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Using Conceptual Frames to Define a Representation for a Medical Expert System that Evaluates Visual Pathologies

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Abstract. This Works propose the benefits of developing an expert system, specialized to evaluate visual diseases. The pathologies of interest in this work are: Diabetic retinopathy, macular degeneration, retinitis pigmentosa and glaucoma. These visual impairments are common in Mexico. The purpose of develop a medical expert system is to evaluate visual diseases with the aim of help people who have no resources or live in a distant town from the major cities in Mexico. We found that the majority of people affected are: in a productive age, have chronic conditions and misinformed about those problems. The number of ophthalmologist is reduced and the often they live in cities. Additionally, we show the type of reasoning methods are used to develop medical expert systems. And we conclude that it is necessary a knowledge representation to store the knowledge of the experts.

Keywords: Expert systems, knowledge representation, reasoning, visual impairments.

1 Introduction

Expert System (ES) has been contributing to the solution of complex problems. One of the first systems was DENDRAL, developed in 1965. This ES had the ability to deduce information about biochemical structures. Later Macsyma were born with the ability to perform complex mathematical analysis. Then HearSay which performs the early attempts of Natural Language interpretation [1]. The evolution of these systems

reaches their zenith in the eighties with the LISP machines. Enterprise applications like XCon form the DEC Company [2]. Since then we can see great variety of applications such as: interpretation, prediction, diagnosis, planning, monitoring, reparation, control, intelligent tutors [3].

In the case of a medical expert system one of the first attempts was MYCIN. The system was design to assist doctors. MYCIN gave a description of treatments for blood infections. Thanks to this specialist in microbiology were capable to provide expertise to other specialist, with less experience in the field. MYCIN asked a series of questions with the aim to recommend a treatment [4].

In Mexico there is a great demand of medical experts. Especially in areas like ophthalmology [5]. There are several advantages of capture the expert knowledge into an Expert System. For example we can have a system available all the time. We can translate it o remote regions of the country. The implementation cost is less than using a human expert. Finally we can have a formal representation of expert knowledge [4].

The following section describes some recent examples of SE used clinical support systems. Section 3 describes the conceptual frames designed to represent knowledge from visual pathologies.

2 Medical Expert Systems

This section reviews the different types of ES. Where we can find that the most used reasoning methods are: production rules [6], Framework for eliciting knowledge for a medical laboratory diagnostic expert system], Bayesian networks [7], pattern recognition. It was found that the common characteristic of medical expert systems they have a validation from an expert in a specific area [6,7] For example as it is shown in [el de la diabetes], a review of several systems developed for diabetes diagnosis. In this case, the majority of the reasoning methods are: production rules, fuzzy reasoning and case based reasoning. In this section we have found that a medical expert system is a very common kind of intelligent systems. Additionally, the knowledge of a system usually is limited to a particular domain. An expert is defined as a person whose knowledge is obtained gradually through a period of time. His learning and experiences shapes his procedural, analytic, social, cognitive, judgement and creative behavior [8]. To become an expert is necessary at least seven years of experience in academy or industry. Normally an expert occupation is classified as academic or industrial [9].

In [6] it shows an ES that helps to determine the age of a hand using an X-ray image. One of the main motivations of this work is to develop a system to detect malformations in children early. This can be a helpful tool to pediatricians. The common method used by specialist is to identify regions of a hand, denominated regions of special interest and then give a diagnosis. To build the body of knowledge were necessary to interview radiologist and endocrinologist pediatricians. After the interviews rules were obtained. Then the rules were modeled from the expert knowledge.

The article emphasizes that experts usually have different criteria to evaluate the bone age. So as a consequence every expert has it owns set of rules and evaluation criteria. Because of that it was necessary to classify and combine every rule from every expert. Finally bone age determination algorithm is developed which fuse all the rules from the experts.

In [7] it develops a clinic system to perform decisions. With the purpose of identify the probability of suffer from a heart failure angina. These suffering has increased because of factors like stress and poor alimentation. The main problem identified is that in a hospital there are not suitable tools for it diagnosis. That leads that patient with the characteristics of an angina to wait, and been observed. And the patient has to wait several hours.

The proposed solution is a web application, filled by a clinician. The system output is the probability the patient can suffer from these condition. The system gives the answers: low, medium and serious. According with the response of the system the patient feedbacks, the patient evaluates the result as correct or incorrect. Allowing the system to update it believes. The constructions of the network were developed the MATLAB library BNT

The system uses Bayesian networks to evaluate 17 variables. The project took place in Spain in a Valencian Hospital. The reasoning process is performed in language C using the NETICA API for Bayesian networks and the front end were using PHP, HTML and JavaScript.

