Rule-based Expert System for Blood Bank

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Abstract

In this paper, rule-based expert system for Blood Donation Bank is proposed in this paper. Rule-based expert systems are a way to store and manipulate knowledge to interpret information in a useful way. They are often used in artificial intelligence applications and research. A rule-based system consists of a bunch of IF-THEN rules, a bunch of facts and some interpreter controlling the application of the rules, given this fact. The method used in this system is Forward Chaining Method which is one of the two main methods of reasoning when using inference rules. Rule-Based expert system used in this paper is intended to provide blood bank.

Keywords: Rule-Based Expert Systems, Rule-Based System, Forward Chaining, Expert System, Accuracy, Blood Donation Bank

1. Introduction

Rule-based system is the domain-specific expert system that uses rules to make deductions or choices. For example, an expert system might help a doctor choose the correct diagnosis based on a cluster of symptoms, or select tactical moves to play a game [2].

Rule-based system attempts to derive execution instructions from a starting set of data and rules, which is a more indirect method than using an imperative programming language which lists execution steps straightforwardly [2].

A rule-based expert system is an expert system which works as a production system in which rules encode expert knowledge.

Most expert systems are rule-based. Alternatives are [2]:

(1) Frame-based - knowledge is associated with the objects of interest and reasoning consists of confirming expectations for slot values. Such systems often include rules too.

(2) Model-based - where the entire system models the real world and this deep knowledge is used to eg. Diagnose equip mental functions, by comparing model predicted outcomes with actual observed outcomes

(3) Case-based - previous examples (cases) of the task and its solution are stored. To solve a new problem the closest matching case is retrieved, and its solution or an adaptation of it is proposed as the solution to the new problem.

The proposed system is about the blood bank which store and retrieve pure blood from the donators. The system is developed as the rule-based expert system for improving the steps by steps processes of the system.

This paper is organized as follow: Section 2 discusses about Rule-Based Expert System and Architecture of the Rule-Based expert System, Rule-Based Systems, Theory of Rule-Based Systems and forward chaining method. Section 3 discusses is about Expert system. Overview of the System is presented in Section 4.Section 5 is about Implementation of the System and Example of rules for Blood Donation. Discusses is about Possibility (Find Accuracy) in Section 6. Implementation environment and conclusion of the system are described in Section 7 and 8. Finally, Reference is described in Section 9.

2. Rule-Based Expert System

Rule-based programming is one of the most commonly used techniques for developing expert systems. A rule-based expert system consists of a set of rules that can be repeatedly applied to a collection of facts. The following concepts are essential to rule-based systems:

Facts represent circumstances that describe a certain situation in the real world [6].

Rules represent heuristics that define a set of actions to be executed in a given situation.

There is a basic distinction between derivations and production rules. Derivation rules have the form if <condition> then <conclusion>, whereas production rules conclusion, in derivation rules, is abstract: it consists of deriving logical consequences from certain conditions. These logical consequences are simply asserted but not executed. An action, in production rules, is concrete: it consists of producing practical consequences from certain conditions. These practical consequences are concretely executed.

ECA rules, namely rules like if <condition> then <action>, which are production rules. However, production rules can implement derivation rules by using a special action “assert”, which asserts knowledge. If the <action> part of a production rule is just a conclusion and not a function that performs actions, we can consider this production rule as a derivation rule.

In both these cases, rules are composed of an "if" portion and a then portion. The "if" portion of a rule the left hand side (LHS), is called predicates or premises. The LHS consists of an expression, which can be a single expression (an individual fact that must be true for applying the rule) or a series of expressions (composite expression). In the literature of rule-based languages, a single expression is usually called pattern.

A composite expression consists of several single expressions connected together by using the conditional elements "and, or, not" in order to create complex rules. Usually, when several expressions are connected by the "and" conditional element, this element is omitted. In rule-based languages we have also the logical connectives "&, |, ~", which are used to manipulate values inside a single fact [6].

2.1 Architecture of Rule-Based Expert System

The main elements of a rule-based system are facts on them. The core of facts, rules, and the engine that acts the architecture shown in Fig 1 consists of the working memory (fact base), the rule base (knowledge base) and the inference engine (rule engine).

The working memory contains facts that are the smallest piece of information supported by the rule engine.

The rule base contains rules in the form of "IF-THEN" statements, which represent the knowledge provided by the user and/or an expert of the problem domain;

The inference engine matches facts in the working memory against rules in the rule base, and it determines which rules are applicable according to the reasoning method adopted by the engine [6].

