Decision Support System For Mosquito Borne Disease

Hnin Su Wai, Daw Myint Myint Maw
University of Computer Studies, Yangon
hninsuwaiucsy@gmail.com, myintmyintmaw2009@gmail.com

Abstract

As the technology grows rapidly, many people take a great interest in computer and then computer-based methods are increasingly used to improve the quality of the medical services. Human experts in medical field are frequently in great demand. Nowadays, medical diagnosis reasoning is a very important application area of computer-based system. People take a great interest in computer and then computer-based methods are increasingly used to improve the quality of the medical services.

The primary goal of this thesis is to develop a case-based system where a new patient could be quickly compared to the numerous cases in the databases. The objective is to find the closest match that can be reused to support a problem and makes a decision based on CBR problem solving cycle. In this thesis, a decision support system for mosquito borne diseases will be implemented by using Case base reasoning which employs an intuitive and easy-to-use framework to assess the patient's information and recommend a diagnosis. The proposed system both contributes to decision support system and has advanced clinical support for Mosquito borne disease diagnosis. This system will implement the C#.Net Programming language.

Key words: computer-based system, case-based reasoning, medical diagnosis system.

1. Introduction

Nowadays, artificial intelligence and knowledge based system are assuming an increasing important role in medicine for assisting clinical staff (physicians) in making solutions. Having confirmed the presence of symptoms the specialist must advise the disease name and can give the treatments. Many medical diagnosis problems solving is a difficult task, which require the contribution of more medical human specialists and medical computational system.

The use of decision support systems in clinical medicine has received considerable attention from information systems researchers and practitioners. Of particular importance is diagnosis decision making, a critical aspect of patient care and management by healthcare professionals. Broadly, diagnosis refers to a classification process through which the attending clinician, on the basis of information and symptoms collected, assigns a new patient to one or more pre-specified medical conditions. An inadequate or incorrect diagnosis can adversely affect subsequent patient treatment or management plan.

When diagnosing a patient, a clinician often needs complex and highly specialized knowledge that may not be accessible in a convenient and timely manner. In this vein, the use of a decision support system that includes precise diagnosis knowledge is desirable, particularly because it may improve service quality and diagnosis knowledge accessibility and dissemination.

Computer-based methods are increasingly used to improve the quality of medical services. Case-based reasoning (CBR) is considered established method for building medical diagnosis systems. Case-based reasoning is a recognized and well established method for building medical systems. It uses for case retrieval and revises the retrieved case solution by using adaptation rules. The system can also retain the successful case solution for future assistance.

In this paper, we described an approach for medical diagnosis system based on the case-based reasoning approach. Case-based reasoning is an approach for problem solving based on similar previous cases. A case consists of problem description (common symptoms and specific symptoms) and solution (disease and treatments). Cases are stored in database as a case that is call case-based. To solve actual problem of similarity between current problems is used to retrieve similar cases form the case base. The solution of these found similar cases use as starting points for solving the actual problem at hand. In this thesis, we focus the developing case-based reasoning system for diagnosis by related symptoms.

2. Related Work

Case-based reasoning has already been applied in a number of different applications in medicine. The Medical Information Groups of Ain Shams developed a CBR-based expert system for diagnosis of Cancer diseases.

Some real CBR systems are: CASEY that gives a diagnosis for a heart disorders, GS.52 which is a diagnostic support system for dysmorphic syndromes, NIMON is a renal functions monitoring system, COSYL that gives a consultation for a liver transplanted patient and ICONS that presents suitable calculated antibiotics therapy advised for intensive care patient.

FM-Ultranet is a medical CBR project implemented with CBR works. FM-Ultrnet detects malformations and abnormalities of foetus through ultrasonographical examinations. The detection, or diagnosis, uses attributes derived from scans of the mother's uterus, and identifies abnormal organs and extremities. Cases are arranged in hierarchical and object oriented structure. The hierarchy is organized in 39 concepts, and every concept has one or more attributes. The attributes consists of anatomical features, medical history and general domain knowledge. Similarity between attributes in the concepts (objects) are mathematically calculated or compared through a look up table, depending on the attribute type.

Salem et al; presented the CBR-based expert system prototype for diagnosis of cancer diseases. The system aids the young doctor to check their diagnosis and it provides recommendation for controlling pain and providing symptom relief in advanced cancer.

