex games. With her help in the military-strategic game conducted by the US Navy, a strategy was developed containing a number of original tactical moves /5, p. 82/. According to one of them, for example, it was proposed to blow up their ships that had been damaged. In this case, the ships that remain undamaged, receive the necessary space to perform the maneuver.

However, after a while it was discovered that the system does not always correctly redefine the rules originally laid down in it. So, for example, she began to violate a strict instruction to apply to programmers with questions only at certain times of the day. Thus, the EURISCO system, like its predecessor, has stopped in its development, reaching the limit, ultimately determined by its developer.

Since 1990, Dr. Lenat, at the head of the research group, has been busy coding and introducing several hundred thousand elements of knowledge, which, in his opinion, are necessary to create an "intellectual" system. This project is called Cyc .

Characteristics of Expert Systems

When developing an expert system, it is common to divide it into three main modules, as shown in Fig. 1 /6, c. 53/:

(1) knowledge base,

(2) an inference machine,

(3) user interface.

The knowledge base contains knowledge relevant to a particular application area, including individual facts, rules that describe relationships or phenomena, and possibly methods, heuristics, and various ideas related to solving problems in this application area. The inference engine can actively use the information contained in the knowledge base. The interface with the user is

responsible for the uninterrupted exchange of information between the user and the system; It also gives the user an opportunity to observe the process of solving problems that occur in the inference machine. It is customary to consider the output machine and interface as one large module, usually called the shell of the expert system, or, for brevity, simply the shell /7, c. 73/.

In the structure described above, knowledge itself is separated from algorithms using this knowledge.

Such a separation is convenient for the following reasons. The knowledge base, obviously, depends on the particular application. On the other hand, the shell, at least in principle, is independent of the applications. Thus, a reasonable way to develop an expert system for several applications is to create a universal shell, after which for each application it is sufficient to connect a new knowledge base to the system. Of course, all these knowledge bases must satisfy one and the same formalism, which the shell «understands». Practical experience shows that for complex expert systems, our scenario with one shell and many knowledge bases does not work as smoothly as it would like, except when the application areas are very close. Nevertheless, even if the transition from one applied domain to another requires modification of the shell, then at least the basic principles of its construction can usually be maintained.

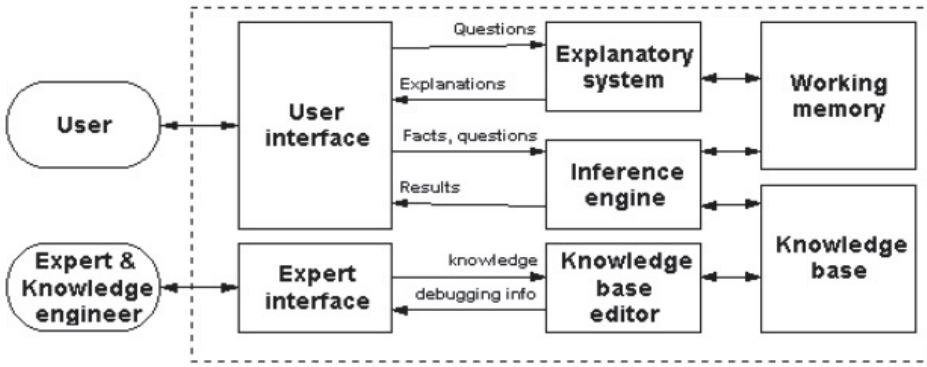

Fig. 1 Structure of the expert system

The expert system differs from other application programs by the presence of the following features /8, c. 62/:

• It simulates not so much the physical (or other) nature of a particular problem area, as the mechanism of human thinking with regard to solving problems in this problem area. This significantly distinguishes expert systems from systems of mathematical modeling or computer animation. One can not say, of course, that the program reproduces the psychological model of a specialist in this subject area (an expert), but it is important that the main attention is paid to the reproduction by computer means of the problem-solving technique used by the expert, ie. doing some part of the tasks in the same way (or even better), as the expert does.

• The system, in addition to performing computational operations, generates certain ideas and conclusions, based on the knowledge that it has. Knowledge in the system is presented, as a rule, in some special language and stored separately from the actual program code, which generates conclusions and considerations. This component of the program is usually called the knowledge base.

• In solving problems, the main ones are heuristic and approximate methods, which, unlike algorithmic ones, do not always guarantee success. Heuristics, in essence, is the rule of influence, which in machine form represents some knowledge acquired by a person with the accumulation of practical experience in solving similar problems. Such methods are approximate in the sense that, firstly, they do not require exhaustive background information, and secondly, there is a certain degree of certainty (or uncertainty) that the proposed solution is correct.

Expert systems differ from other types of programs from the field of artificial intelligence.

• Expert systems deal with real-world objects, operations with which usually require significant experience gained by a person. A lot of programs from the field of artificial intelligence are purely research and focuses on abstract mathematical problems or simplified versions of real problems (sometimes they are called "toy" problems), and the goal of such a program is "to increase the level of intuition" or to practice the technique. Expert systems have a pronounced practical orientation in the scientific or commercial field.