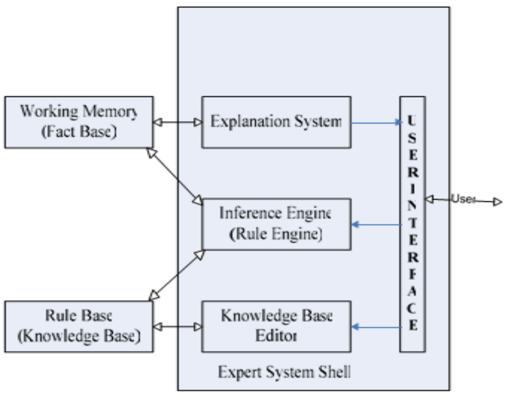

Figure: 1. General Rule-Based Expert System Architecture

2.2. Rule-based Systems

Using a set of assertions, which collectively form the 'working memory', and a set of rules that specify how to act on the assertion set, a rule-based system can be created. Rule-based systems are fairly simplistic, consisting of little more than a set of if-then statements, but provide the basis for so-called "expert systems" which are widely used in many fields. The concept of an expert system is this: the knowledge of an expert is encoded into the rule set. When exposed to the same data, the expert system AI will perform in a similar manner to the expert [3].

Rule-based systems are a relatively simple model that can be adapted to any number of problems. As with any AI, a rule-based system has its strengths as well as limitations that must be considered before deciding if it's the right technique to use for a given problem. Overall, rule-based systems are really only feasible for problems any and all knowledge in the problem area can be written in the form of if-then rules and for which this problem area is not large. If there are too many rules, the system can become difficult to maintain and can suffer a performance hit. To create a rule-based system for a given problem, the followings are needed to create: [3]

1. A set of facts to represent the initial working memory. This should be anything relevant to the beginning state of the system.
2. A set of rules. This should encompass any and all actions that should be taken within the scope of a problem, but nothing irrelevant. The number of rules in the system can affect its performance, so you don't want any that aren't needed.
3. A condition that determines that a solution has been found or that none exists. This is necessary to terminate some rule-based systems that find themselves in infinite loops otherwise.

2.3. Theory of Rule-Based Systems

The rule-based system itself uses a simple technique: it starts with a rule-base, which contains all of the appropriate knowledge encoded into "If-Then" rules, and a working memory, which may or may not initially contain any data, assertions or initially known information. The system examines all the rule conditions (IF) and determines a subset, the conflict set, of the rules whose conditions are satisfied based on the working memory. Of this conflict set, one of those rules is triggered (fired). Which one is chosen based on a conflict resolution strategy. When the rule is fired, any actions specified in its "THEN" clause are carried out. These actions can modify the working memory, the rule-base itself, or do just about anything else the system programmer decides to include. This loop of firing rules and performing actions continues until one of two conditions is met: there are no more rules whose conditions are satisfied or a rule is fired whose action specifies the program should terminate. Which rule is chosen to fire is a function of the conflict resolution strategy. Which strategy is chosen can be determined by the problem or it may be a matter of preference. In any case, it is vital as it controls which of the applicable rules are fired and thus how the entire system behaves [1].

2.3.1 Forward Chaining

Forward chaining is one of the two main methods of reasoning when using inference rules (in artificial intelligence). It is referred in philosophical circle as modus ponens. The opposite of forward chaining is backward chaining.

Forward chaining starts with the available data and uses inference rules to extract more data (from an end user for example) until a goal is reached.

For example, suppose that the goal is to conclude the color of a pet named AA, given that he croaks and eats flies, and that the rule base contains the following four rules:

1. If X croaks and eats flies - Then X is a frog
2. If X chirps and sings - Then X is a canary
3. If X is a frog - Then X is green
4. If X is a canary - Then X is yellow

This rule base would be searched and the first rule would be selected, because its antecedent (If AA croaks and eats flies) matches the data. Now the consequent (Then X is a frog) is added to the data. The rule base is again searched and this time the third rule is selected, because its antecedent (If AA is a frog) matches the data that was just confirmed. Now the new consequent (Then AA is green) is added to the data. Nothing more can be inferred from this information, but we have now accomplished the goal of determining the color of AA. Because the data determines which rules are selected and used, this method is called data-driven. One of the advantages of forward-chaining over backward-chaining is that the reception of new data can trigger new inferences, which makes the engine better suited to dynamic situations in which conditions are likely to change [7].