A framework is proposed in [10], for the elicitation of a medical expert system. The aim is to elicit knowledge from expert, because the shortage of medical experts. The work is divided in three stages: The selection of an expert, the elicitation part and a fuzzy evaluation.

In the first stage, the framework proposed a selection of an expert. Many factors in the selection of an expert were identified. First be aware that the knowledge of an expert is affected for his personal experiences, perspectives and goals. Then the conditions where the expert gains his knowledge can be gained at the industry or in the academic field. It is also important to consider the number of publications and public debates.

The elicitation part of the framework, are described as follows: The positioning phase allows the knowledge engineer to "explain the structure of the system" that need to be described. Then a description phase permits to know the set of inferences by the expert. We also know the set of variables and a range of variables used by them. The work generates a form to obtain the first description of the knowledge. The aim of discussion phase is to validate, validate and improve the description obtained. The results are compared and analyzed to clarify the different in results from one expert to another.

3 Conceptual Frames

We propose a set of frames divided in: diseases, symptoms and risk factors. The frames are divided in three to have the possibility to ask an expert for each case

individually [4, 11]. The frame developed for eye diseases. We expose the proposal for the frames, the following are the proposal for the diseases.

3.1 Frames for Diseases

In table 1 it is shown the diseases for the different visual impairments, In the frame the synonyms are written for further explanation. In the image section. Human expert will provide information about how a patient visualized an image. For example, in diabetic retinopathy patients usually see a black hole in the center of their vision. Finally, in the risk factor play an important role. In order to relate other information, like the clinical history of the patient.

Table 1. Diseases.

Frame	Slot	Slot value
Diabetic retinopathy		
	Synonym	Diabetic eye disease
	Symptoms	Visual acuity, Blurred vision
	Images	Black hole in the center image
	Risk factors	Diabetes
	Inheritance	Yes, No
Macular degeneration		
	Synonym	Age-related macular degeneration
	Symptoms	Visual acuity, Blurred vision
	Image	Distorted vision, Missing of vision areas, shadows, Do not identify colors.
	Risk factors	Hypertension, age, atherosclerosis High cholesterol, obesity
	Inheritance	Yes, No
Retinitis pigmentosa		
	Synonym	Degenerative eye
	Symptoms	Visual acuity, Blurred vision
	Image	No central vision, Night blindness, Tunnel vision, Photophobia, Poor color separation, Slow adjustment to light, Head ache, Latticework vision.
Glaucoma		
	Symptoms	Visual acuity, Blurred vision
	Image analysis	Angle vision
	Risk factors	Hypertension
	Family History	Yes, No

3.2 Frames for Symptoms

The more common symptoms are discretized according to the level of importance. In table 2 it is shown some examples of them. In the case of the slot value for the frame visual acuity were classified from normal to no vision. Then we can see an example of the variables that the system will take into account, named as image analysis.

Table 2. Symptoms.

Frame	Slot	Slot value
Symptoms		
	Visual acuity	Over, Normal, Low, No vision
	Blurred vision	
Image analysis	Angle vision	Wide, central, reduced, none
	No central vision,	Yes, No
	Night blindness	Yes, No
	Tunnel vision	Yes, No
	Photophobia,	Yes, No
	Poor color separation,	Yes, No
	Slow adjustment to light	Yes, No
	Head ache	Yes, No
	Latticework vision.	Yes, No
	Distorted vision	Yes, No
	Missing of vision areas	Yes, No
	Do not identify colors	Yes, No
	shadows	Yes, No
	Black hole in the center image	Yes, No

3.3 Frames for risk factors

The frame risk factor has the intention to describe the elements that can affect directly or indirect the vision of a person. According with the specialist obesity and hypertension have a significant impact as an indirect factor. When you sum this factor can derive into a serial of important diseases. For example, high cholesterol combined with a hypertension can arise serious problems to a person. Especially if the person has 60 to 70 years old. Finally exert can decide which factor are more relevant in the analysis of vision. So the frames are deemed according their utility to the study of visual acuity. See table 3.

Table 3. Risk Factors.

Frames	Slot	Value
Risk factors		
	Hypertension	Yes, No
	Age	1,2,3
	Atherosclerosis	Yes, No
	High cholesterol	Yes, No
	Obesity	Yes, No
	Diabetes	Yes, No

4 Conclusions

According to expert we have found that the majority of the expert prefers divide visual impairment problems into three main categories: Diseases, Symptoms and Risk Factors. The elicitation process gives the necessity to ask further question in order to obtain more information about the diabetic problems since there so many factors related to the affection. Finally, the technology propose to the implementation is Python and Django framework.

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