Jaulent et. al, is diagnosing histopathology in the breast cancer domain. Their system uses cases that are derived from written medical reports. A case has an internal tree structure, and represents a collection of macroscopic area. Every macroscopic area is a collection of histological areas, and each histological areas contains a cytological description of subjective features, like a big cell size. The features are also weight for importance. Cases are compared for structural (structure of the histological tree), surface (semantic resemblance of microscopic areas) and feature similarity. A translation transposes the subjective feature into numerical values.

Artificial Intelligence has been applied in numerous applications in the health science domain. In the late 1980's, Case-Based Reasoning (CBR) appeared as an interesting alternative for building medical AI applications, and has since been further established in the field. Certainly, one of the intuitively attractive features of CBR in medicine is that the concepts of *patient* and *disease* lends itself naturally to a case representation. Although several advantages of using CBR in medicine has been identified, the medical field certainly is not without its problems, some of them specifically affecting CBR systems [6].

Data about correct diagnoses are often available in the form of medical records in specialized hospitals or their departments or their clinics. All that has to be done is to input the patient records with known correct diagnosis into a computer program. The medical diagnostic knowledge can be automatically derived from the description of cases solved in the past. The derived classifier can then be used either to assist the physician when diagnosing new patients in order to improve the diagnostic speed, accuracy and/or reliability, or to train students or physicians non-specialists to diagnose patients in a special diagnostic problem [2].

3. Case-Based Reasoning System (CBR)

Case-based reasoning (CBR) is a problem solving techniques that solves new problem by reusing or adapting solutions that were used to solve similar problems in the past. The previous problems or past experiences are encoded as cases, known as a case-base, is the knowledge base of experience used to solve new problems. Case-based reasoning (CBR) is memory based, reflecting human of remembered problems and solution as a starting point of new problem solving.

CBR is an analogical reasoning method providing both a methodology for problem solving and a cognitive model of people. CBR means reasoning form experiences or old cases in an effort to solve problems, critique solutions, and explaining anomalous situations. It is consistent with much that psychologist have observed in the natural problem solving that people do. People tend to be comfortable using CBR methodology for decision making, in dynamically changing situations and other situations were much is unknown and when solutions are not clear.

There are two style s of CBR: problem solving style and interpretive style. Problem solving style can support a variety of tasks including planning, diagnosis and design (e.g. Medicine and Industry). The interpretive style is useful for (a) situation classification (b) evaluation of solution (c) argumentation (d) justification of solution interpretation or plan and (e) the projection of effects of a decision of plan. Lawyers and managers making strategic decision use the interpretive style. CBR has been used to create numerous applications in a wide range of domain such financial analysis, risk assessment, forecasting, medical diagnosis. CBR is recognized and well established method of building medical systems.

Figure 1.1 shows the case-based reasoning cycle. Case-based reasoning cycle consists essentially of the following parts:

Retrieving: Similar previously experienced cases whose problems are considered to be similar are selected.

Reusing: The cases are reused by either copying or integrating the solution from the retrieved cases.

Revising: The retrieved solution are revised or adapted to try to solve the new problem.

Retaining: The new solution is stored after being confirmed and validated.

