DEVELOPMENT OF EXPERT SYSTEM APGAR AND SILVERMAN ANDERSON SCORING MODELS

Хассанин Х. М.

Berestneva O. G.

Tomsk Polytechnic University

Introduction

Apger and Silverman Anderson are first quick assessments of the newborn’s overall well-being, which given one minute after birth and five minutes after birth. If there are concerns about the baby's condition or the score at 5 minutes is low, the test may be scored for a third time at 10 minutes after birth. Apgar is a very widely common used nowadays. Apgar expert system (AES) is the process of applying Apgar score model using the new information technology tools with artificial intelligence methods for monitoring and assessing newborn status automatically during the first five minutes after birth in the hospitals.

The purpose of this work is providing decision support system for assess all main newborn activities for depression of cardiopulmonary and neurological function as it is considered quick medical diagnosis for doctors for Neonatal Assessment.

Expert systems

Artificial Intelligence is the ability of a machine to perform functions that would be considered intelligent, if performed by a human being, for example, to make a decision [1]. One possible application of this concept are expert systems, specialized computer programs designed for a specific area of knowledge, which uses artificial intelligence.

Expert systems have been implemented to support decision making in several areas of medical, but few works has been done in the field of neonatal assessment. Some expert systems have been developed to assist not only specialists, but also general practitioners [2]. In nursing, the circumstances are not very different. Moreover, Russia has few nurses who are specialists in this area, and an expert system could be very useful in clinical practice or teaching. In addition, according to some authors [3], expert systems could be particularly well suited for use in newborns medical investigations.

The following characteristics are present in proposed expert systems [1]:

• They simulate the manner in which one or more human specialists solve a problem;

• They use the knowledge of one or more people (not taken from the scientific literature or other non-human sources of knowledge) explicitly represented in the program. This knowledge is acquired through particular techniques from Knowledge Engineering;

• The preferential tasks for this kind of system are fundamentally those of a symbolic nature, which involve complexities and uncertainties usually only solvable with *good sense* rules and implementation of reasoning similar to human thinking;

• The capability of using knowledge in problem solving permits that the search for solutions of complex problems be conducted in a guided manner, in opposition to the search for exhaustion of conventional computerized systems.

In order to make a decision about a given subject, the human expert, starting with the facts found and hypotheses formulated, searches in his memory for previous knowledge that has been stored for a long time, in his formative years and in the course of his professional life, about such facts and hypotheses. Then, in accordance with his experience and his accumulated knowledge on the subject, he makes his decision. During the reasoning process, he verifies the importance of the facts found and goes on formulating new hypotheses and verifying new facts; and these new facts will influence the reasoning process. This process is always based on previously accumulated knowledge. A specialist may not arrive sat a decision with this reasoning process if the facts on hand to apply his previous knowledge are not sufficient. He may, for this reason, arrive at a wrong conclusion; but this mistake is justified in function of the facts found and his previously accumulated knowledge.

An Expert System should have the capability of learning new knowledge and, in this manner, improve its reasoning performance and the quality of its decisions. Since the Expert System is not influenced by external elements, as occurs with the human specialist, it should offer the same set of decisions for the same conditions[4].

Therefore, the expert systems may be used in two different ways [5]:

1. Decision support: the program helps the professional to remember topics or options, which it is believed he knows, but may have forgotten or ignored. This is the most common use in medical and diagnoses.

2. Decision making: it makes the decision for someone, as it would imply something beyond his training and experience level. This is the most common use in many industrial and financial systems.

The structure of an expert system is composed of four essential components [4] as shown in figure [1]:

1. Knowledge Base: an information base containing all the relevant knowledge about a problem in an organized form [1]- the place where the facts (data) and the rules are stored. The content of the knowledge base is of two main types: *factual knowledge*, in the form of proven information and accepted by the scientific community; and *heuristic knowledge*, in the form of *common sense* rules obtained through the experience of experts. These rules result from the intuition of specialists that usually cannot prove them scientifically [1];

2. *Acquisition Interface*: used to modify and add new knowledge to the base by the experts;

3. *Inference Mechanism*: a set of intelligent methods of knowledge manipulation [1]. Part of the program that will interact with the user in the search mode and access the knowledge base to make inferences about the case proposed by the user; and

4. *User Interface*: it is activated each time the user requests an explanation about a particular decision made by the system, or about any fact or knowledge stored in the base as it is shown in figure [1] and [2]. The independence between the form of specialized knowledge storage and the form of utilization of this knowledge allows the updating of knowledge stored in the system without implying in modifications of the program code and this allows for the conclusion proposed to be based on updated knowledge about a given knowledge domain [1].

