PROPOSAL OF A CASE-BASED REASONING MODEL FOR IACVIRTUAL PROJECT

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ABSTRACT

The IACVIRTUAL project (Artificial Intelligence Applied in the Modeling and Implementation of a Virtual Medical Office) proposes an intelligent system to simulate a Web-based Medical Office conceived to support *(i)* patients who are interested in following their medical reports, *(ii)* professionals interested in decisions support systems for diagnosis and treatment, and *(iii)* students interested in learning by following available medical cases. The IACVIRTUAL project has an Educational Module (that is based on Intelligent Tutor System) and a Decision Support Module that will use Case-Based Reasoning (CBR) to disease diagnosing and training of medical apprentice. This paper has as objective to present a CBR model in the context of this system.

KEYWORDS

Case-Based Reasoning. Virtual Medical Office. Decision Support System. Intelligent Tutor System.

1. INTRODUCTION

Computer science has been recognized as an important component in the process of decision taking, supporting, particularly, the medical diagnostics and education. Nowadays, thanks to the advances of the Information Technology, there are diverse proposals of virtual environment for the integration of people with common interests. In the medicine field, this virtual space can be guaranteed through Virtual Medical Offices. The IACVIRTUAL project (Artificial Intelligence applied in the Modeling and Implementation of a

Virtual Medical Office) aims the availability of an environment that promotes the integration of three kinds of people interested in health: patients, doctors and medical students (Almeida 2004).

In the field of the medical education, in which the evolution of the techniques of Artificial Intelligence (AI) and the research in the field of Cognitive Sciences brought a significant increase of the degree of "intelligence" of the educational systems, the Case-Based Reasoning (CBR) is being satisfactorily applied (Bichindaritz and Sullivan 2002). The CBR has a lot in common with our natural learning process. The human beings learn with problems that are presented to them and later decided. Firstly a system has to be capable to automatically generate solutions for problems, based of its knowledge of the domain, being able to be flexible. This feature allows the system to analyze complex and not common solutions for problems, and to recognize and to explain errors. On the other hand, the representation of the user behavior in learning models allows the system dynamically to adapt itself to the necessities of the student (Tsaganou 2002).

This paper describes a CBR model representing the interaction of the involved elements in the education and the medical diagnosis in the context of the IACVIRTUAL project.

2. MATERIALS AND METHODS

CBR (Kolodner 1993) is an approach for problem solution and for learning. This method tries to use past experiences (e.g., cases) for the solution of new problems. CBR solves a new problem using solution adaptations of already known similar problems.

The architecture of CBR systems generally follows a cycle known as 4R: *(i)* Recuperation: the most similar case or a set of them is recuperated from the case base; *(ii)* Reutilization: the information and knowledge that solved the recuperated problem is reutilized, associating its solution to the context of the current problem; *(iii)* Revision: the past solution is revised (if necessary) and adapted to be used in the new situation (problem); *(iv)* Retention: all the case elements considered useful to the new problem are stored in the case base. Further, it has to be decided how to store the case and how to index it for future recuperations (Aamodt and Plaza 1994). In the IACVIRTUAL project, CBR aims at dynamically mapping clinical cases to an electronic medical register in a case base. Such past experiences will be available to the professionals in the medical area through the processes of recuperation, reuse and retaining of these cases.

The IACVIRTUAL architecture has several modules being developed in the construction of the Virtual Medical Office (VMO). The main ones are: Data Module, User Module, Interface Module, Educational Module and Decision Support Module. In this step, the problems to be dealt with will be from the area of Cardiology. IACVIRTUAL will be used by three levels/types of users: the expert, the patient and the student. The system interface adapts itself according to the profile of the user (Almeida 2004). However, in this work the CBR is inserted in the Decision Support Module, but it also will help in the Education Module in learning of a medical apprentice or/and a medical professional.

The Educational Module of the VMO was based on the MATHEMA architecture (Costa 1995), which was conceived to provide a space for promoting cooperative interactions between an apprentice and a society of artificial tutor agents, having a human experts' society as a backup assistance for such interactions.

The knowledge of the expert is necessary in the phase of definition of the Architecture of Reasoning and in the definition of Cases. The expert collaborates with the delimitation of the characteristics and more important indexes and with the evaluation of the local and global similarity. Then, must have place a second stage of knowledge acquisition with the expert for the definition of the weights for calculation of global similarity. In all the moments must be used some techniques of Knowledge Acquisition to try to select the ideal functions of reasoning and weight for each attribute, in a manner that all the aspects involved in the recovery are represented the way the expert desires.

