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EXPERT SYSTEMS IN MEDICINE

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Abstract

Recent advances in the field of artificial intelligence have led to the emergence of expert systems. Paper is devoted to these systems. Expert system is an artificial intelligence program that has expert-level knowledge about a particular domain and knows how to use its knowledge to respond properly. The paper is of interest to people fond of artificial intelligence. Expert systems are used to help people make decisions in a whole range of situations, example in hospitals expert systems can help doctors diagnose illnesses and suggest treatments. Development of medical expert systems is rather actual today. The paper gives a detailed analysis of two experimental medical systems – PUFF, HDP.

Key words

Expert systems, human expert, artificial intelligence, neural networks, production rules, knowledge base.

Introduction

Expert systems were first introduced by researchers in the Stanford Heuristic Programming Project, including the "father of expert systems" with the Dendral and Mycin systems. Principal contributors to the technology were Bruce Buchanan, Edward Shortliffe, Randall Davis, William vanMelle, Carli Scott and others at Stanford.

Expert systems are designed to help people make decisions by making the knowledge of a human expert available to them in a software package. Expert systems are used to help people make decisions in a whole range of situations.

- In the financial world they are used by people to make decisions about investments, risks, and complex projects;
- In hospitals expert systems can help doctors diagnose illnesses and suggest treatments;
- In the oil industry they are used in exploration for oil fields;
- In industry expert systems are used to help maintain and repair equipment;
- In factories they are used to help manage complex production processes.

An Expert systems is a knowledge-based computer program containing expert domain knowledge about objects, events, situations and courses of action, which emulates the process of human experts in the particular domain. In other words, expert system is a computer application that performs a task that would otherwise be performed by a human expert.

Development of medical expert systems is rather actual today, by means of such systems, the doctor can avoid own mistakes. These systems can be applied to various tasks of medicine domains including prediction, design, monitoring, instruction, control, generation of alerts and reminders, diagnostic assistance, therapy critiquing and planning, information retrieval, image recognition, and interpretation.

Expert systems have one huge difference from other systems of artificial intelligence: they are not designed to solve some of the universal tasks, such as neural networks and genetic algorithms. Expert systems are designed for high-quality solutions to some tasks of developers, in rare cases - areas.

Expert systems are extensively used in the medical field. The most popular are:

1. PUFF – expert system to diagnose lung diseases on the basis of pulmonary function
2. SPE – makes the diagnosis of states in inflammatory processes;
3. ABEL – diagnoses of acid and electrolyte disorders;
4. AI / RHEUM – diagnosis of diseases of the connective tissue;
5. CADUCEOS – diagnosis of general internal medicine;
6. BLU FOX – diagnosis and treatment of depression;
7. CASNET/GLACOMA – diagnosis and treatment of eye diseases associated with glaucoma;
8. MYCIN – diagnostics and treatment of infectious diseases;
9. HDP – is a large diagnostic program covering most areas of heart disease.
10. ONCOCIN – treatment of cancer patients chemotherapy and supervision over them;
11. PIP - diagnosis of kidney disease;
12. MODIS-2 – symptomatic diagnosis of hypertension;
13. GUDON – learning system of diagnosis and treatment of infectious diseases.

From the transferred medical expert systems was decided to consider in detail PUFF, HDP systems.

Pulmonary Function System (PUFF):

PUFF can diagnose the presence and severity of lung disease and produce reports for the patient's file PUFF was the first system developed using EMYCIN (Essential MYCIN, van Melle, 1979). It included the domain-independent features of MYCIN:

- rule interpreter;
- explanation;
- knowledge acquisition.

This provided a mechanism for representing domain-specific knowledge in the form of production rules, and for performing consultations in that domain. PUFF was originally written in Interlisp using the SUMEX-AIM computer facility and had to be rewritten in BASIC before it could be installed at PMC. PUFF does not require direct interaction with a physician, avoiding the human engineering problem.

RULE31
IF:
1. The severity of obstructive airways disease of the patient is greater than or equal to mild, and
2. the degree of diffusion defect of the patient is greater than or equal to mild, and
3. the TLC observed/predicted of the patient is greater than or equal to 110, and
4. the observed/predicted difference in RV/TLC of the patient is greater than or equal to 10
THEN:
1. There is strongly suggestive evidence (0.9) that the subtype of obstructive airways disease is emphysema, and
2. It is definite (1.0) that "OAD, Diffusion Defect, elevated TLC, and elevated RV together indicate emphysema" is one of the findings

Fig. 1. Example of a PUFF rule

Knowledge Representation: there are 75 clinical parameters (representing pulmonary function test results such as "total lung capacity" and "residual volume").

Control Structure: PUFF is primarily a goal-directed, backward chaining system employing some 400 production rules. If it cannot conclude the value for a parameter, it asks the user. A pulmonary physiologist reviews the PUFF report, and if necessary modifies it on-line before printing it out. The report was found not to require modification in 85% of cases.

Advantages of PUFF

1. Many medical expert systems had required large amounts of time for data input, PUFF produced PF interpretations automatically without the necessity for user interaction. The data needed to interpret patient status are available in a computer from the patients history and from measurements taken in a laboratory. Other information is not required in order to produce accurate diagnoses of pulmonary disease in the patient.
2. The amount of domain-specific knowledge involved in pulmonary function testing is limited enough to make it feasible to acquire, understand, and represent that knowledge.
3. It is easy to use PUFF system and the clinical staffs in the PF lab were already receptive to the use of computers within their clinical routines.