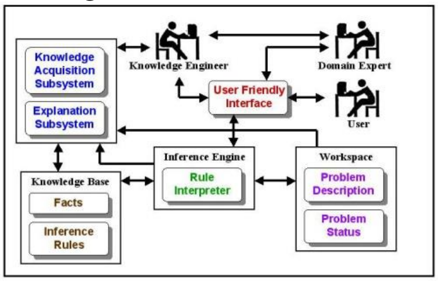

Fig. 1: Expert system structure

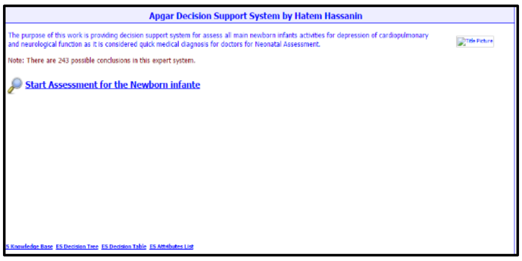

Fig. 2: Expert system User Interface

Expert systems for neonatal assessment – APGAR

The figure [3] below shows how these components interact to provide solutions for problems requiring a high level of expertise in a specific domain.

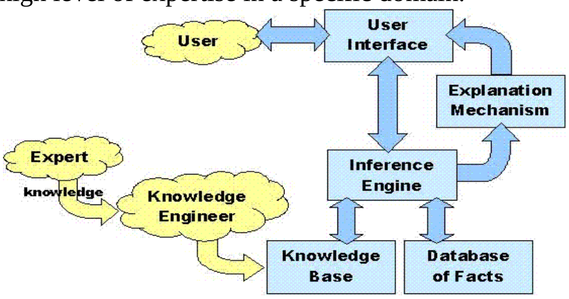

Fig. 3: Expert system components

Systems with rule-based logic

The rule-based logic was able to eliminate some difficulties of algorithms. They are sentences, usually conditioned phrases, of the type *IF something occurs THEN other thing occurs, OTHERWISE another thing is expected*, stored in a file containing the knowledge base. Example [5] as in figure [4]:

IF the baby has skin color blue (0), **AND** the heart rate is absent (0), **AND** the respiration is absent (0), **AND** there is no reflex response to nose catheter (0), **AND** the muscle tone is limp (0), **THEN** the diagnosis for this baby is very serious case and need medical assistance urgently.

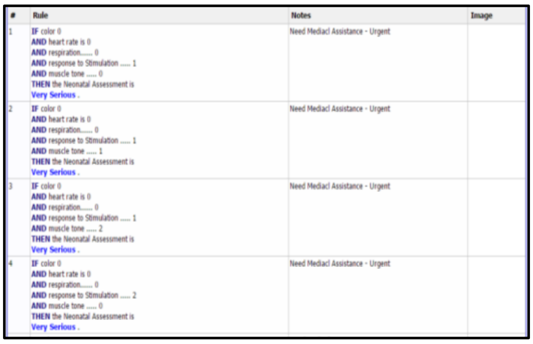

Fig. 4: Knowledge Base Rules for purposed expert system.

The explanation mechanism is an important feature of expert systems. It explains how the system has reached a decision and can also allow users to find out why it has asked a particular question. Because it is a rule based, the system is able to provide the user with an explanation of which rules were used during the inference process. This allows the user to make a judgement on the reliability of the decision. As mention in figure [5] there is a decision support tree which shows all the attributes of the system and their value.