3. Expert System

An expert system is a software system that attempts to reproduce the performance of one or more human experts, most commonly in a specific problem domain, and is a traditional application and/or subfield of artificial intelligence. A wide variety of methods can be used to simulate the performance of the expert however common to most or all are 1) the creation of a so-called "knowledgebase" which uses some knowledge representation formalism to capture the subject matter experts (SME) knowledge and 2) a process of gathering that knowledge from the SME and codifying it according to the formalism, which is called knowledge engineering. Expert systems may or may not have learning components but a third common element is that once the system is developed it is proven by being placed in the same real world problem solving situation as the human SME, typically as an aid to human workers or a supplement to some information system.

As a premiere application of computing and artificial intelligence, the topic of expert systems has many points of contact with general systems theory, operations research, business process reengineering and various topics in applied mathematics and management science[4].

4. Overview of the System

Mainly, there are 4 steps included in the proposed system. Step 3 will be done in manually as computers cannot test the blood types and diseases; therefore, step 3 is not count as the steps of proposed system. Step by step processes of the system are as follow:

1. Questionnaire for the blood donator
2. List of the person who can donate the blood according to their questionnaire results
3. Take blood from donators for test blood type and clear diseases or not. If the blood is pure, taken the blood from the donators.
4. Accept donated blood and store at the blood bank with blood type, donator age, gender, serial no, donated date, expired date and donator’s contact list.
5. When someone come and ask for blood, the system will find whether the requested blood is available at the blood bank or not; if the requested blood quantity is greater than the available amount, the system will list out the donators’ contact list who can donate the blood.

The features of proposed system are based on knowledge data using knowledge base. Forward chaining method is used to find the knowledge data from the knowledge database. The explanation of why using forward chaining method in the proposed system.

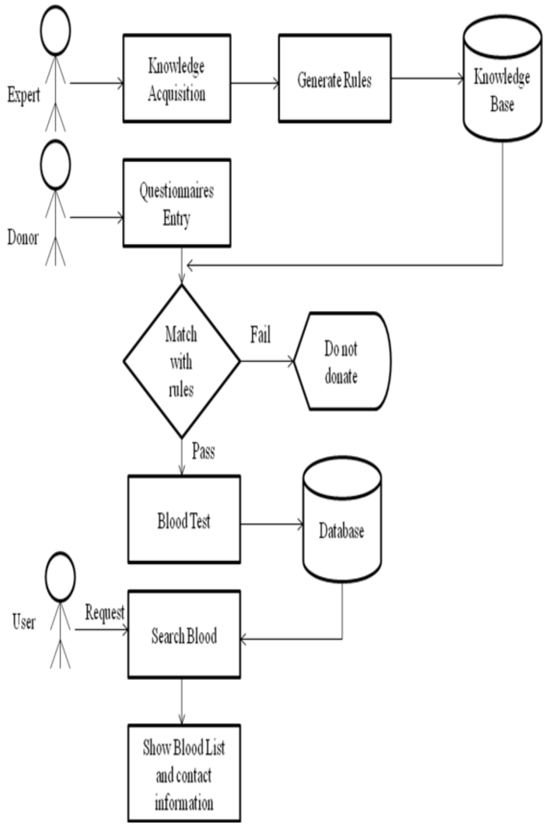

Figure: 2. Overview of the System

5. Implementation of the System

In the proposed system, Expert needs to put the knowledge data into the Knowledge Base first. This system gets knowledge data by knowledge acquisition from the expert, and then, saved those expert defined rules in knowledge base.

To donate blood, there are two different steps for blood donors. If the donor has not been donate blood before (new donor), the donor should fill the personal information data first. Then, the donor can fill the questionnaire form. If the donor donated the blood before, the donor does not need to fill the personal information data again.

The donor only needs to fill the NRC no. If the donor last donated date in within last 4 months, the system will not allow donor to continue further process such as filling questionnaire, blood test and so on. If the donor last donated date is above 4 months, the donor can donate blood and the system will allow donor to fill the questionnaire form. When donor click the save button from questionnaire form, the system will check whether the questionnaire results are correct or not, and save those results to the database, and the system will show the pass or fail results to the donor.

If donor passed the questionnaire, the system will show how much correct percent (%) the donor gets of the results and after that, the system will show the manual guideline of the blood test process.