Disadvantage of the model-driven paradigm is that the correct solution depends heavily on the correct model and initial focus. If the system begins by focusing on an incorrect diagnosis, it will check only the data that are relevant to wrong diagnosis

Russian equivalent of the expert system is a “ORION” .A new medical technology ORION (assessment of the major noncommunicable disease risk) is the first Russian expert system (ES) which not only assesses absolute and relative total levels of 10-year individual risk of major chronic non-communicable diseases (NCD), but also identifies high-risk groups and provides the basis for targeted, effective and cost-effective preventive interventions in these groups.

Heart Disease Program (HDP):

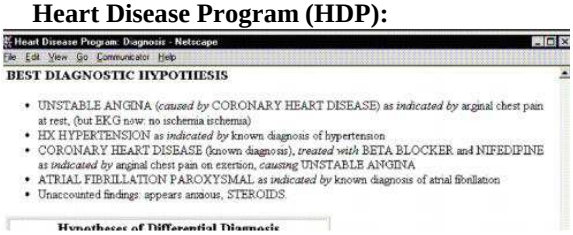

Fig. 2. Mechanisms to summarize and explain diagnoses

The HDP is a large diagnostic program covering most areas of heart disease. The physician can enter patient information about the history, physical examination, and laboratory tests, and then the program generates detailed explanations of differential diagnoses indicating the clinical data items which support each diagnosis. Its' Purpose is to assist physicians in the diagnosis of patients with heart disease.

The Heart Disease Program (HDP) can be divided into 3 main components:

1. A user interface.
2. The knowledge base and inference mechanisms.
3. Mechanisms to summarize and explain diagnoses

Knowledge Representation

Knowledge must be modeled or represented in a way that a computer can process. The model of knowledge used by expert system is called knowledge base. The knowledge base of first version of HDP was rule based; a program has large number of interconnected and nested IF- THEN statements, or rules, that are the basis for knowledge in the system. However, it soon became apparent that uncertainty plays large part in the diagnosis and management of heart disease that the program had to deal with probabilities directly.

For this reason, the knowledge base of second version of HDP is implemented as a network of 200 nodes, analogous to a Bayesian belief network, representing common potential heart diseases. The nodes are linked by probabilities; the probability on the link may be fixed or dependent on patient data. However, nodes in the HDP can represent different severity levels of diseases, and feedback loops are permitted. Mechanisms to reason about the time course of symptoms and diseases are incorporated. The output vocabulary of HDP includes over 200 terms and the input vocabulary includes about 500 terms.

Advantages of HDP: HDP is a web based diagnostics system that available from any point on the Earth 24 hours per day, so it spreads the expert knowledge of a few highly skilled advanced doctors leading experts in their fields to a much broader medical staff.

Problem of HDP: Time required entering data, expecting physicians to enter a lot of clinical data like physical examination, and laboratory tests. Survey of participating physicians indicates that these difficulties stem from lack of familiarity with computer systems. For this problem, I suggest instead of enter all these information extract data directly from patient record in hospital information system.

Russian equivalent of the expert system is a “KardioEkspert”. Expert System "KardioEkspert" provides services to further analyze the results of functional diagnosis of the cardiovascular system (veloergometry and spiroergometry) and the formation of an expert opinion containing evidence-based conclusions about the current state of the patient and the potential for life-threatening diseases in the near future.

Conclusion

In summary, it should be noted that despite all these limitations, expert systems have already proved their entire value and significance in many important applications.

Table 1. Comparative analysis of two MES

	MES	
	PUFF	HDP
Expert system diagnose	lung	heart
GUI	-	+
Easy to use	+	+
Rules	IF- THEN	IF- THEN
Knowledge base	64 production rules, 69 clinical parameters	network of 200 nodes
Agreement on Diagnosis	92	98

In summary, it should be noted that despite all these limitations, expert systems have already proved their entire value and significance in many important applications.

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ИССЛЕДОВАНИЕ ЗАВИСИМОСТИ КАЧЕСТВА КЛАССИФИКАЦИИ ОТ РАЗЛИЧНЫХ ПАРАМЕТРОВ ИНС

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Введение

Искусственный нейрон (ИН) – является математической функцией, представляющей собой модель биологического нейрона, и является главной структурной единицей искусственной нейронной сети (ИНС). ИН получает на вход значения сигналов и суммирует их для получения значения выходного сигнала. Сумма является взвешенной и пропускается через нелинейную функцию – функцию активации (рис. 1).

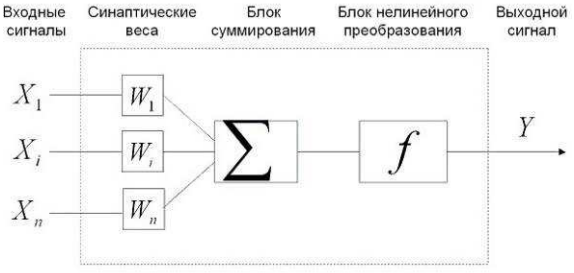

Рис. 1. Модель Искусственного нейрона