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Using Case-Based Reasoning for Diagnosis in Medical Field

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ABSTRACT
The Case-Based Reasoning (CBR)is a method of problem solving that uses prior experiences (cases) to understand and solve new problems. In case-based reasoning, new problems are matched with similar previous cases resolved successfully. However, so far there is no general method or algorithm has been provided for case adaptation. This method has long been used in medical field. In this paper, four cooperating systems are investigated to show the methods and benefits of case-based reasoning in medical field. Then, it aims to investigate how these AI systems do research with medical research and practice, integration of several Artificial Intelligence (AI) and methods of computation, the impact of a small number of cases, the reason or time series data, and integration of numerical data, text data and subjective. These systems are presented: 1) Care-partner 2) 4DSS 3) RHENE 4) MSS
Keywords: *Case-Based Reasoning, medical support systems, medical information*

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INTRODUCTION

Medical decision support systems are used in various stages of the process of care from prevention, care and treatment to monitoring and following up [1].Case-based reasoning (CBR) systems have a lot of experience in Health and Medical Sciences. Eight international workshops on CBR consider its challenges and applications in medical fields. In one of these CBR workshops, held 2012 in Lyon, some prototype systems were introduced. In accordance with CBR procedure which examines the existing cases and learns from them, four of these systems were selected as medical CBR systems. These systems include: Care-Partner, The 4 Diabetes Support System, RHENE and Mälardalen Stress Systems (MSS).

In this paper we examine each of these systems. Then, the evaluations of systems are discussed. Furthermore, we find a tight and significant relationship between artificial intelligence and medical research. We also see the integration of artificial intelligence and computing technology and we found that complex areas require complex knowledge structures. We will understand the Leverage of a small number of available cases. We are facing time series data and new ways to present them to make reasoning. We integrate numerical data with textual and subjective data. Actually, the cooperative combination of CBR and medicine in these systems leads to the emergence of new approaches in both CBR research and development and medical performance.

We hope that these experiences will be reassessed, modified and maintained for future research studies on CBR systems. Finally, we explain the proposed method using the telemedicine systems.

CASE-BASED REASONING (CBR)

CBR provides solutions for decision support systems to solve new problems. These solutions are based on similar past solutions. Each of these past experiences is called a *Case*. Each case consists of a description of the problem and part of the solution. [2]. CBR method has strong ability to learn, it can learn from the experiences of the past, to deal with new problems [3].The CBR methodology is based on a cycle, namely the R4 model, composed by four phases: retrieve, reuse, revise and retain. In the first phase, when a new problem is logged, CBR retrieves the most similar case to the problem. In the second phase, the retrieved solution is reused. In the third phase, the solution will be reviewed to fit the new problem. And in the fourth step, the reviewed solution is maintained and retained for future reuse. Obviously, CBR is best appropriate for knowledge-based decisions [4].

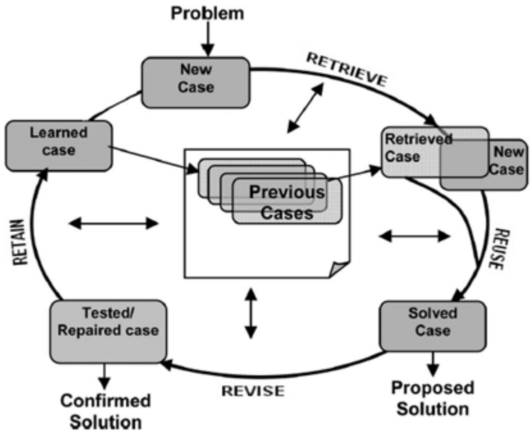

Figure 1: An example of CBR cycle

An Introduction to Expert Systems and Their Applications in Medicine

Most of the problems in modern medicine are very complex and there are no enough reasons to make exact decisions. Medical decisions are based on science and experience. The useful medical information related to a small range of diagnostic is so much that will make the exact and quick decisions so difficult. In addition, the variety of diseases, biological characteristics of the disease and the patient's clinical record make the new decision particular.

According to the above-mentioned issues, it seems easy to understand that we have serious problems in the process of medical diagnostics in general and physician's performance in particular, requires collective wisdom with the help of expert systems.

In medicine, expert systems are computer software designed to help clinical diagnosis. These systems use information and medical knowledge to diagnose disease and prescribe various medical advices which are not designed and they have been proposed merely for assisting medical professionals in the diagnosis of diseases based on scientific and experimental set of rules.

In fact, the history of expert systems in medicine is the history of cooperation between physicians and mathematicians [5].

CBR in Medicine

In medicine, experts' knowledge is not only the knowledge of rules but it is a combination of knowledge, text books and experience [2,3].

Physicians exploit from both the explicit knowledge obtained from the guidelines and regulations and tacit knowledge which is based on their experience with prior patients and other physicians [5].

Over the years, CBR has been known as an interesting alternative for the manufacture of medical applications of artificial intelligence. One interesting feature of CBR in medicine is that the disease and the patients represent a case [6].

Although many advantages of CBR have been identified in the field of medical health, but medical field without doubt is not without problems and some of these problems have affected CBR systems in particular [6].

Advantages and Disadvantages of the Systems CBR in the medical field

Some of The Benefits of CBR in The Medical Field

CBR is similar to the way physicians make reasoning about the patients and also use their expertise. CBR systems show synergistic knowledge. Patient records collected by hospitals and doctors, can easily be integrated and used with CBR [7].