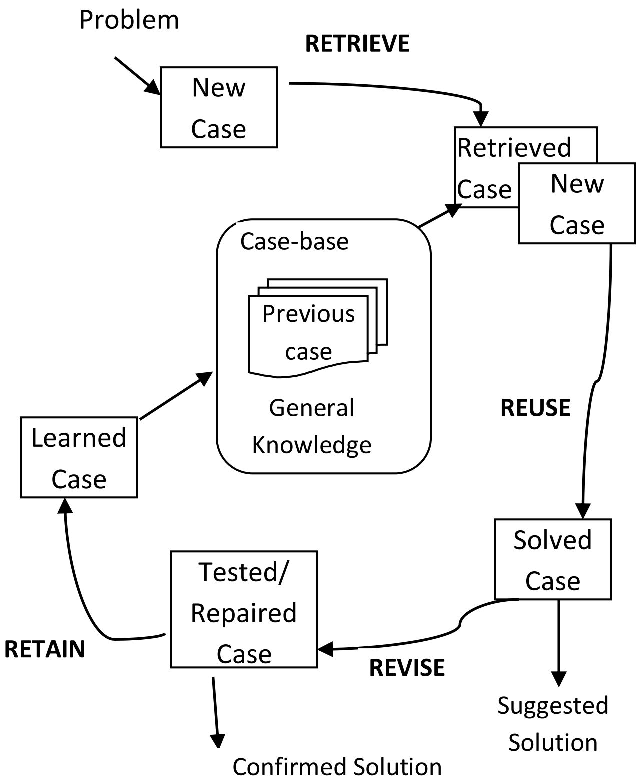

Figure.1. Case-Based Reasoning Cycle

3.1 Case Representation

A case is a specific problem that has previously been encountered and solved: the case base is the set of historical records of solved problems and the observed solution is empirically justified. In other domains: a “case” is a idealized, typically way of solving a problem or set of problems: the case base is a collection of hypothetical problems and corresponding solutions.

A case can be regarded as three features:

1. Its description
2. Its associated solution
3. The justification of its solution

3.2 Steps in the Case-Based Reasoning Cycle

1. Retrieve a case matching given problem
2. Adapt the matching case’s solution to produce desire solution.
3. Test and revised suggested solution
4. Retain confirmed solution by adding it to case base for future use [8].

3.3 Case Retrieval

The retrieval tasks starts with a problem description, and ends when the best matching previous cases has been found. Given a description of a problem, a retrieval algorithm should retrieve the most similar cases to the current problem situation. Among well known methods for retrieval are :

1. nearest neighbor
2. induction
3. knowledge guided induction
4. template retrieval

3.4 Nearest-Neighbor Algorithm

The most widely use technology in CBR. This approach involves the assessment of similarity between stored cases and the new input case, based on matching a weighted sum of features. The procedure of this algorithm is as follow:

- for each feature in the input case
- find the corresponding feature in the stored case
- compare two values to each other and compute the degree of match
- multiply by a coefficient representing the importance of features to match
- add a result to match to derive an average match score
- this number represent the degree of match of the old input case
- A case can be chosen by choosing the item the threshold.

The main distance equation is :

$$\sum_{i=1}^{N} wi * Sim(f^I_1\ f^R_1)\ I \sum_{i=1}^{n}$$

where:

wi is the importance of the feature (slot) i

Sim( ) is the similarity function

f^I_1 f^R_1 are the values for feature f_i in the source and target cases, respectively

n is the number of attributes in each case

This similarity function is defined as follows:

$$Sim(f^I_1\ f^R_1) = 1 - (|f^I_1\ f^R_1|/|f_{max}\ f_{min})$$

if feature f_i is numeric

0 if feature f_i is symbolic and $f^I_1 \neq f^R_1$

1 if feature f_i is symbolic and $f^I_1 = f^R_1$

3.5 Case Adaptation and Retain

The reuse process in the CBR cycle is responsible for proposing a solution for a new problem from the solutions in the retrieved case. Reusing a retrieved case can be as easy as returning the retrieved solution, as the general solution for new problem. If there are significant difference between the new problem and the retrieved case's problem, reuse become more difficult. In these situations, the retrieved solution is needed to adapt.

In general, there are two kinds of adaptation in CBR:

1. Structural adaptation, in which adaptation rules are applied directly to the solution stored in cases.
2. Derivational adaptation, that reuses the algorithms, methods or rules that generated the original solution to produce a new solution to the current problem.

Most existing CBR systems achieve case adaptation for the specific problem domains they address by encoding adaptation knowledge in the form of a set of adaptation rules. Adaptation rules are then applied to a retrieved case to transform it into a new case that meets all of the input problem constraints.

4. Evaluation method and System Accuracy Measurement

Given data are randomly partitioned into two independent sets, a training set and a test set. Two thirds of the data are allocated to the training set, and the remaining one third is allocated to the test set. The training set is used to derive classification whose accuracy is estimated test set. The estimate is pessimistic since only a portion of the initial data is used to derive the classifier.