• One of the main characteristics of the expert system is its productivity, i.e. the speed of obtaining the result and its reliability (reliability). Research programs of artificial intelligence may not be very fast, you can come to terms with the existence of refusals in certain situations, because in the end it is a research tool, not a software product. But the expert system should find in a reasonable time a solution that would not be worse than what an expert in this subject area can offer.

• The expert system should be able to explain why such a solution was proposed, and to prove its validity. The user must obtain all the information necessary to him in order to be sure that the decision is made "not from the ceiling". In contrast, research programs "communicate" only with their creator, who already (most likely) knows what the result is based on. The expert system is designed in terms of interaction with different users, for which its work should be, if possible, transparent.

Areas of application of expert systems

Areas of application of knowledge-based systems can be grouped into several main classes: medical diagnostics, control and management, fault diagnosis in mechanical and electrical devices /9, p. 84/:

a) Medical diagnostics.

Diagnostic systems are used to establish a link between impairments in the body's activity and their possible causes. The most known diagnostic system MYCIN, which is designed to diagnose and monitor the condition of the patient with meningitis and bacterial infections. Its first version was developed at Stanford University in the mid-70s. At present, this system makes a diagnosis at the level of a specialist doctor. It has an expanded knowledge base, which can be used in other fields of medicine.

b) Forecasting.

Predictive systems predict possible outcomes or events based on the current state of the object. The software system "Winning the Wall Street" can analyze the market situation and use statistical methods of algorithms to develop a plan for you investment in the future. It does not belong to the number of knowledge-based systems, since it uses procedures and algorithms of traditional programming. Although there are as yet no ESs that are able to help you increase your capital due to your information on the market situation, forecasting systems already today can predict weather, yield and flow passengers. Even on a personal computer, by installing a simple knowledge-based system, you can get a local weather forecast.

c) Planning.

Planning systems are designed to achieve specific goals in solving problems with a large number of variables. Damascus company Informat for the first time in trade practice provides customers with 13 workstations installed in the lobby of their office, where they hold free 15-minute consultations to help customers choose the computer that best suits their needs and budget. In addition, Boeing uses ES to design space stations, as well as to identify the causes of aircraft engine failures and helicopter repairs. Expert system XCON, created by DEC, serves to determine or change the configuration of computer systems such as VAX and in accordance with the requirements of the buyer. DEC is developing a more powerful XSEL system, which includes the knowledge base of the XCON system, in order to help customers choose the computers with the required configuration. Unlike XCON, the XSEL system is interactive.

d) Interpretation.

Interpretive systems have the ability to derive certain conclusions based on observation results. The PROSPECTOR system, one of the most well-known systems of the interpretive type, combines the knowledge of nine experts. Using a combination of nine methods of examination, the system managed to discover deposits of ore worth $ 1 million, and the availability of these deposits did not involve any of the nine experts. Another interpretive system is HASP / SIAP. It determines the location and types of vessels in a quiet ocean according to acoustic tracking systems.

e) Control and management.

Knowledge-based systems can be used as intelligent control systems and make decisions by analyzing data from several sources. Such systems already operate on nuclear power plants, control air traffic and carry out medical control. They can also be useful in regulating the financial activities of an enterprise and assisting in the development of solutions in critical situations.

e) Diagnosis of malfunctions in mechanical and electrical devices.

In this area, knowledge-based systems are indispensable both in the repair of mechanical and electrical machines (cars, diesel locomotives, etc.), and in the elimination of faults and errors in the hardware and software of computers.

Conclusion

So, since the 70s, ES have become a leading direction in the field of artificial intelligence. When they were developed, the AI methods developed earlier were used: methods of representing knowledge, inference, heuristic search, recognition of sentences in natural language, etc. It can be argued that it was the ES that made it possible to obtain a very large commercial effect from using such powerful methods. This is their special role.

To develop an ES, it is necessary to have a special kind of specialists who possess this set of knowledge and perform the functions of "intermediaries" between experts in the domain and computer (expert) systems. They were called knowledge engineers (in the original - knowledge engineers), and the process of developing ES and other intellectual programs based on the representation and processing of knowledge - knowledge engineering (knowledge engineering). In developed foreign countries, the "knowledge engineer" specialty has been introduced in many universities, in our country the fundamentals of knowledge engineering are studied so far in the framework of specializations in system programming. The functions of the expert and knowledge engineer are rarely combined in one person. More often the functions of the knowledge engineer are performed by the developer of the ES. As the experience of many developments has shown, for the initial acquisition of knowledge, involving experts, knowledge engineers and EC developers, active work of all three categories of specialists is required. It can last from several weeks to several months.

Integration of all types of software products and their individual components into a single ES is recognized as economically profitable, since the use of ES allows to significantly reduce the costs of training qualified personnel, further testing the operability and reliability of the developed and research systems, and also to reduce design and research time.

Object technology, on the basis of modern ES can be created and developed, is a significant step forward in comparison with CASE-tools, as it is similar to our perception of the surrounding reality. Our notion of modeling changes, the same happens with objects, so the accompaniment of programmable objects can be performed in a similar way to the adaptation of our speculative images to a change in the surrounding conditions. This

technology is perfectly suited to analysts and programmers, as it is very similar to the problem solving strategy and corresponds to the thinking processes of people who are considered experts in their field.

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