Some of Flaws and Problems of CBR in Medical Field

Regarding the fact that a large number of features (symptoms) can be found in medical records, this make case adoption problematic.Although the reliability of a CBR system increased with a range of problems which covers, it is not guaranteed [7].

Review of pervious works (Review of Literature)

FM-Ultranet: A medical project works with CBR and detects abnormalities and disorders of the fetus [7].

TeCoMED: The combination of CBR systems and temporal abstraction which controls the cycle of infectious diseases [7].

WHAT: A CBR medical training system used to teach sports medicine [7].

CASEY: one of the first medical support systems which has employed CBR. This system is used in the diagnosis of heart failure [2,3].
FLORENCE: a health care planning system, in a broader sense for nursing [2,3].
MEDIC: a model based on diagnostic reasoning in the lung field [2,3].
M2DM: a remote project management established by the Commission of Europe in order to provide services to diabetes patients [8].
An expert system for the diagnosis of disorders related to stress was proposed in 2006. The disorder is classified with heart rate patterns [9].
COPD: a decision support system for diagnosing the chronic obstructive pulmonary disease (COPD) [10].

Care-Partner system

It is a support system for long-term follow-up of cancer patients who are undergoing stem cell transplantation. This system was created in Hutchinson Cancer Research Center at Washington University between the years 1996-2000.Three physicians as well as a physician assistant as experts in this field have been contributed during the construction.
Although, the Care-Partner is not an active project, but its core idea is employed in the ongoing projects [11].

Care-Partner system and its goals

Case partner helps physicians in long-term follow-up (LTFU) patients who have undergone stem cell transplantation.
This system has the ability to answer online questions of those who keep patients at home. Whereas before that, they should phone their nurses and nurses should tell their questions to doctors. The electronic contact management system is developed to replace the paper and phone that has the advantages over the old method and acts as an example of medical knowledge management.
The system provides the following types of decision support:
* interpreting laboratory results for each of tests
*List of testing procedures or methods for diagnosis.
*List of planned actions for the treatment procedure.
An important system which is required for Care-Partner is Crisis management. A physician who has not specialized in one field may not be able to assessor guide and may not even notice the big mistakes. In the field of stem cell transplantation, complications of transplantation are completely unfamiliar to those who keep patients at home. These complications can be life threatening rapidly. As a result, very high safety standards are applied to protect patients. Therefore, high reliability and safety of system is so critical.

Care-Partner System design

Figure 2 shows the reasoning cycle of Care-Partner. Cooperation between different sources of knowledge is done in LTFU area in which, as in most of these areas, knowledge has several forms:

1. Practice Guidelines
2. Practice directions
3. Case performance
4. medical textbooks

In this project, naming objects is standardized by Unified Medical Language System Semantic Network.
The cornerstone of the process of obtaining knowledge is the concept basic cases or clinical pathways. The basic case consists of three parts:

1. A list of findings related to signs and symptoms.
2. The diagnostic evaluation which is a plan to confirm (or information) about the probable diagnosis.
3. A treatment plan / solution to treat the disease when a diagnosis is confirmed or a solution when there is no path to a disease.

Evaluation of Care-partner

Table 1 shows the results of a survey in which two physicians ranked the system (by the scale failure) as: comply with the minimum standard / adequate standards / compliance with all standards. This study included 163 different medical conditions or cases related to the contact between the system and a doctor for three patients. As can be seen from Table 1, the system is ranked 82.2 % of compliance with all standards and 12.3% with adequate standards. In total, from the viewpoint of medical specialists, 94.5% of findings have the minimum acceptability in terms of medical (clinical) perspective. Table 1 also shows that the advice provided by the system covers many medical tasks: Interpretation of test results, the method of results interpretation, diagnosis, and treatment and recovery methods.
Another part of this evaluation deals with measurement of system development deals. While solving a new case (patient), the system's ability to learn was studied in complete diagrams of the three different patients.

System function significantly improved in patients 1 and 3 to reach 98.6% acceptable for 54 of patients in the Table of the third patient. Since (Therac25) recent events have shown that even 100% certainty is not enough to ensure patient safety. The system was equipped with a safety control module which can refer the cases that require special attention to the direct supervision of a physician.

Type of case	Number of case	Fails to meet standards(%)	Adequate (%)	Meets all standards (%)
Lab	54	3.7	3.7	92.6
Procedures	67	8.9	3.0	88.1
Diagnosis	68	16.2	13.2	70.6
Treat ment	71	9.9	11.3	78.8
Pathways	47	8.5	8.5	83.0
Total	163	5.5	12.3	82.2

Table 1: Results of the evaluation of Care-partner

The 4 Diabetes Support System (4DSS)

4DSS aim to help patients with diabetes mellitus type 1 (T1D) and their professional caregivers. Work on the system began in 2004 and continues to this day. There are two field experts: Frank ... is an endocrinologist and Jay ... is a diabetes specialist Jay ...., they are doctors who have treated several hundred patients with type 1 diabetes.

They also are faculty members of Medical College of Ohio. CBR which has applied successfully in long-term cases of medical practice seemed to be appropriate for use in this area [12].

Type 1 diabetes

Nearly 346 million people worldwide have diabetes. About 20 million of them have type 1 diabetes (T1D) , also known as juvenile diabetes or insulin-dependent diabetes is a chronic disease which occurs when the pancreas secretes a small or no amount of insulin (a hormone required to import sugar into cells to produce energy). Several factors including genetic factors and certain to become infected with the certain viruses can lead to type 1 diabetes. However, type 1 diabetes usually occurs in childhood and adolescence, but there is a possibility of the disease risk in adults.

