Decision Support System for International Prostate Symptom Score on Case-Based Reasoning

Hsu Yadanar Soe, Mon Mon Thei
Computer University (Pyay)
hsuyadanarsoe@gmail.com, monmonthei@gmail.com

ABSTRACT

Nowadays, medical diagnosis reasoning is a very important application area of computer-based system. There is a wealth of data available within the healthcare systems. There is a lack of effective analysis tools to discover hidden relationships and trends in data. Most hospitals today employ some sort of hospital information systems to manage their healthcare or patient data. Medical diagnosis is a very active field as far as introduction of the above techniques is concerned. Preventing the disease is better than caring it. So, to overcome the BPH(Benign Prostate Hyperplasia) diseases, it needs to predict IPSS score. This system is an implementation of a decision support system of IPSS(International Prostate Symptom Score) diagnosis using Case-based Reasoning. This system diagnosis the IPSS score based Case-based Reasoning. Then it can give the operation or health care advice whether the patient should be operated or given with medicine and habit care.

1. Introduction

A decision support systems is an interactive software-based system intended to help decision makers compile useful information from a combination of raw data, documents, personal knowledge, or business models to identify and solve problems and make decisions. Clinical decision support systems (CDSS) are interactive computer programs, which are designed to assist physicians and other health professionals with decision making tasks. Basic definition of a CDSS in its simplest form is that it is a DSS that is used in the clinical setting[4]. Often a Diagnostic Decision Support System DDSS is assumed to be equivalent to a CDSS and are thought to be interchangeable. However, in a clinical setting, making diagnosis based on clinical data is only a subset of the spectrum in which DSS can be used in a clinical setting. A clinical decision support system has been coined as an "active knowledge systems, which use two or more items of patient data to generate case-specific advice." This implies that a CDSS is simply a DSS that is focused on using knowledge management in such a way to achieve clinical advice for patient care based on some number of items of patient data.

The main purpose of modern CDSS is to assist clinicians at the point of care. This means that a clinician would interact with a CDSS to help determine diagnosis, analysis, etc. of patient data. Previous theories of CDSS were to use the CDSS to literally make decisions for the clinician. The clinician would input the information and wait for the CDSS to output the "right" choice and the clinician would simply act on that output [3].

2. Related Work

In medicine, CBR has mainly been applied for diagnostic and partly for therapeutic tasks. Case-based reasoning was a recent approach to problem solving and learning that has got a lot of attention over the last few years. Case-Based reasoning is one of the best approaches which is using with knowledge discovery to make a help desk systems and there are some works done by using CBR. For example, the case based reason for medical support tasks by Ralph Bergmann at University of Kaiserslautern (Jan, 1998), web service composition with case based reasoning by Benchaphon Limthanmaphon and Yanchun Zhang at University of Southern Queensland Toowoomba, Australia(2003), and airborne fungi identification by case-based reasoning by Petra Perner, Thomas Günther and Horst Perner. A physician, after having examined a particular patient in his office gets a reminding to a patient that he treated. Assuming that the reminding was caused by a similarity of important symptoms, the physician uses the diagnosis and treatment of the previous patient to determine the disease and treatment for the patient. And a financial consultant working on a difficult credit decision task uses a reminding to a previous case, which involved a company in similar trouble as the current one, to recommend that the loan application should be refused. The CBR field has grown rapidly over the last few years, as seen by its increased share of papers at major conferences, available commercial tools, and successful applications in daily use[6].

3. Case-based Reasoning

Case-based Reasoning is a general artificial intelligence paradigm for reasoning from experience. CBR methodology has been investigated in improving human decision-making and has received much attention in developing knowledge-based systems in medicine. Unlike the traditional rule-based approach in which expert knowledge must be represented in “if-then” rules, a case-based approach allows knowledge to be grouped and stored as case.

CBR is very useful when there is enough empirical date for accurate induction. It is composed of four main steps: case matching, case retrieval, case adaptation, and case storage. CBR uses a case base where it stores learned cases. At the highest level of generality, case-based reasoning method has in common the following processes[7].

- RETRIEVE the most similar case(s)
- REUSE the retrieved case(s) to solve problem
- REVISE the proposed solution if necessary
- RETAIN the new solution as part of a new case

4. K-nearest Neighbor Technique

A retrieval algorithm using the indices in the case–memory should retrieve the most similar cases to the current problem or situation. The retrieval algorithm relies on the indices and the organization of the memory to direct the search to potentially useful cases [2]. This approach involves using heuristics to constrain and direct the search. Methods for case retrieval are nearest neighbor, induction, and knowledge-guided induction and template retrieval. These methods can be used alone or combined into hybrid retrieval strategies. If the nearest neighbor is used, then case features should be able to be weighted and similarity measures customized. If inductive techniques are used, the index tree generated should be open to inspection and alteration by developers. Nearest neighbor method depends on a similarity (or distance) metric. This method allows partial matching which eliminates the problems associated with exact matching.

