Care Systematization in Pediatric Nursing Applying Case-based Reasoning

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Abstract--It is very difficult to find and collect nursing diagnoses in hospitals, where various clinical records and procedures are done by hand and manually stored on paper form. This condition impairs the readability of hospital process documents, and the archival method makes the information recovery very slow, which ultimately frustrates the search which could result in important information to improve the decision making process. The aim of this paper is to present an application to help the nurses in the clinical reasoning, keeping their experiences as a collection of cases for future research. The process is to scan diagnoses of pediatric nursing, and insert them into a case database, in a structure that provides for recovery, adaptation, indexing and comparison of cases, to be used to evaluate the effectiveness of the prototype application in handling these cases. This article presents a computational tool for health care support, employing techniques of case based reasoning, whose performance was satisfactory in the location of cases directly related to the presented test case. This fact suggests that the prototype presented is able to recover diagnoses made previously and it is of great importance for decision-making and improvement of diagnoses.

1. INTRODUCTION

The theoretical and scientific steps performed by the nurse from the beginning until the end of treatment the patient, called the nursing process and systematization of nursing assistance (SAE) and is currently known [22, 19, 11], was introduced in Brazil by Nurse Wanda Aguiar Horta in the 70s since then, has been talking about their difficulties in deployment and use in Brazil [16,12].

Recently increased the interest in deploying and using the SAE in Brazil, because their use facilitates the management and retrieval of information relevant and useful for decision making in future diagnostics, targeting the needs of each patient, indicating the most appropriate interventions or actions that must be performed by nurses, thus contributing significantly to improving the quality of the care [5, 21]. Another factor that encourages its use is the decision of the regulatory organizations, federal and state of São Paulo to make the implementation of the SAE in all institutions of public and private health care [24, 6].

However, SAE has some difficulties in implementation because it is seen as a slow, complex and bureaucratic, which differs from the nursing care of damaging the humanization of care provided to patients, because of time spent on administrative activities that generate a large volume of data that are not reused [23, 3]. Is as difficult to recover this information, either by the legibility of annotations [21], or by the quantity of documents to be lifted manually, resulting in loss of quality of care to the patient. Added to these factors we have situations of daily tragedies, suffering and emergency which these professionals are, further increasing the level of stress by changing its satisfaction at work undermining the subject and the institution and may even result in health problems of physical nature and mental [2].

These factors point to the need to improve the manual system used [21], since it is mainly various limitations on the recovery of information specifically for inference of the nursing diagnosis which is considered the most complex step of this process [23], undermining the achievement of systematization of nursing assistance.

As the field of nursing is human nature and there is no mathematical resolution, or there are rules to determine its conduct before the problems of nursing, but are more related to their technical and scientific expertise, on the various aspects of the individual that are of a physiological, mental and social, that is, analyze the individual as a whole. The NANDA says that to develop a nursing diagnosis is necessary in analyzing, synthesizing and accuracy in interpreting complex clinical data to have meaning. This process of critical thinking enables the nurse to take a decision on the results expected of the patient and the interventions needed to reach this result.

In this environment the conventional computational systems and techniques of artificial intelligence-based rules are not efficient to support the decision making of nurses, because they expect the problems are well understood and structured, where no well-defined standards, but experience of resolutions of cases. This ideal condition for applying the technique of artificial intelligence called Case Based Reasoning (CBR) [26], where its purpose is to act as a human memory that stores the past experiences in their memory and when necessary, retrieving to decide what should resolution to make the new problem. Moreover, the systems of classifications used internationally in nursing such as: Association North American Nursing Diagnosis (NANDA), Nursing Interventions Classification (NIC) and Nursing Classification Results (NOC) [13], which respectively, to diagnosis, interventions and outcomes of nursing, is identified with the type of representation used in the RBC by its structural similarity, which is fundament to build their cases, consisting in defining the problem and its solution, may be associated with the outcome, so, allowing the mapping of the entire scenario involved in the settlement process for the computer.

Using the technique of artificial intelligence case-based reasoning for the recovery of information and decision

making of nurses will be more rapid and efficient, providing a personalized service to their patients by improving the quality of care, giving greater satisfaction in their work contributes for their academic and vocational training.