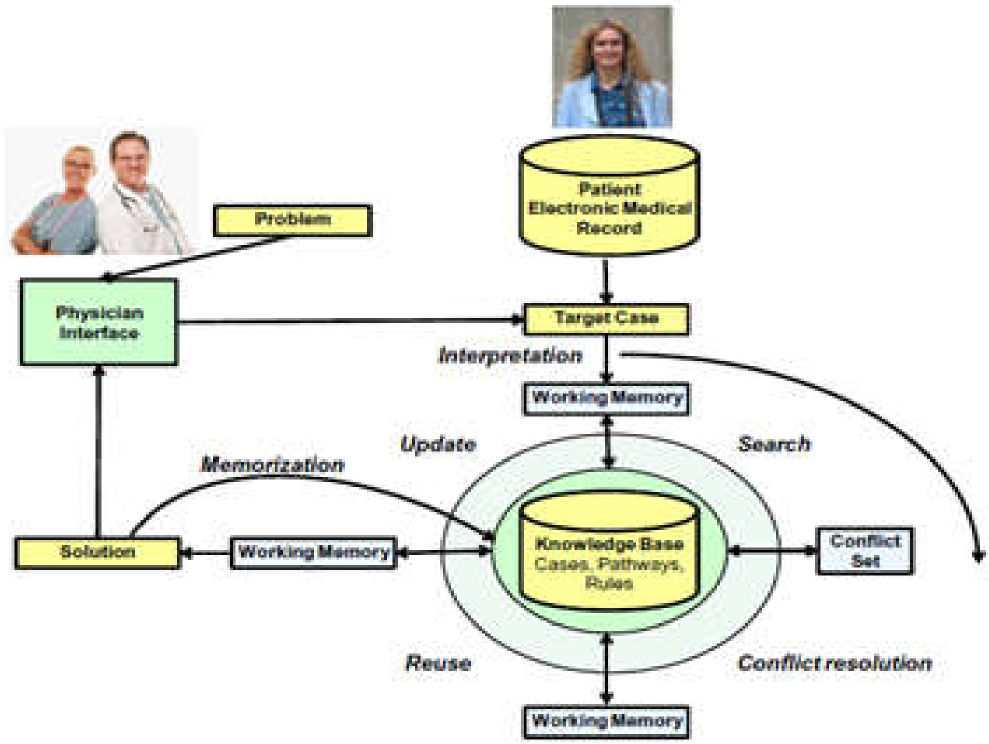

Figure 2. Care-partner reasoning cycle

Diabetes Management

T1D patients who are involved in the project 4DSS are treated by *Insulin pump*. The patient may teach pumps (ordered) to provide extra insulin for meals or blood sugar. While diabetes cannot be cured completely but it can be actively managed by controlling blood sugar. Intensive control of blood glucose in T1D patients can delay or prevent the long-term complications of diabetes such as blindness, amputation, kidney failure, stroke and heart attack.

Effective control of blood sugar requires patient self-monitoring and self-care. T1D patients with superficial puncturing of their fingers from 4 to 6 times a day use a glucometer to measure their blood. They also may attach a device called (CGM) to the body, the device shows the blood glucose levels every 5 minutes. We collect data from CGM in which patients have used it as a daily routine [13].

The blood glucose measured data was given to physicians to interpret these data manually. In order to control blood sugar problems and recommend appropriate treatment, since the data on the volume of blood sugar (large) lead to data overload for physicians, the information related to life events that affect the level of blood sugar are not normally preserved. Doctors may feel, paradoxically, they have too much data but not enough information.

4DSS system overview

4DSS is a combined case-based reasoning system which identified problems in glycemic control and proposes treatment settings (private) to amend them. Figure 2 shows a graphic of 4DSS. It is a data-driven system, the blood glucose data are obtained via glucometers and CGM devices. And the insulin data is taken from patient pump. The patient sends insulin blood glucose data to the system where data is extracted and transferred to the 4DSS database. Every day, the patient enters data manually into the database. This data includes the measurement of blood sugar, the amount of injected insulin, food, sleep, work, exercise, stress, illness, etc [13].

The patient manually enters life events data that affect blood sugar such as food, exercise, sleep, work, stress and illness. Originally it is compiled by computer-based browsers. Life information now are enters through smart phones. Evaluation module scans the patient data. Traditionally, in CBR systems, evaluation begins with a description of the current problem, but it differs in this case because glycemic control problems continue over lifetime and the patients are not necessarily aware of the problems that occur. The evaluation module has three main components: problem identification / classification of blood sugar / diabetes forecast. These components have been developed by rule-based reasoning, machine learning algorithms, and time series forecasting techniques. They make 4DSS a combined system.

Problem identification includes 18 rule-based procedures that combine physicians' strategies to find problems in patient data. At a higher level, these procedures seek problems related to: 1) high blood sugar, leading to diabetes complications in the long term, 2) low blood sugar that causes weakness, dizziness, seizures or coma, 3) swing between high and low blood pressure, 4) An error in diabetic patient's self-care.The classification of blood pressure evaluates the problems related to fluctuations in blood sugar; this section detects excessive changes in blood sugar.

When the specialists' rules are proved to be inappropriate, machine learning algorithms including Multilayer Perceptron (neural networks) and support vector machines (SVM) were introduced. These algorithms 24-hour classify plots with various levels. In order to match the physician diagnosis (opinion) with such plots (similar plots).

The diabetes forecasting section is currently under construction. For combining the time series forecasts, in order to prevent problems before they occur we are preparing the data that will be available in the short term. Forecasting problems, even 30 minutes before their occurrence, give time to the patients that they can take preventive actions and thus patient safety is improved.