The final goal of a CBR system is to find the case which has the maximum similarity to the input case. The features of the input case are assigned as indices characterizing the case. These indices are used to retrieve a similar past cases(s) from case memory. This system uses the Nearest-neighbor technique that finds the closest matches of the cases already stored in the database to the new case using a distance calculation, which determines how similar two case are by comparing their features, the overview process can be written as follows:

For each feature in the input case:

- Find the corresponding feature in the stored case.
- Compare the two values to each other and compute the degree of the match.
- Multiply by a coefficient representing the importance of the feature to the match.
- Add the results to derive an average match score.
- This number represents the degree of match of the old case to the input.
- A case can be chosen by choosing the item with the largest score.

A typical algorithm for calculating nearest neighbor matching is [7]:

$$similarity(case_1, case_R) = \frac{\sum_{i=1}^{n} w_i \times sim(f_i^1, f_i^R)}{\sum_{i=1}^{n} w_i} \qquad (4.1)$$

In the K-nearest neighbor technique,

T = target case

S = source case

n = number of attributes in each case

I = individual attribute from 1 to n

f = similarity function for attributes i in case T and S

W= important weighting of attribute i

So, the weight is introduced in the case retrieval and the similarity between cases is considered to be the weighted summation of the similarity between attributes.

At this system,

T=new case

S=old case

n=number of features in each patient case

i=initial feature

w=level of each feature

Table 1. Example of Patient Cases Comparison

Features	Weight	New Case	Old Case1	Old Case2
Incomplete emptying	4	yes	yes	no
Frequency	3	yes	yes	yes
Intermittency	2	yes	yes	yes
Urgency	1	yes	no	no
Weak Stream	3	yes	yes	no
Strangury	2	yes	no	yes
Noctaria	4	yes	yes	yes
$\sum_{i=1}^{n} w_i$	19			

For Old Case1, Patient ID-2008-01,

$f(T_1,S_1)*W_1=4$

$f(T_2,S_2)*W_2=3$

$f(T_3,S_3)*W_3=2$
$f(T_4,S_4)*W_4=0$
$f(T_5,S_5)*W_5=3$
$f(T_6,S_6)*W_6=0$
$f(T_7,S_7)*W_7=4$

$$\sum_{i=1}^{n} (T_i,S_i)*w_i = 16 \quad (4.2)$$

Therefore, Similarity (T,S)=0.84
For Old Case2, Patient ID-2008-04,
$f(T_1,S_1)*W_1=0$
$f(T_2,S_2)*W_2=3$
$f(T_3,S_3)*W_3=2$
$f(T_4,S_4)*W_4=0$
$f(T_5,S_5)*W_5=0$
$f(T_6,S_6)*W_6=0$
$f(T_7,S_7)*W_7=0$

$$\sum_{i=1}^{n} (T_i,S_i)*w_i = 5 \quad (4.3)$$

Therefore, Similarity (T,S)=0.26

Since, the old case 1 has greater than 0.5, the old case 1 is selected as "case found", based on the nearest neighbor approach.

5. Architecture of the System

This system is to implement a decision support system for International Prostate Symptom Score on Case-Based Reasoning. This system aims to give a pre-decision making for BPH patients, to support health care service with a computer-based medical diagnosis system and to understand how to apply CBR in decision support system. In this system, there are 7 features. Each feature has 6 levels or scores (0 to 5) for symptoms. This level or score is used as weight in k-nearest neighbor equation. The user must chose one level for each feature.

Then this system checks whether the new patient's weight is similar with old cases in the case library by using K-nearest Neighbor Technique. It computes the similarities for all old cases. Then it chooses the highest similarity as a similar case for new case. According to Nearest-neighbor technique, the case similarity $\geq$ 0.5 is accepted as similar case. The case similarity $<$ 0.5 is un-similar case. Then the system gets the highest case similarity, and produces the total score of similar case.

Then the system checks whether the user is BPH patient and the weights of feature no 2 and feature no. 3 are greater than 4. If so, the system gives surgical advice for new case. If it is not, the system gives suitable medical advice for new case, based on its total score.

If there is not any similar case in the case library, the system asks the user whether this new case is saved or not. If the user saves it, this new case will be old case at next time. In this system, there are 1512 cases. These cases are collected from expert doctors in BPH domain from No.(2) Military Hospital (Bedded-500).