However, based on literature studied were not found software that can understand this scenario and the conventional computational tools that come closest are not under Open Source license which aims to promote the institutions of public and private health care with scarce resources, which makes the acquisition of software licenses.

To alleviate the problems encountered, the goal of this work is to comply with the first phase of work that is to create a software prototype of diagnostic search, using the technique of artificial intelligence case-based reasoning for the validation phase of this project, which consists of several stages, commented on the topic of conclusion and discussions. Resulting in recommendations of possible solutions to the problems of nursing proposed by assisting the nurse in decision-making and in its clinical trial, thus favoring the generation of knowledge, leading to the learning of new diagnostics and contributing to the implementation of the Systematization of Assistance Nursing.

To better understand the considerations explained in this work was divided into six sections. Here is a summary provided for each section. The first presents the issues addressed in this work. The second deals with the literature review related to the topics covered. Third discusses the specifications, architecture and modeling software and prototype development of the project. Fourth presents the prototype and the results. Thursday presents the conclusion and discussions.

II. BACKGROUND

A. Artificial intelligence

The definition of intelligence, is given by the composition of two words of Latin origin inter (between) and legere (choose), which together mean choose between one thing or another. Similarly the term Artificial leads the Latin word that means something artificial that is not natural, or created by man [9]. Thus we can say that the literal meaning of that term, is the ability to choose between one thing and another is not natural. According to Weber [28] to Artificial Intelligence (AI) is an area of computing focused on developing computational tools that allow the emulation of some aspect of human cognition [17]. Luger & Stubblefield [17], even stating that intelligence alone is not well defined or understood, better believe that definition is that the AI is a branch of computing concerned with the automation of intelligent behavior. Already Camargo [4] says the AI is the field of computing that aims to develop computer programs that simulate the human cognition. Based on these definitions, we can conclude that the Artificial Intelligence is the area of computing that seeks to understand the different approaches to human cognition and create models computational capable to simulate one or more aspects of human behavior.

To create intelligent systems capable of simulating aspects of human behavior is necessary building a base of expertise, which built the use of engineering knowledge, defined as the realization of processes of extraction, representation and reunion of knowledge related to the implementation using the artificial intelligence [17, 20, 28]. The engineering of knowledge is responsible for managing the design and conduct of an expert system [4]. For the establishment of Specialist [8] defined six stages: assessment of the problem of knowledge acquisition, system design, test and evaluation, documentation and maintenance. Among these steps the acquisition of knowledge and representation, are the most important steps that vary depending on the need of the system, leaving it to the engineer to acquire knowledge and experience necessary to build a knowledge base [4, 9].

B. Knowledge Acquisition

Knowledge is an abstract term that tries to capture an understanding of a particular subject [8]. And the process of acquiring the knowledge to capture the implicit knowledge to specialists or other sources (e.g. books, manuals) and represent it explicitly in the smart system [7, 28].

Acquisition of knowledge is a cyclical process, consisting of the collection, interpretation, analysis and planning knowledge of the methods for collecting additional knowledge [8]. Basically there are two methods of acquiring knowledge, in direct and indirect. Since the methods involved direct interviews and case studies conducted with the expert. And the indirect using questionnaires to obtain the knowledge of expert [4].

C. Knowledge Representation

To make the acquisition of knowledge is necessary to find the best data structure that represents the human knowledge, some representations are:

Graphs - is a set of points (vertices) connected by lines (edges) that represent the transition of state, which in turn corresponds to logical inference, for which expert systems, for example, describes our knowledge about a problem in some state of the rational process [17];

Semantic networks - are a type of directed graph representing a knowledge in which concepts are the vertices and edges are semantic connections between them. If you cannot have inheritance between semantic attributes the networks need treatment for exception [8, 4];

Frames - Attribute-value pairs represent a data structure that is an abstract entity using its features and abilities, and the characteristics and skills are represented by methods [4];

Concepts, Objects and Facts - Object is something that incorporates information and behavior, where information is the description of the object (attributes), behavior and says he should do (methods), representing

something concrete real world. The representation of the concept may be an abstraction of one or multiple objects on a single definition. When there is association between the object and an attribute value, then this attribute can be true or false, that features a fact. [8, 4];