Evaluation Module reports the problems to the doctor, and the doctor should choose the intended problems. The selected problem creates a case-retrieval module in the 4DSS. The case-retrieval module, matches more similar cases from the 4DSS case base.

The case base includes 80 items, each of which includes a special blood sugar control problem experienced by a T1D patient / recommendation of a physician to adjust the treatment of this problem / and results that patients get after the treatment. These are entered during the medical research studies and following items influenced these studies:

1) The blood glucose data in T1D patients, insulin and life events, 2) detection of glycemic control problems and the solutions recommended by doctors to patients. 3) whether the patients act on therapy recommendations or not, and 4) evaluation of the subsequent data by the physician to find whether the solutions were effective or not. To evaluate the more similar cases from the case base, the retrieval module uses a traditional 2-stage process. First, a subset of cases which are potentially similar is defined and then its nearest neighbors are selected from the subset.

In the first stage the problems are divided by type, in the second stage, a standard metric system of the nearest neighbor is used. Domain specific similarity functions have been combined with the weight that has been determined experimentally to obtain a total score for each. Where the cases gain a similarity threshold, they are sent to the matching module. The compatible module (Compliance) personalizes a solution of a retrieved case according to a patient's condition that is currently being investigated. It is here that begins with the most similar case, but if the solution of the case did not compatible, the process continues to the next similar case. A solution is a set of one or more therapeutic action that a patient can do. During the adaptation, the individual actions may be deleted or changed.

For example, a possible action may be taking nap through the day, if the investigated patient has enough time to sleep, this can be removed from the recommendations. In other situations, it can be modified for instance, the patient eats more or less food before sleep before sleep or eats a different type of food before bed or snacks during the day.

Health regulation compliance as decision support goes to the doctor. Your doctor will decide whether or not to bring these recommendations to patients. This long-term goal is to provide recommendations directly to the patient in real time as well as their physicians. However, this remains an objective as long as the safety and efficiency of the system is proved through medical examination and state regulatory agencies have approved it.

4DSS Evaluation

Each part of 4DSS is evaluated after completion. These evaluations provide the proof of concept, identify strengths and weaknesses and guide the development of the system. Note that a confirmed medical examination which evaluates the effect of system on the results obtained by patient still remains.

The problem diagnosis section, after the first and second medical studies 4DSS was evaluated. in the first evaluation team of diabetes specialists ranked the examples of problem diagnosis and in the second evaluation the doctor of each patient ranked all the medical diagnoses for the patient.

In the first experiment 77.5% of diagnoses were classified as correct diagnosis, while in the second experiment 97.9% were classified as correct diagnosis.

The classification of blood sugar was tested twice. Here, 10-times cross-validation were used to evaluate the accuracy, sensitivity and specificity of each of the categories, where accuracy is defined as the physician's consistent classification.

In a pilot study, a simple Bayes classifier was 85% match with doctors. Currently, the best classifier is a multilayer perceptron that its accuracy is 93.8%, sensitivity is 86.6% and specificity is 96.6% respectively.The retrieval module was evaluated by a group of diabetes experts. After the first and second medical studies, the leav-oneoutsection was used to provide a retrieved sample for evaluation.

In the first experiment, observers ranked the retrieved cases that were similar to experiment cases the 80% of the time and ranked retrieved solutions that were effective for patients 70% of the time. In the second experiment, the same they carried out the same ranking for similar retrieved cases 79% of the time and also ranked effective retrieved solutions 82% of the time.

Matching module (compliance, compatibility) was analyzed by showing the physicians sample problems or both original and compatible solutions and elicit feedback on a questionnaire- physicians classified 47% of the original good solutions with no modification. 40% of solutions require minor adjustments, 13% of solutions require overall adjustments. They concluded that 83% of matching solutions can be better than original solutions.

(RHENE) recovery of hemodialysis in kidney disease

Recovery of hemodialysis in kidney disease (RHENE) supports doctors who work in the field of advanced renal failure (ESRD) .

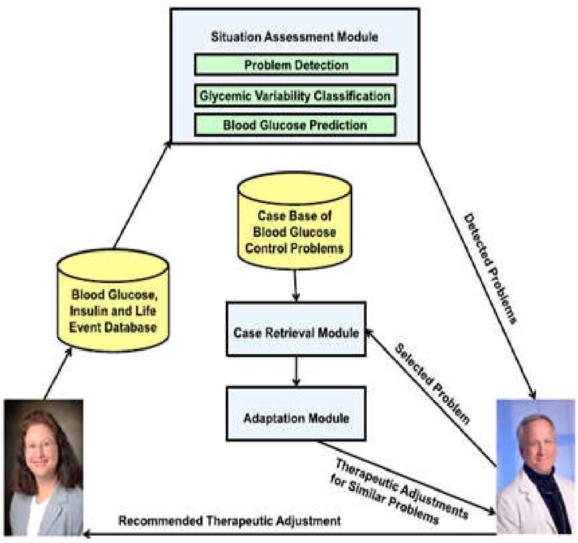

Figure 3: Overview of the 4 Diabetes support system (4DSS)

The work on the system (RHENE) was started in 2004 and has continued to the present day. Roberto Bellazziis RHENE project specialist who is a kidney specialist in Vigevano hospital in Italy.