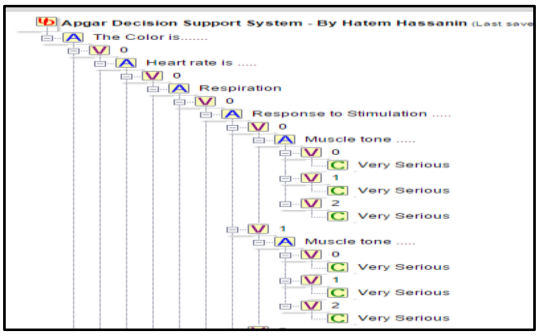

Fig. 5: Decision support tree

The aim of the system, according to the authors, was to use the parameters obtained APGAR scoring system to arrive at the correct diagnosis. The expert system shell EXSYS, a rule-based system with the possibility of assigning probabilities to the different solutions, was used. Shell is a system that may be used to prepare new expert systems by means of addition of new knowledge, corresponding to the new problem domain [6].

Tree diagrams were created for each diagnosis and the corresponding predictive values (statistical approach) were calculated; then rules based on the authors' experience (heuristic approach) were added as it shows in figure [6]:

Node	Text	Values	Notes	Image
The Color is.......	Color	0 [Pale or Blue] 2 [Normal color - completely pink] 1 [Normal color body, but blue extremities (arms and/or legs)]	Skin color: If the skin color is pale blue, the infant scores 0 for color. If the body is pink and the extremities are blue, the infant scores 1 for color. If the entire body is pink, the infant scores 2 for color.	
Heart rate is ___	Heart rate is	2 [good strong heartbeat] 1 [slow but steady heartbeat] 0 [little or no heartbeat]		
Respiration	Respiration.....	0 [Not breathing] 1 [Weak cry, irregular breathing] 2 [Strong cry]		
Respiration	Respiration.....	0 [Not breathing] 1 [Weak cry, irregular breathing] 2 [Strong cry]		

Fig. 6: Expert system list of attributes

Conclusions

In spite of the good performance of the expert systems to differential diagnosis of APGAR scoring parameters here, there are problems associated with using systems based in artificial intelligence to decision support on this field, which also happen in other medical expert systems.

Firstly, health professionals frequently hesitate to use the computer system to support their decision making process. There are many reasons for this to happen, from ignorance about of these computer systems to insecurity about of the paper that they can carry out.

Second, there are important ethical aspects that should be considered and that are commonly misunderstood. One of them referred to the difficulties in determining correctly the responsibility if the *opinion* of the expert system are incorrect. On the other hand, with an ever-increasing medicolegal environment, the surgeon may be found to be negligent if the expert system had not been preoperatively consulted. However, the development of expert systems may be useful not only for teaching purposes but also as decision support in daily clinical practice, making expert knowledge accessible to less experienced professionals and helping health professionals to manage with a lot of information that are important for an adequate diagnostic process and patient treatment.

References

1. Abel M. Sistemas especialistas [texto na Internet].1998 [citado 2006 abr. 23]. Disponível em:http://www.ppgia.pucpr.br/ ~scalabrin/SE_MILTON/SistEspec%20MaraAbel%20mar2002.pdf.
2. Laurikkala J, Juhola M, Lammi S, Viikki K. Comparison of genetic algorithms and other classification methods in the diagnosis of female urinary incontinence. Methods Inf Med. 1999;38(2):125-31.
3. Riss PA, Koelbl H. Development of an expert system for preoperative assessment of female urinary incontinence. Int J Biomed Comput. 1988;22(3/4):217-23.
4. Fávero AJ, Santos NM. Sistemas especialistas: tutorial [texto na Internet]. [citado 2006 abr. 23]. Disponível em: http://www.din.uem.br/ ia/especialistas/
5. Amêndola CS, Rabêlo FM, Santos NM. Sistemas especialistas e a medicina: introdução [texto na Internet]. [citado 2006 abr. 23]. Disponível em: http://www.din.uem.br/ia/intelige/especialistas/ medicina/introducao.html
6. Pappa GL. Sistemas especialistas: Shells [texto na Internet]. [citado 2006 abr. 23]. Disponível em:http://www.din.uem.br/ia/intelige/especialistas/ especialistas/shells.html