Accuracy can be measured by sensitivity and specificity. Sensitivity and specificity are the most widely used statistics used to describe a diagnostic test. Sensitivity is the probability of a positive test among patients with disease. Specificity is the probability of a negative test among patients without disease.

$$\text{Sensitivity} = \frac{\text{t-pos}}{\text{pos}}$$

$$\text{Specificity} = \frac{\text{t-neg}}{\text{Neg}}$$

$$\text{Accuracy} = \text{sensitivity}\frac{\text{Pos}}{(\text{pos} + \text{neg})} + \text{Specifitity}\frac{\text{neg}}{(\text{pos+neg})}$$

5. Overview of the proposed system

Mosquitoes are a vector agent that carries mosquito-borne disease, transmitting viruses and parasites from person to person without catching the disease themselves. Mosquitoes carrying these viruses stay healthy while carrying them because their immune system recognizes them as bad and "chops off" the virus's genetic coding, rendering it harmless. It is currently unknown how they handle parasites so they can safely carry them. Infection of humans occurs when a mosquito bites someone while its immune system is still in the process of destroying the virus's harmful coding. Female mosquitoes suck blood from people and other animals as part of their eating and breeding habits.

When a mosquito bites, she also injects saliva and anti-coagulants into the blood which may also contain disease-causing viruses or other parasites. This cycle can be interrupted by killing the mosquitoes, isolating infected people from all mosquitoes while they are infectious or vaccinating the exposed population.

This system stores the mosquito borne disease patients' information in case base. The system can be used by two types of user depending on their roles. For authorized user to maintain the case base, he/she can save new case with their corresponding successful solution into the case base. For user, he/she can use the system to support the diagnosis of their input case by entering the case features. This system uses the 1000 total cases. There are 750 training case and 250 testing case.

5.1 System Design

The system stores the mosquito borne disease patients' information in case base. For efficient case retrieval, this system used case indexing based on features. The system can be used by two types of user depending on their roles. For authorized user to maintain the case base, he/she can save new case with their corresponding successful solution into the case base. For user, he/she can use the system to support the diagnosis of their input case by entering the case features.

To give the solution of the new case, the system uses the nearest neighbor algorithm for matching the new case with the existing cases in the case base. In this phase, the system can retrieve either the exact match with the new case or the nearest match which has the greatest similarity with the new case. If the exact match is found, the system gives the exact case solution to the user directly. Otherwise, the system reuses the solution of the most similar case as the general solution. Then it revises that solution by using adaptation rules and gives the solved solution to the user.

Figure 2 shows the architecture of the case-based medical diagnosis system.

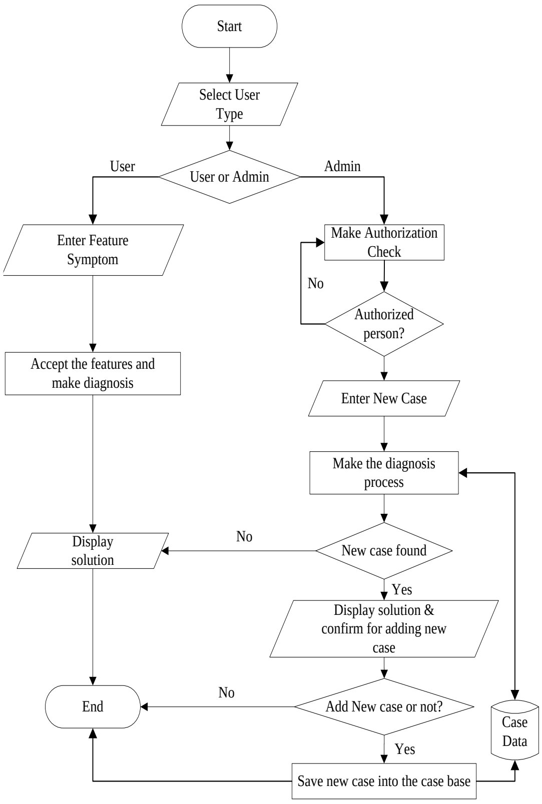

Figure 2. System architecture

6. Conclusion

Computer based diagnostic decision support systems will play an increasingly important role in health care. They may improve the quality of the diagnostic process in accuracy and efficiency while cost and burden of patients may be reduced. In addition, they can play an invaluable role in medical education. The system permits junior medical personal to improve their diagnostic skill to solve problems concerned with mosquito borne diseases when experience medical person is not available.

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