Advanced renal failure

The prevalence of kidney disease in the world is increasing for several reasons [14]. ESRD is a severe chronic illness that without medical intervention, leading to death. The average global growth of the disease in the last 5 years had been 8 %. In Iran, this growth is more than the average global growth of about 12%. According to the Research Center for kidney patients and kidney transplant in 1386, about 29,000 patients were treated with chronic renal insufficiency, of which 14,000 (48.5 %) were treated with hemodialysis [14].Hemodialysis is used for the treatment of patients with ESRD.

During hemodialysis, an electromechanical device called a hemodialyzer cleans the patient's blood from metabolites, releases equal acid-base again and removes wastes and excess fluid from the body, which are normally removed by healthy kidneys. A personal hemodialysis session typically lasts four hours. A hemodialysis patient receives three weekly treatments. Hemodialyzer follows several time series variables in each session, and each of the sampling intervals is about 1 to 15 minutes. These variables are analyzed to assess the effectiveness of dialysis treatment sessions and see if it is in accordance with the patient's treatment program. Patients without renal surgery can survive for years by hemodialysis.

The chronic renal insufficiency and its maintenance treatment, hemodialysis, resulted in a change in patient lifestyle, health status, and his role. These patients face multiple stressors of physical, psychological, and social. The patient physical problems may include: uremia, anemia, joint pain, cardiovascular diseases, and infection. The psychological problems among these patients are also high, so that the admission of CRF patients with mental disorders is higher than patients with other c The main problems that lead to depression, hopelessness and inconsistency in these patients include work problems, financial problems, nutritional problems, concerns of marriage and sexuality, readmission, and the fear of death.

Social problems in patients with chronic renal failure include tension in social interactions and limitations in social activities and leisure time. Most of these patients have financial problems, so that it is common to see hemodialysis and factors associated with it as a stressful issue. In today's classifications of hemodialysis patients the patients classified as special. Due to the special problems of this group of patients with the disease and its long-life issues that are most affected by them, these patients need emotional support for coping with the current situation [14].

The interpretation of a dialysis session should be considered as a case, we have to deal with time-series case features. Interpreting time-series case features on the screen or on paper, can be tedious and error prone. Doctors may be asked to identify small or rare irregularities in this category partial or recognize slight resemblance with the patient past condition which doesn't depend on personal values in this category.

While in patient care, these diagnoses need high expertise, therefore, an automatic interpreter of the data and decision support system is desirable.

An overview of RHENE system

The time dependent areas, the need to describe the dynamic process strongly influences the case presentation and the retrieval, as it is analyzed in [2], most of the reported procedures based on the recovery time series are common in the presumed reduction dimension, which is a simple display of knowledge. The number of dimensions often reduced by using mathematical transforms such as Discrete Fourier Transform which is the ability to maintain or ignore the distance between the two sets of time. However, mathematical transforms has several limitations and complex calculations is often sought.

In contrast, RHENE implements a framework for recovery of time series which uses Temporary Abstracts (TA) to reduce the dimension of time series through Multidimensional index structures for efficient retrieval. Using TA make interpretation of output results betterand make the recovery process more understandable.

The vast amount of temporary information is mapping in a compact display mapping by collectingthe shared points of the time series (ie, the same quality, the same process) for a period, which is run by a tag icon. This technique not only summarizes the main longitudinal data, also indicates significant features symbolically and clearly.

Exploiting TA for exploration and recovery of cases, as well as to the interpretation of the data is the best of our knowledge. Typically, TA is used to interpret the data, but not for the recovery.

The basic principle of TA is moving from one spot based display to a distance based from the information. TA can solve and interpret data [16], where the entry points (events) are the elements of time series and output intervals (parts (episodes)) are the total surrounding events that share a similar behavior over time [4].

Episodes (episodes) are known with symbols. Basic abstract concepts can be further divided into a TA mode and the TA procedure. TA mode can be used to extract the parts in relation to the quality of monitoring capabilities, for example, small, normal, or high amounts. The TA procedure can be used to identify specific patterns, such as increasing, decreasing or stable behavior of the time series. RHENE supports multi-level abstractions of the original data .The value of time series can be considered as an abstract and bold question in the smallest or biggest level of detail with two dimensions: the classification symbols, and a classification of time. For example, a classification of the symbols can be introduced, in which the symbol I (increase) is the most professional I W (weak increase) and I s (strong increase), according to the slope. As another example, a set of two adjacent intervals of I W, each for half an hour, can be integrated with in a single interval, for one hour. In order to increase the scale of two or more of the values expressed, an increasing function is provided. This function is dependent on the range, but it obeys the overall number of restrictions, including the '' stability '' and '' uniformity ''.When we compare the two time series, it is possible to retrieve similar cases. Retrieval depends on the metric distance between symbols in the classification of similar measures.

In order to facilitate the retrieval query language developed as a sequence of symbols at different levels of detail.RHENE supports the field of inquiry.To increase the efficiency of recovery, RHENE includes Indexing strategy that measures to take two-dimensional indexes of classification. A typical forest structure provides a flexible indexing of the different levels of the symbols and / or time classification. The root node of each structure is displayed by a string of symbols, and it is defined at the highest levels in both dimensions. An example is shown in Figure 3 in the box on the right. Here, I that isa root node is refined over time from 4 hours to 2 hours bit by bit. So that node II , SI and SI of it, provided that the node (I, S) = I, and the node of I = (S, I) where S stands for is stationarity. After leading from each node of the structure, another indicator could result. The structure is developed according to the leading indicator.

In summary, RHENE acts as follows, shown in Figure 3:

- Time series properties in ESRD (Eg, dialysis sessions) have been pre-processed by TA server which is in the context of the symbol level and time classification.
- The pre-processed case then stored in a relational database.
- When the physician needs to check the patient, he can recover the database for similar cases at every level of details.
- Indexes have the ability to respond rapidly and interactively.

