Intelligent System for Diagnosing Tourette Syndrome using Case-based Reasoning

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Abstract. The process of medical diagnosis is always complex. It demands the valuation of multiple interacting factors in the case under examination. The signs and symptoms of the patient are put under the experienced opinion of one or more doctors who propose a corresponding treatment. With the advent of Artificial Intelligence (AI) techniques such as Case-based reasoning (CBR), education of medical subjects has become effective. CBR plays an important role in building intelligent system for disease prognosis and diagnosis. We discuss a CBR-based intelligent system built for diagnosing Tourette syndrome. The results of the proposed system justify its usefulness for diagnosing Tourette syndrome.

Keywords: Tourette syndrome, Case-based reasoning, Medical Education

1 Introduction

Last years of the present century and the first decades of the next one, indicate a tendency in the evolution of the research in the field of the health. The superior medical education, in its constant improvement, requires the introduction of technical outposts to prepare an individual able to stay updated in its specialty during all his or her life. National System of Mexican Health has developed a plan of action for increasing the quality of people's life by continuously updating the health sector professionals through innovative medical education systems. Human resource and its development are always important for a national growth. In the modern era, computer systems are an important ally for this purpose. Healthcare forms an integral part of improving quality of human life. Integration of modern intelligent systems for medical education plays a significant role. Tourette Syndrome (TS) is a widely known syndrome [1]. Hence an intelligent system built for educating health professionals about TS can be a very useful system. We discuss such system in this paper.

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This paper is organized into following sections. In section 2, we describe the Tourette syndrome, its causes and importance to build an intelligent system for providing medical education of TS. In section 3, we discuss the development of our system. In section 4 we discuss the proposed software. In section 5, we discuss results given by our system and lastly in section 6 we conclude our work.

2 Tourette Syndrome Description

In 1825 the first case of Tourette Syndrome (TS) was registered in medical Literature [2]. Marquise de Dampierre showed the symptoms such as involuntary tics in many parts of the body and several vocalizations including echolalia and coprolalia. She lived until 86 years. In 1885, a doctor Georges Gilles of the Tourette, a French neurologist, described a disorder characterized by tics. During the present century, many studies have been undertaken, in search of an explanation and of a solution of the above disorder. These studies show that 1% of the general population is affected by this disorder [3]. The causes of this disorder can be organic, hereditary or psychological. The "tics" are short duration involuntary movements. They are non-rhythmic, abrupt, repetitive and painful [4]. It is possible to suspend these movements for a limited time. However, it requires great amount of will power from the patient. Usually they worsen under conditions of stress, anxiety, annoyance and fatigue. They can also occur when something unpleasant is anticipated [5]. They can also be induced by the presence of certain stimuli such as cough or gestures of another person. However, its presence is reduced in the presence of strangers or certain physical activities like playing or doing repairs [6]. The tics and the TS can be associated to many other problems such as obsessive-compulsive upheavals, atentiocional deficit disorder with or without hyperactivity, problems of language, difficulties in the control of the impulses and dream disorders [7]. In order to prevent as well as make a correct diagnosis of this syndrome, it is important to have proper education among the healthcare professionals. In the next section, we discuss about the computer-based medical education systems.

2.1 Computer-based education systems

The computer-based education systems (e.g. linear programs, graft programs, generative systems) are also known as Computer Assisted Instruction Systems (CAIS) [8]. The main deficiencies of the CAIS are:

- They try to include complete courses instead of limiting itself to concrete subjects.
- Barriers of communication between the tutor and the student, which restrict the interaction among them.
- Students do not have knowledge of how and why the tasks are executed. Also the programs reacts using a series of anticipated situations independent of student’s answers.

- It is not possible to transfer these systems from one domain to other. They are domain incompatible.
- These systems tend to be static instead of evolving and dynamic.
- Once constructed, the knowledge that it includes is not updated with time.

In summary they are expensive and repetitive programs in which there is no relation between what is taught and how it is taught. Due to these problems and efforts made by certain researchers in this area, Intelligent Tutorial Systems (ITS) are developed. The ITS combines techniques of Artificial Intelligence (AI) with psychological models of the student and the expert. It also involves application of theories of the education [9]. We are proposing application of ITS for the education of Tourette syndrome. In next section, we will justify the need of such ITS.

2.2 Justification

Although the Tourette Syndrome is not a world-wide problem of health, the necessity to propose a CBR based system for its educational use does not arise from the number of TS incidents, but by the human aspect that chronic suffering may lead to much serious complications, if proper attention and care is not provided. Hence it would be useful to provide necessary information about the syndrome. Also CBR involves solving new problems using the solutions from the previous cases. It is a suitable approach for medical diagnosis as it involves proposing a corresponding treatment using past cases of the patients. This system is certainly valuable in the absence of a Psychiatrist or a Neurologist at the first level of attention in various societies [10]. Medical education systems must have high quality. In the context of undertaken development, the system will involve compilation and retrospective revision of material sources i.e. clinical histories of the real cases from psychiatric medical practice [11]. In order to define strategies and content of the system, the organization and analysis of the information will require the consultation of different specialists and experts, as well as the corresponding bibliographical revision. The following examples illustrates the utility of ITS for various medical applications.