Rules - may be conceptualized as a logical sequence composed of predefined assumptions and conclusions will be triggered when premise is true. Together they give rise to the suit, and the premise can be composed of several events connected with logical operators such as AND, OR and NOT [4];

Scripts - are data structures representing about stereotypical events that are recorded in memory, as proposed by the theory of Schank and Abelson [26];

Memory organization packets (MOPs) - are representations of events organized and standardized structures together in similar events through hierarchical abstractions [4];

Cases - using the analogy to seek similar or identical to the problem proposed in its knowledge base, which contains experiences [9];

"Formlike" - to make representation is composed of fields and their values, similar to the record of a database [28, 14].

D. Representation of reasoning

In addition to represent him, we must also understand its significance, the technique used for this purpose is the representation of reasoning that is the process that combines knowledge, facts and strategies for solving problems to reach a conclusion [8], the types of reasoning cited by Durkin [8] are:

The deductive reasoning is the use of facts (axioms) to deduce other information using logical reasoning;

- The inductive reasoning is used to reach general conclusions from a limited set of facts, using the general (e. g. if A is true and if the results in B is true then B is true);
- The deduction is exact, where the inferences drawn from facts established and the implications are valid logically correct (e.g. if B is true AND IF A implies B is true, so true?)
- The reasoning by analogy is the application of existing mental models in memory to assist in the understanding of other situations or objects, the analysis of the similar and different from the previous stored in the memory and the new situation;
- Common sense is the use of experience to derive a solution, relying more on trial than in good logic accurate. Here heuristics are used to guide the solution of a problem in expert systems, which is called the best looking;
- Non-monotone reasoning is reasoning about a problem for many situations where the information is static;
- Monotone reasoning is when the state true or false remains constant during the process of resolving the problem.

E. Expert Systems

With the acquisition of knowledge and their interpretation, what remains of the techniques of artificial intelligence will be used. One of the most used techniques are called Expert Systems that aims to solve the problems of the enforcement machinery to explicit knowledge oblivious of specialists. The expert systems are computer systems through which information gathered in a base of expertise in any field of application, provides a solution to a problem, and its knowledge base contains facts, rules, concepts and relationships, can be extracted from specialists, books and manuals. And the inference engine is the process of knowledge. Some type of Expert Systems in the work and key areas of application [4].

- Interpretation- Describes from observations: speech understanding, image analysis.
- Prediction - Deduces consequences from situations: prediction of time, weather, and traffic.
- Design & Run configurations of objects that meet certain requirements or restrictions.
- Planning - Develop plans, courses of action: movement of robots, military strategy or business.
- Observation - Compare observations of behavior of systems with characteristics deemed necessary.
- Debugging - Prescribes fixes to defects: e.g. debugging of programs.
- Instruction - Diagnoses and adjusts the performance of students: the whole area of "computer-aided instruction."
- Control - Commands in the adaptive behavior of a system: robots, management of production.
- Maintenance - Develop and implement plan to fix problem diagnosed.

F. Decision Support System

The Decision Support System (DSS) is one of several types of existing systems experts, the difference is that DSS is a system that interacts with the user using its base of knowledge (data and models) to generate information, suggesting the best decision from evidence and data supplied to the system, increasing the capacity of extending professional in decision making, not only provide a solution to one problem [18, 10]. Basically consist of three components: the domain of knowledge, inference engine and user interface. May include different components of reason, i.e., inference engines, such as fuzzy logic, neural networks or Bayesian networks, reasoning based on rules RBR and finally the object of this study, the reasoning based on cases RBC [10].