The retrieved cases then are given to the physician as decision support and he is responsible for decisions about the patient [16].

RHENE Evaluation

RHENE empirically was examined, using a data set of 10,388 real hemodialysis sessions (eg, the ESRD cases) gathered at the Vigevano hospital in Italy. TA methodology was compared with other classic methods implemented in the previous version of RHENE.

The method is based on DFT to reduce the size of the index and for indexing; it is on the basis of on the basis of TV-trees to improve the performance of the retrieval.Little experiments are done to compare the required time for queries by the two approaches and scalability when dealing with something that is gradually growing size.

A subset of 2,000 to 10,388 of actual cases was used to evaluate the performance of each system. As shown in Figure 4. , TA based on fixed method is much more efficient in responding to the query in comparison to the DFT, with the time query below 1 second.

The qualitative comparison of the two methods was performed by examining case studies. Details of these examinations are present. In short, it was found that the ability to consider the process of retrieval based on TA is useful. DFT Sometimes loses the related cases, because it considers the distance between the points and looks for the best overall alignment. Shifts along an axis, such as lower absolute values, can prevent DFT to find similar cases. In addition, TA-based approach offers the user more understandable queries and mathematical methods.

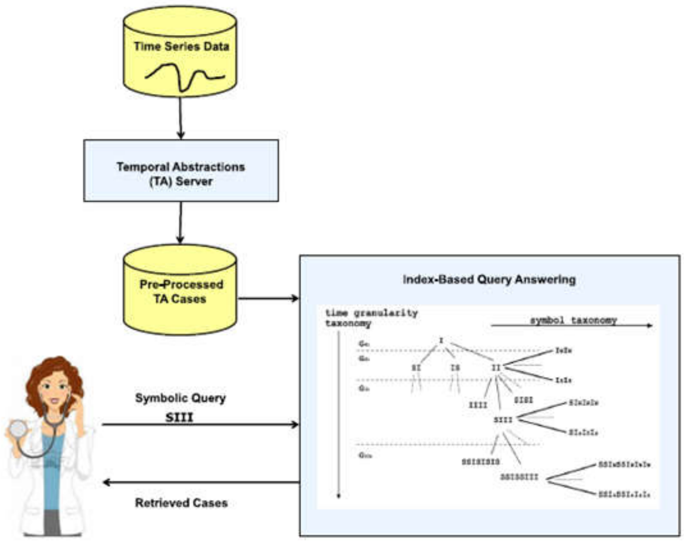

Figure 4: Review of RHENE

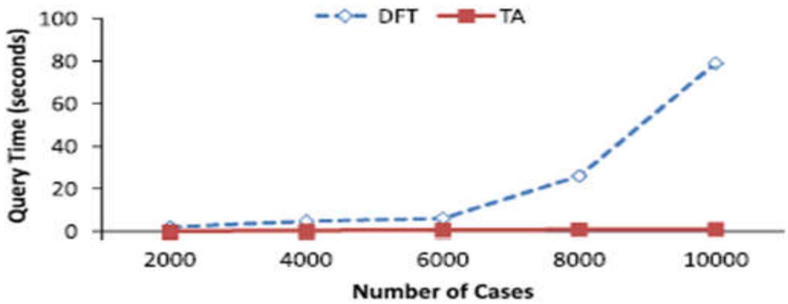

Figure 5: Average time, in seconds, to answer the question of DFT increased compared to TA.

Mälardalen Stress System (MSS)

Mälardalen Stress Systems (MSS) is a support system for the diagnosis and treatment of stress. This system was developed between 2002 and 2011 at Mälardalen University in Vasteras, Sweden. The system experts were psychologist Bo von Schéele and Erik Olsson. Dr. von Schéele has more than 30 years' experience in the clinical diagnosis of stress by using new method of Biosensors and biofeedback.

Stress Management

Stress is a factor of daily life which may produce severe physical and mental problems at worst [9].

While the causes of stress typically cannot be removed, patients can be trained to cope with stress effectively and minimize its bad effects. Doctors diagnosed stress-related disorders read various sensors. The measure classification process is long and difficult. It requires enough experience to learn skill for accurate classification [11].

Medical measure of stress is finger temperature (FT). By placing a sensor on a patient's fingertip, constant temperature can be achieved. In general, clinical studies show that the finger temperature (FT) in general is reduced by stress [9. However, changes in FT are different from patient to patient, and its analysis and interpretation requires knowledge and experience. Another sign of stress is Respiratory sinus arrhythmia (RSA) in humans [17].

Moreover, other factors, such as emotions, behavior of the patient, the environment and lifestyle also play important roles in stress management. Features text that represents the patient's perception of stress is collected as input text and the visual analog scale (VAS).VAS is used for measuring mental traits or attitudes scale of 0 to 10. The signal sensor and text information both used to diagnose patient's stress level. After analyzing a number of FT signals, it is found that that the temperature is increased or decreased over time [18].

Biofeedback training is used as a treatment for stress management. This training includes non-drug treatments such as yoga, relaxation exercises and calming movements, etc. During biofeedback training, a patient can change its internal or mental state, as observes FT changes on the screen. Since the patient sees his inner psychic changes on the screen he/she can train his/her body and / or mind to deal with the stress. Relaxation exercises may be recommended to help patients make positive changes. This method is a stress reduction tool which results to safety in long-term. [9]

MSS Overview

MSS shows how some common CBR techniques need to be modified to provide physicians with an effective support about past cases currently related to the patient. This type of medical application adds a number of specific requirements. For example, in addition to considering the similarity of the case, the results are also should be noticed. A case with a sever result may need the physician's precautions to avoid a similar outcome.