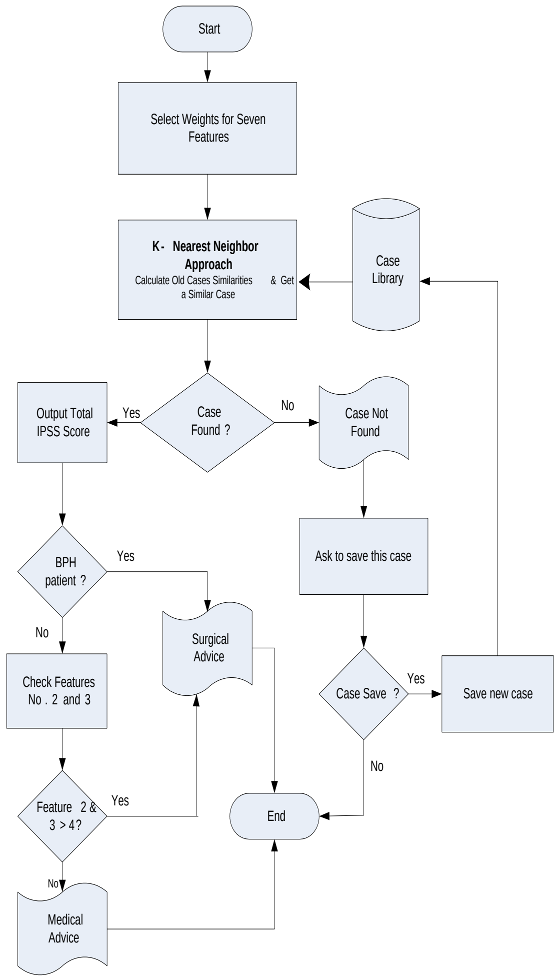

Figure 1. Process Flow of the System

6. System Process Results

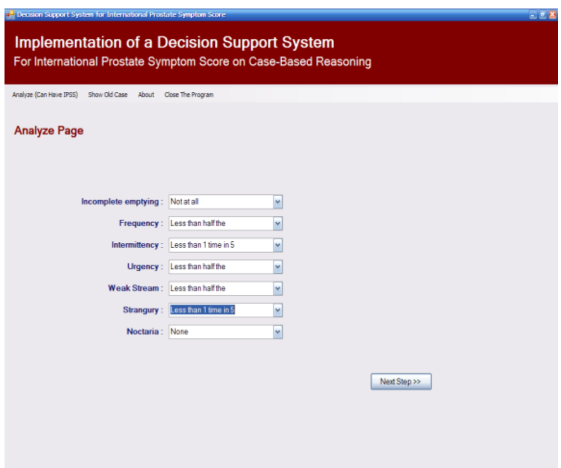

Figure 2. User selects IPSS weights

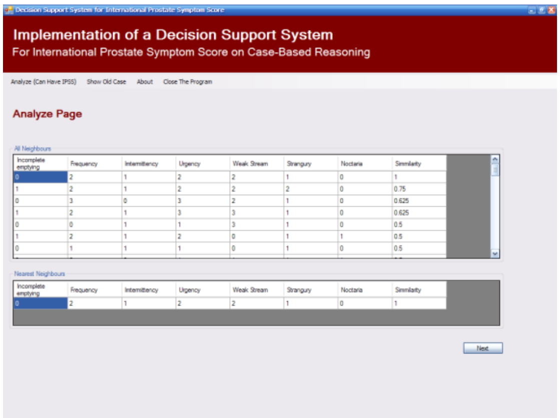

Figure 3. Similarity of Old Cases for New Case

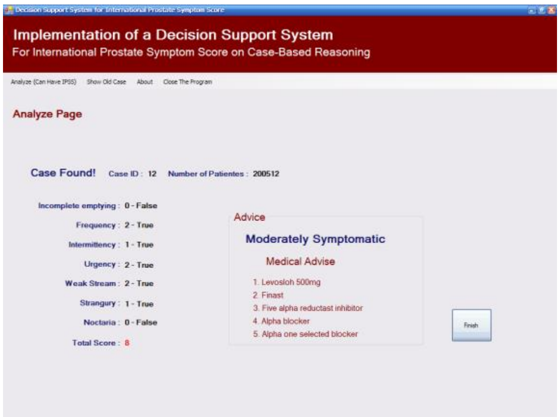

Figure 4. Output of the System

7. Conclusion

This paper has described the design and development of a clinical decision support system. This system can decide who a person’s IPSS score and his current state. As the system’s output advice, the patients can get health care in time and prepare their habit which causes BPH symptoms. This system can support the physicians, doctors and health care services in decision IPSS score to the patients.This system helps the medical practitioner to take a decision with the limited amount of information he has about the patient’s disease and prevent delay in the commencement of medical treatment. However, the aim of this system is not to replace a specialist but to reduce the time consumed in carrying out lengthy lab tests. Hence, the system acting as an assistant for medical diagnosis and can be used in any other related domain. Most DSS System use Data Mining Technology and AI approach techniques. But in this system, CBR techniques are used because it is easy to implement and well support our organization needs by studying the past cases.

8. References

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