G. Case-Based Reasoning

The Case Based Reasoning (CBR) has emerged in an attempt to Schank and Abelson create cognitive models of problem solving and learning based on knowledge acquired in past episodes, and suggested that our knowledge is recorded as scripts of situations, the same way, to recover and implement, we will obtain the same results which was

obtained previously [14, 27]. Two hypotheses support the idea of this reasoning: the first hypothesis refers to similar problems have similar solutions and the second hypothesis is that problems tend to repeat [15]. With the understanding of this principle arose more a technique of artificial intelligence which is its basic philosophy, to seek a solution to the current situation by comparing with a similar experience, and the current, its characteristic process is to: identify the current problem, seek a similar experience in memory and apply the knowledge of past experience in the current problem. One of the first systems based on the cases was CYRUS, which contained a database of questions and answers obtained from the knowledge acquired in various trips and meetings of former secretary of state Cyrus Vance of the United States, which was developed by Janet Kolodner of Yale University [14] and aims to find a diplomatic solution similar to what Cyrus Vance had already settled in his diplomatic travels.

The CBR cycle proposed by Aamodt & Plaza [1] can be divided into four main steps, retrieve, reuse, revision and retention fig. 1:

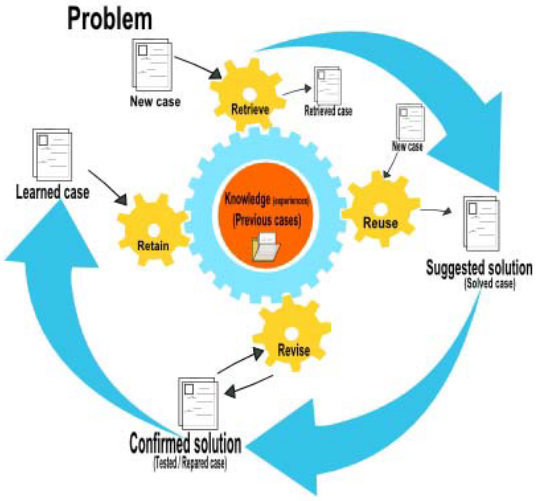

Figure 1- CBR cycle

H. Representation of cases

In a CBR system the representation of knowledge is mainly represented by cases, the main concern is deciding what should be stored and how to find an appropriate structure for the description of its contents [1, 26]. Before creating the system based cases is necessary to define how the case will be structured, where a case can be interpreted as a contextualized piece of knowledge representing an experience that teaches basic concepts to achieve the goal of reason, or that records a fact occurred and requires a decision, solution for all or part of a situation [14, 26, 15].

Decomposed into three components:

- Problem (difficult situation which requires action to change the current context);
- Solution (one or more to indicate what should be done to solve the problem);
- Result (and the consequences of actions taken to resolve the problem)

According Wangenheim [26] is possible to describe more than one form of representation of cases (or types of memory organization structure of the cases), and attribute-value pair solves most of the applications, when the complexity is low. When increasing the complexity of the implementation can be used in the object-oriented representation, graphs, semantic networks, KD trees.

I. Similarity

After defining the data structure of the cases is necessary to define the evaluation of similarity that can be similarity syntactic, semantic, structural, organizational, pragmatic. That defines the similarity between the actual case and the candidates cases (solved cases) [9].

J. Index

Determining the assessment of similarity to be used the next step is the indexing, which aims to identify the characteristics to be compared, facilitating the analysis of similarity between the case of entry, and the base, can be defined as sorting through indices [26].

K. Retrieve

Recovery is the phase that is executed in the function of similarity to retrieve the relevant cases. There are several methods of recovery: Ranking and Matching, Nearest Neighbor Retrieval, and to overcome the limitation of the methods of recovery can be used for distance measures: Euclidean distance, Euclidean square, cityblock (Manhattan), chebychev, strong, percentage, Inductive (Inductive Retrieval), Flat memory, serial search, Shared feature networks, discrimination networks, discrimination redundant networks (RDN), flat library, Parallel Search, Hierarchical Memory, Parallel Search. Selecting the Best Match [14, 9]. As the most used commercially are Nearest Neighbor Retrieval and Inductive Retrieval [27], used in this work.

L. Reuse

When the rehabilitation period ends and returns the most similar cases, the next step is actually solving the problem by using the case more appropriate, if not find a suitable position becomes the stage for another review.