One example is that the finger temperature of most of the patients is increasing during stress and calmness reduction, it is a normal response of the parasympathetic nervous system. But in some patients, the effect of the temperature of the finger may be different due to rare conditions; the physician should consider this in his/her diagnosis. If the current patient is similar to many of the last patients as not being at risk for stress-related illness is like a patient who is in the situation that there are serious consequences for his health condition if he/she left untreated,, the second case is more noticeable for the physician, that additional measures may be needed to reject it.

To meet the needs of the medical field, the cases include: a) the characteristics of the signs, including the sensor and reading text data, b) diagnosis, c) training actions, for example, biofeedback therapy, and d) the result, for example, how quickly the patient improves, e) comments, which can be added by a doctor who is willing to share his/her knowledge and / or important sources with his/her colleagues. The comments on this case may be added by the physician or by a field specialist.

Mark features for a case a ranking derived from a calibration protocol in which the patient is asked to do a series of stressful, relaxing and neutralizing tasks while FT is measured. This calibration is necessary, because the sensor readings vary widely from one patient to patient. Sensor reading may be normal for a person while it is warning for another one. The patient is also asked to store the text data through a text and VAS. A total of 25 sensors and the textual features is included this part of the case. The patient's diagnosis classification keeps stress, which may be very slow, slow, normal / stable, stressful or very stressful. Confidence level to classify is high, medium or low, which is also registered for every diagnosis. The measures taken include treatment and the outcome of treatment, for example, the rate of improvement after treatment.

Biofeedback is a tool used by doctors to treat and generally reduces stress. The last diagnosis as a parameter settings used for biofeedback. The patient gives his/her feedback to improve the parameter. Another important parameter is the recovery time after stress, for example, the taken time after a phase of stress to heal a patient. This parameter is to choose relaxation exercises / treatment for the patient which can be used. During the workout, the biofeedback system observes the patient and the estimated time for recovery after stress. This enables patients to do biofeedback training by a computer system and sensors either alone or with the help of a physician. The relaxation exercises/ treatment are selected to achieve good results. They are selected on the basis of how effective they are in previous similar cases. If the recovery time does not change after the exercises, then different exercises will be selected.

The exercise selection is based on previous cases and the results of the exercise / therapy. Different exercises have different effects on patients. Appropriate exercise selection and following the patient's progress in this way increases the efficiency of the exercise.

MSS does diagnosis and treatment in three steps: 1) Analysis and classification of a patient and risk assessment, 2) determining the individual levels and parameters and 3) compliance and biofeedback training. CBR is used as the core technology for the system, as shown in Figure 5.

Since the patients in the case storage have already been diagnosed / classified, this can be used to identify features that are important to compare and retrieve. Other techniques of AI, such as fuzzy logic, rule-based reasoning and retrieval of textual information have supporting roles.

MSS Evaluation

MSS system has been investigated through different methods. Diagnostic performance of the system, including clinical specialists and junior doctors with limited training in the diagnosis of stress by using sensor readings is compared with physicians' diagnosis. Using a series of tests, the system was able to classify more than 80 % of the cases correctly compared with between 57 % and 69 % for junior doctors and 73 % for a senior doctor. In comparing the output of the system with the doctor, taking into account the compatibility the doctor's response when faced with a patient more than once; was important. In another diagnostic performance test, a cross-validation was abandoned.

In this evaluation, cases were taken from case storage once to see how the system can classify each. Using a fuzzy matching algorithm, as in the report, MSS was able to perform close to expert level. In addition to judging the overall accuracy, taking into account the sensitivity and specificity of the system was important. From clinical point of view, the patient with no stress (false negative) is less acceptable than recognition of a healthy person as an emphasis (false positives).

The Effectiveness of Research and Methods

In this section, the usefulness of the research and methods provided by CARE-PARTNER, 4DSS, RHENE, and MSS has been elaborated.

The Relationship of AI Research and Medical Research and Practice

All four systems are developed through strong cooperation with medical researchers and doctors.For example, CAREPARTNER is an evidence-based medical practice to support cancer.

During the main study, stem cell transplantation was a very new method, and there was no guideline in the Cancer Center for patients' long-term follow-up. By compiling patient problems, solutions and results, CARE-PARTNER is one of the best medical practices.

The 4DSS, RHENE, and MSS systems all show how diabetes treatment, hemodialysis and stress, include an individual therapy for each patient based on patient needs and preferences are given.

4DSS is a research medical help in the field of glycemic variability (GV), measuring and predicting blood sugar. Since there is no metric has been accepted for GV in common clinical practice, but 4DSS experts have developed new standards for 4 DSS to identify excessive GV. This metric is then published and presented at the Diabetes Technology Society to develop a GV metric for everyday use. Current research in predicting blood sugar not only helps to support smart decisions, but with the help of it an "artificial pancreas, '' is under construction and development. This project belongs to the Juvenile Diabetes Research Foundation.

Hemodialysis sessions usually only judged based on the macroscopic properties of time series. RHENE provides deeper insights into clinical status, in addition, using RHENE can lead to Systematic mapping to identify the behavior of the TA (For example, an increase in diastolic pressure) and specific damages or side effects, in applications where there is no type of this scientific knowledge.