Global similarity measures determine the similarity between a case whose solution is not known and the cases of the base, considering all the indexes. Local Similarity Measures, used in the calculation of the global similarity, compares specific attributes (relevant characteristics), tuning the case recovery and making it more sensitive. The choice of a similarity local function depends on the characteristics of the attribute (numerical or binary, range of values or just one value) and how close is the function with the expert's way of reasoning.

The case recovery uses a sequential method, which calculates the measure of similarity for every record in the case base. The process of sequential recovery allows the determination of the k more similar cases. For the determination of a relation of specific preference for the situation, the concept of similarity is applied

successively to every one of the case base records. Then, all the cases are sorted according to the result of the similarity function (Kolodner 1993). In this project, the system will return *k* similar cases, in accordance with the set of parameters registered by the KE in the system. In its current version, the adaptation and retention of new cases are manually performed.

In order to demonstrate to the use of case representation proposed by the model, a base of cases referring to the Ischemic Cardiopathy disease was modeled and submitted to execution.

3. RESULTS

For validation of the CBR Model proposed, the base of cases was yielded by the Fundação Baiana de Cardiologia (Cardiology Foundation of the Bahia State, Brazil) with 1052 clinical records collected along two years, being 491 with low probability, 224 with intermediate probability and 337 with high probability to be suffering a severe coronary event.

In CBR systems the validation of the prediction is necessary, and it requires the existence of historical cases for test with known results or gotten of human experts. The validation occurs with the comparison between the results of the system and the already known results. This comparison proves that the system has a satisfactory accuracy in accordance with the desired. This evidence was performed using the approach of sensitivity and specificity (Friedland 1998). The terms sensitivity and specificity can be used basically for diagnostics that have only two outcomes: when it is used "to discard" or "to confirm" the problem in question. To execute the validation, every each case was removed from the base, one by one, then the test was performed and later on the case was returned to the base. This way, it was possible to fulfill the validation for 100% of the cases. For each case, it was generated the results of the global similarity functions defined in the model. Later, with the booth results of the final diagnosis and of the global similarity functions, it was created a worksheet with the results for the calculation of the sensitivity and the specificity.

4. CONCLUSION

Based on the proposed model, a case study was carried through, which evidenced that in the system we did not obtain a global similarity function that simultaneously takes care of to the variables of sensitivity and specificity. Hence, emerged the necessity of insertion of rules in the system so that it is possible to select the global similarity functions with the best results for the specificity and for sensitivity, this way, the system presents satisfactory results. CBR Module has contributed for the IACVIRTUAL project *(i)* suggesting and explaining medical diagnosis for support to the decision taking process and *(ii)* in the Educational Module, where the student learning can occur through problems presented to them and later solved.

REFERENCES

Aamodt, A., Plaza, E., 1994. Case Based Reasoning: Foundational Issues, Methodological variations and System Approaches. *Proceedings of AI Communications*, Vol. 7, N. 1, pp 39-59.

Almeida, C.W.D. et al, 2004. Virtual Web System for Realization of Consultation and Diagnosis. *Proceedings of the Conference on Medical Cybernetics in Clinical Practice in Burdenko Main Military Clinical Hospital, vol. 2*. Moscow, Russia, pp.98-110.

Bichindaritz, I. and Sullivan, K. M., 2002. Generating Practice Cases for Medical Training from a Knowledge-Based Decision-Support System. *Proceedings of Workshop on Case-Based Reasoning for Education and Training, 6th ECCBR*. Aberdeen, Scotland.

Costa, E.B. et al, 1995. MATHEMA: A Learning Environment Based on a Multi-Agent Architecture. *In J. Wainer and A. Carvalho (Eds.), Proceedings of 12th Brazilian Symposium on Artificial Intelligence, LNAI*, Vol. 991, Springer-Verlag, Campinas, Brazil, pp. 141-150.

Friedland, D.J. et al, 1998. *Evidence-based medicine: a framework for clinical practice*. Appleton & Lange, Stamford, USA.

Kolodner, J., 1993. *Case-Based Reasoning*. Morgan Kaufmann Publishers, San Francisco, USA.

Tsaganou, G. et al, 2002. Modeling Student's Comprehension of Historical Text Using Fuzzy Case-Based Reasoning. *Proceedings of Workshop on Case-Based Reasoning for Education and Training, 6th ECCBR*. Aberdeen, Scotland.