2.3 Examples of ITS

In relation to Medical Sciences, the university cannot teach all the required knowledge, facts and abilities without informing new discoveries and changes in the medicinal science. Internet offers vast information on the new discoveries in the form of technical advances in the medical sciences, on-line educational sources with clinical histories, images and findings in different cases from various medical institutions. Users can surf all the existing advances in the world of telemedicine through a virtual university. With such advances in computer science, many applications are developed for medical education [12].
A Paediatric Hospital in Germany has applied Case-based reasoning for knowledge acquisition [13]. They developed a program called “Casus” to resolve the problem of education in medicine using a case library taken from real medical practice. The

program assists an apprentice to determine a diagnosis using its in-built case-library. This program gave satisfactory results and hence it is believed that this system can be used daily in future. Another example of such case-based system is a system involving case library with psychosocial aspects of the patients with breast cancer. The students learn from this system using "game of rolls". This system represents "patient" and "specialist" using a special style of presentation and is applicable to other types of cancer as well. Also it offers useful recommendations to the doctor [14].

In Italy, CBR systems are applied for medical education especially for learning and diagnosis of congenital malformations [15]. From the above examples, it is clear that case-based systems are quite useful systems for medical education. We propose to extend the application of such systems for the education of Tourette syndrome. Hence we develop such approach of Intelligent Tutoring for the education of Tourette syndrome.

3 Development of the System

The system will justify the solution from the similar cases. The knowledge acquisition process involved at least 35 cases mainly originating from the consultations of medical experts at the first level of attention in different areas. These cases were presented to the expert so that the experts perform diagnosis, prognosis and the medical conduct. The resident specialist diagnoses these cases. The specialists are either from Psychiatry or Neurology area. The expert confirms the diagnosis and then only it is incorporated in the system.

3.1 Methodology

To formulate a diagnostic conclusion in Psychiatry is a complex clinical problem. To obtain the efficiency of the expert, 87 % of the diagnosis given by the system must match with expert's diagnosis. Elements of observation by the expert must also be considered. Due to this complexity, there is always a scope of improvement to make the system as perfect as possible in future investigations.

Categorizing the diagnosis, prognosis and the medical conduct can test the specificity and sensitivity of the system. The proposed instrument will be a medical aid tool, which would be useful in orienting the medical conduct of TS. It would be more sensible and little specific to the variations in the phenomenon under study and the user's valuations. This is an important result, which justifies use of such tool. Also it is guaranteed that this tool will have a capacity of giving accurate results in more than 80 % of the diagnostic considerations.

The case library in the proposed tool would consist of use of interpretative type explanations and using archives with a similar extension [16]. It is feasible and easily transportable between different domains. It uses the option of internal correlations of the program and estimation of the weights assigned to the predicting characteristics. It defines 25 predicting characteristics and 3 objectives of the system. Those are:

i. The diagnosis in the 9 proposed groups

ii. Directions in the medical conduct to follow
iii. User's valuations with a total of at least 100 cases in its case library.

With this background discussion of the proposed system, we now present the development of the proposed software in the next section.

4 Developed Software

The intelligent system for diagnosing Tourette Syndrome (SIDSTOU), showed in this paper, is a program developed in Java using Jbuilder 9.0 [17]. It uses extension files *.sto that constitute the case library. Its application was very useful for the creation of the case-based system. It uses the option of internal correlations of the program and estimation of the weights of the predicting characteristics. It defines 25 predicting characteristics (See Figure 1) and 3 objectives of the system that are: the diagnosis in the 9 proposed groups, directions in the medical conduct to follow and user's valuations with a total of 355 cases in its case library. The following figure shows the software interface.

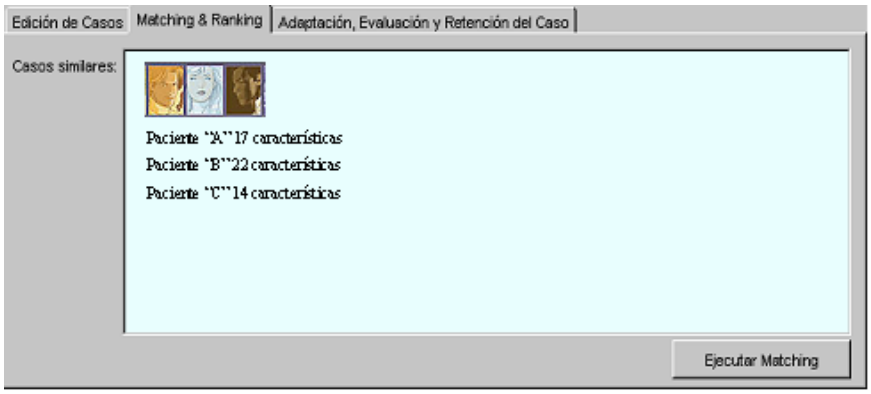

Fig. 1. Developed Software Interface

The system justifies its solution from the similar cases. It provides auto learning mechanism-using values of the predicting characteristics. It involved consultations of medical expert.