The specialists (experts) during the MSS project found that systems can improve their work and modify their methods in their medical diagnosis. They also found that a systematic analysis of the evidence required by the system improves the quality and value of electronic health records (EHR), which they keep for their patients. In addition, the cooperation will make it clearer how specialists find patients' similarities while reading signs and doing measurements to help them in diagnosis and treatment. This leads to the discovery of new features which are valuable in the process of diagnosis.

Integration of AIs and Computational Methods

All of these four systems are multi-quality or synthetic which are cooperated with the CBR, AI and other computational methods. CARE-PARTNER is a combination of CBR, rule-based reasoning and data retrieval .A knowledge base includes both theoretical knowledge and practical knowledge, which may be expressed in a controlled vocabulary or text. 4 DSS is the integration of rule-based reasoning to identify the problem and case adaptation, multiple machine learning algorithms to classify changes in blood sugar levels, and support vector regression to predict blood glucose. RHENE includes abstract time for representations, compare and retrieve items.

MSS is the power of rule-based reasoning, fuzzy logic, and data recovery. Fuzzy rule-based classification is used when the domain is explicit knowledge (for example, if X and Y are high, we know that Z is high) but that is not accurate terminology (for example, the absolute value may high or low, depending on the context.)

Knowledge-based systems can be manipulated. For example, hemodialyzers produce data that cannot be easily accountable without loss of features or make them abstract. So, RHENE represents a new combination of TA and CBR that can be extended to other areas of time series data.

Leverage of a Small Number of Available Cases

In this era of big data much emphasis is placed on extracting useful information from large volumes of available data. For medical decision support applications, however, it is still unusual to have all relevant information. Although RHENE had thousands work to do, CARE-PARTNER, 4Dss, and MSS make use of the leverage of a small number of cases more effectively. CARE-PARTNER, for example, began with an incomplete database includes summary of patient's status chart which is paper based.

The initial ninety-one people have been created by using knowledge engineering efforts that enables the range of knowledge to complete available data. 4DSS began with a lot of blood sugar data, but it was also necessary to interpret life events that normally were not kept. MSS project is clinical studies have been done to get the patient's stress profiles. However, the case coverage was incomplete at the outset. The artificial cases for strengthening the real patient cases were created by using the features of extended sensor and a fuzzy inference system.

The system ability to recover the executable cases has been improved. While there are many ways to influence a large number of samples, the ability to solve problems with a limited knowledge is the power of CBR.

Reasoning with time series data

All of these four systems make reasoning about the cases developed over time. This is unlike most of the CBR systems, which is a snapshot of the current situation to assess the reasoning about the problem is available. CARE-PARTNER, for example, will inform to track long-term care and patient record of the current situation. Time series data for 4 DSS is obtained as a blood glucose sensor data, which is collected up to 90 days in intervals of 5 minutes, with life event data, and insulin which have been reported in the same period. Prediction of blood glucose as a time series forecasting problem was kept using the support vector regression.

RHENE time series data about the hemodialyzer are increased over a period of 4 hours, and between 1 to 15 minutes. RHENE integration with time series data, using TA to show, compares and retrieves the hard cases. Time series data for the MSS from finger temperature sensors can be achieved by patients in calibration sessions of 15 minutes. Feature extraction system from sensor data, including the rate of recovery after stress, gradients during stress, and difference between reading the finger temperature in calm and stress. The extracted features are used to build the system.

Integration of numerical data with subjective and textual information

In the medical field, it is often necessary to consider the hard numerical data and text information in light of the patient's subjective perception. The world of the patient affects the patient's health. Furthermore, treatment recommendations not appropriate with patient's lifestyle and personal preferences may be ignored, no matter how medically recommended. In 4DSS, numerical data of blood glucose is considered regarding to the patient's life events which affects blood glucose level.

The effectiveness of treatment recommendations has been examined according to whether the patient has really done them or not. In MSS, the finger temperature sensor signals that indicate stress, along with the factors that can cause stress in the lives of patients. CBR allows flexible use of data in different types of cases, which is appropriate to the medical field.

The proposed method

Development of information technology has led to today's increasing number of systems to support and improve the health of communities. These systems hold information about the patients and their care through electronic communication.

The maintenance of health information systems requires a flexible and efficient communication infrastructure and the use of advanced technology. Communication infrastructure includes hardware, software, network, and all equipment required for monitoring and control services. Due to increasing advancement of technology, the use of telemedicine to treat diseases is increasing. Development of telemedicine services requires extensive cooperation of communication technology on the one hand and medical sciences on the other hand.

In our proposed method, the patient has a profile for data storage, including the following:

- The patient's basic information such as name, age, gender, occupation, language, literacy, addresses, phone numbers, etc.
- The patient's history, personal and family history and records
- The patient's medical information, including tests and…

Through this system, the patient can be remotely in touch with his/her doctor, in the way that the patient enter the necessary data into his/her system profile and the system gives the results to the physician. And subsequently the physician gives the treatment recommendations through the patient's profile. Sending results directly to the patients requires system high security.

SUMMARY AND CONCLUSION

In this paper, four cooperative systems were studied to show the methods and benefits of case-based reasoning in medical field. These systems are CARE-PARTNER, 4 diabetes support system (4DSS), recovery of hemodialysis in advanced kidney disease (RHENE) and Mälardalen stress system. We have discovered how These AI systems are cooperated with research and medical practice, how multiple artificial intelligences (AI) and computational methods are integrated with each other, we see the impact of a small number of items, as well as how we can work with time series data, and the integration of textual and numeric data with subjective data. We hope that these medical CBR systems expand CBR future research in medicine.

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