M. Revise

Review of cases occur when there is a case in the phase of reuse that can not be used, requiring adjustments to be used, this process has an important role in the RBC because not all solutions are perfect and meet our expectations, and thus were created several technical changes such as structural adjustment, Adjustment Derivational, zero adjustment, solutions parameterized, Abstraction and Specialization, Resettlement. To conduct the review needs to fulfill two tasks. The first is to carefully evaluate whether the solution

generated is correct, then if you learn more and retain the new case on the basis of cases. The second task is performed when the case is not appropriate, being necessary to repair the case using the user's knowledge or information about the field of application.

N. Retain

For the CBR learning occurs when new cases are recorded (experience) in his memory, and with his right index [14]. The past cases make the CBR able to make decisions and learn from their experiences, through generalization, specialization of the knowledge base, including cases adapted and reused and finally the cases assessed and recorded at the base. The assessment can be automatically or with the participation of the user and through it is observed that the quality of the solution, to define whether or not conditions have to be added in memory.

III. MATERIALS AND METHODS

To develop the project using the case-based reasoning were conducted searches in national and international bibliographies about related works, to obtain grants for the planning and implementation for the prototype software. After the lifting of the state-of-art, next step was asking the nurses about their experiences with regard to nursing consultation, gather documents, forms used in implementing the steps of the Nursing Assistance Systematization. The next step was to propose a system architecture of fig. 3, and then determine the tools to be used to perform the modeling and implementation of prototype software. To develop the prototype was used in Java programming language from Sun Microsystems, the JColibri framework based on Java that implements the technique of artificial intelligence reasoning based on cases, which initially contains within its base 17 cases of pediatric nursing diagnoses from the system diagnostic classification of North American Nursing Diagnosis Association (NANDA).