After this initial knowledge acquisition, 100 more cases unknown to the system are added. These cases were associated with psychiatric upheavals to the TS in adults. After constructing the case-base, the software gave the following results:

- 87% of efficiency for the diagnosis
- 89% for the medical conduct to follow
- 92% for the user's valuations.

These results are considered good. It meets the aims of the medical aid. It assists the doctor in consultation. These results show the effectiveness of this software over the

systems designed for study of the Tourette syndrome at the international level. The results provided in the next section justify the usefulness of the proposed system.

5 Results

In relation to specificity and sensitivity of the system, sensitivity from the instrument was 88.88%. Specificity of 85.45% with a predictive value for the true positives of 83.33% was obtained. Specificity with a predictive value for the truly negative ones was 90.38%.
In relation with the treatment, sensitivity of system was 93.5%. 78.57 % specificity was obtained. Specificity with a predictive value for true positives of was 91.78% and for truly negative ones was 81.48%. In case of prognosis, one obtained a sensitivity of 98.90%. Specificity of 22.22%, with a predictive value for the true positives was 92.78% and for truly negatives was 66.6% [See Table 1].
With relation to the number of cases in case library for a better expert operation, the expert with case library of 18, 36, 45, 72, 135 and 176 cases respectively was tested. The Chi-square test verified that the variables, number of cases and correct answers given by the system for the three objectives of exit had statistically significant relation for a smaller P of 0.001. The tests of Spearman correlation were not statistically significant. The exact criterion about the number of optimal cases is not decided at present for a greater effectiveness of the system. With greater number of cases, the amount of correct answers from the system was increased [See Table 2].

Table 1: Performance evaluation by the expert for 100 cases

Group	VP	VN	FP	FN	S %	E %	Predictive Value VP %	Predictive Value VN %	Efficiency
Personality T.	40	47	8	5	88.88	85.45	83.33	90.38	87%
Ambulatory T.	67	22	6	5	93.05	78.57	91.78	81.48	89%
Reserved Prognosis	90	2	7	1	98.90	22.22	92.78	66.66	92%

Where, Label:
VP: true positive. VN: true negative. FP: false positive.
FN: false negative. S: sensibility. E: specificity.
Predictive value of truly positives. Predictive value of truly negatives.

Table 2: Comparison of agreement between the experts and the human specialist for each one of objective characteristics

Number of Cases	Agreement in diagnosis	No agreement in diagnosis	Agreement in medical conduct	No agreement in medical conduct	Agreement in Prognosis	No agreement in prognosis
18	1	17	5	13	11	9
36	8	28	18	18	29	7
45	11	34	27	18	27	18
72	26	46	63	9	69	3
135	113	22	119	16	122	13
176	154	22	157	19	162	14

Chi-square for the diagnosis =175.641. Chi-square for medical conduct=81.669.
Chi-square for the prognosis=51.735. DF=5 Smaller P of 0.001.
Correlation Coefficient of Spearman for diagnosis=0.11595.
Correlation Coefficient of Spearman for medical conduct =0.34786.
Correlation Coefficient of Spearman for prognosis=0.144
Critical value -/+=0.81165 for a smaller P of 0.05

6 Conclusion

The proposal of using the case library for the education of the patient with Tourette syndrome is based on the set of aspects that are enunciated next and that constitute results of our investigations.

1. The results will have to at least agree with the results reported by Literature about Case-based reasoning. This tool with an acceptable effectiveness conserves the integrity of the knowledge and provides better results. It is reliable and relatively simple for its application.
2. The proposed case library is integrated by 28 characteristics with 288 possible values or domains and will have to contain at least 100 cases. It should use the criteria of Moriyama for the validation of the content.
3. Relation of statistically significant association with the test of Chi-square between the numbers of cases of case library exists.
4. The created software has an effectiveness of 87% in his diagnostic considerations, 89% in his capacity of direction in medical conduct to follow and of 92% in its predicted valuations. These results are considered good in comparison with the results obtained by the other authors [18].
5. The expert who sets out to create tool of medical aid for the diagnosis must be more specific. The expert's capacity of direction in the medical conduct to follow should be more sensible.
6. It is tried to widely value the utility of the expert who plans to create a tool of medical aid for the boarding of the patient with Tourette syndrome with psychiatric upheaval.

The above results are considered good. In summary, we have proved usefulness of the CBR based system diagnosing Tourette syndrome.

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