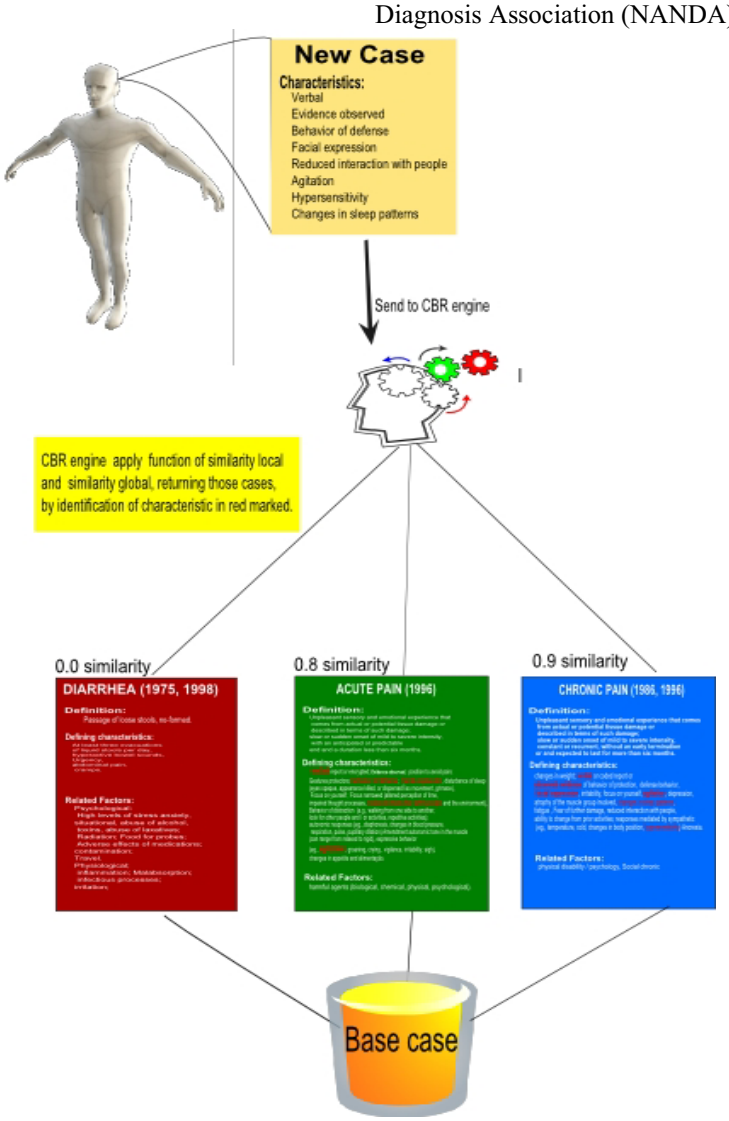

Figure 3 - Software Architecture

For modeling and implementation follow the same steps performed by wangeinheim [26] to develop a test application of CBR, which is to model the cases, the definition of measures of similarity, enter the case on the basis of cases, consult the basis of cases for tests, and make the application. The modeling of the cases were based on the structure of the taxonomy of NANDA, ie using the same descriptors fields (defining characteristics, related factors, risk factors and name of the diagnosis, but only being considered for evaluation of similarity related factors, risk factors and defining characteristics) and are certain types of texts.

To create the basis of cases was the removal of the nursing diagnosis classification system for diagnoses (NANDA). To view the case was developed using a software framework Jcolibri. The inference process starts when the case of entry, i.e. the characteristics found are sent to the CBR inference engine, then starts the phase of recovery, which will implement the function of local similarity, which is comparing all attributes the basis of the cases among themselves and establish a list of events, which enable the CBR cases suggest alternatives to problems that are not fully compatible. Already the global similarity compares the attributes of the cases of entry with the characteristics of the cases stored in the database of cases using the metric of overall similarity (1), where N is the new case, C is the case in the memory of cases, n is the number of attributes, i is an individual attribute f is the function of similarity to the attribute i where N and C w is the weight of the attribute i.

$$sim(N,C) = \sum_{i=1}^{n} f(Ni,Ci) * Wi$$

Equation –1 - metric of global similarity

The whole process culminates in the case most similar to the basis of existing cases, as shown in fig. 3.

IV. RESULTS AND CONCLUSIONS

Results obtained as a prototype capable of performing direct inference to the diagnosis by the inclusion of the defining characteristics (characteristics that are present in the nursing diagnoses) in the text, which results in rapid recovery of nursing diagnoses, and also can list all the diagnoses contained the basis of cases by clicking the List tab as shown in fig. 4, includes the internationalization that facilitates the translation of subtitles for other languages that can run on any operating system that has the JRE (java run time environment).

Initial results generated by the prototype were satisfactory, but it is still necessary to improve its performance, we believe that with the inclusion of importance degrees of the defining characteristics, increase efficiency in the recovery of diagnoses. Leading to the conclusion that it is feasible to implement the reasoning based on cases in pediatric nursing, and the achievement of future work will be possible to conclude that the major objective is to promote a rapid and quality care to patients and improve the quality of life of nurses on your desktop.

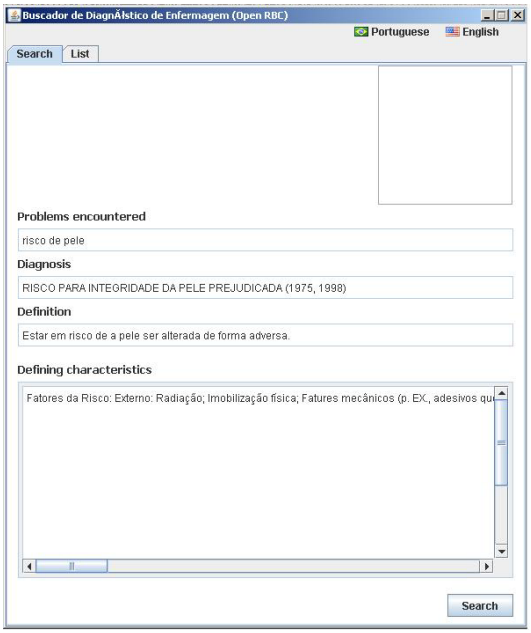

Fig. 4.

V. FUTURE WORK

As future work goals to be achieved are: create the form input data for data acquisition, define the best type of storage of the database of cases, and establish the inter-relationship between the stages of systematization of nursing assistance. And incorporate new components, as human body three-dimensional, to expedite the process of acquiring data on the anatomy of the patient. Inclusion of reports of diagnoses per patient, on screen, printed; on web among others, and to complete enable consultations system using the personal digital assistant (PDA).

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