Blood test has to enter into the system from Blood Test Results form.

Only the donor who passed the blood test process can be donated the blood. Donated blood information will also be saved in the system.

When someone come and ask for blood, the system will find whether the requested blood is available at the blood bank or not and the system will also list out the donators' contact list who can donate the blood.

If the requested blood quantity is greater than the available amount, the system will only show the list of donors' contact information who can donate blood.

5.1. Example of Rules for Blood Donation

This system is depending on this questionnaire answers. There are questions thirty in questionnaire form but questions twelve is main question. Because of the questions eighteen is allowed yes or no and accept. Expert modify the rules by explicit. So, questions twelve is under mentioned

Q1. Are you feeling quite well between eighteen and fifty-five ear of age?
Q2. Have you suffered from jaundice within 5 year?
Q3. Have you made major operation during the last six months; if so, describe the name of your operation?
Q4. During last year have you made tattoo?
Q5. Have you made No.4injection in to your nerves?
Q6. Have you been suffered from malaria during last three years?
Q7. Have you been suffered from any diseases below, Asthma, ascent disease, skin disease high blood pressure , diabetes , desire, heart disease, kidney disease , goiter, hemophilia, and (other ---------------------------)
Q8. Have you been suffered from measles, Mumps, herpes facials, chicken pox, German measles, within three weak?
Q9. Now are you in menses period?
Q10.Have you born a body or have you been abortion during last six months?
Q11. Now so you have pregnancy?
Q12. Now do you have breast-feeding? Are you child(s) under the age of 1 and half years?

IF Q1 = YES AND Q2 = NO AND Q3 = NO AND Q4 = NO AND Q5 = NO AND Q6 = NO AND Q7 = NO *AND* Q8 = NO AND Q9 = NO AND Q10 = NO AND Q11 = NO AND Q12 = NO

THEN allow blood donation

6. Possibility (Find Accuracy)

A possibility is a future state, a goal, a purpose, something perhaps just out of reach but tickles the imaginations. Creates curiosity and wonderment about it is achievability. A possibility denotes forward movement and momentum. There is no past influences or negative reactivity. It doesn't feel claustrophobic or have a negative feeling that one is compelled to change anything because one is forced to. A possibility frees us to wonder, it is open and airy freeing and stretching.

It does not require one to change anything. The reality does not have to be changed. That implies force. Rather, a choice to grow and develop a new set of strategies or a new behaviors, systems, processes relationships that will move to forward is much more compelling and useful. The path and the outcome are to be chosen. There is a gap between the perceived reality and the end result the possibility creates. But within that gap lies the solution for growth and development. The gap is critical and can be examined with objective eyes and understanding [5].

In this system, possibility is used on questionnaire answers. Depends on the possibility of questionnaire answers, both donors and blood bank can estimate and decide whether the donor should donate the blood or not even the donor passed the questionnaire questions.

There are 12 main questions in questionnaire form which Donor's answers should be the same with expert's answers. If Donor fails to answers those, the system will not allow Donor to make a blood test. If the Donor passed those 12 answers, the system will calculate the possibility of the Donor's answers without including those 12 answers and shows the possibility result. Therefore, the Donor or the staffs from Blood Bank can decide whether the Donor should make the blood test and donate the blood or not.

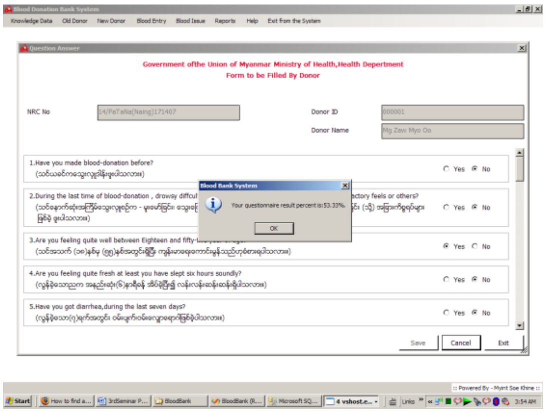

Figure3: Accuracy Result

To find the accuracy of the donor input results,

1. System check whether the donor pass the questionnaire or not
2. If pass questionnaire, check the donor's questionnaire answer with expert's knowledge data (expert defined rules).
3. The system counts the correct answers of donor by comparing donor's questionnaire answers with expert defined rules.
4. Then, find the accuracy of the donor's answers.

7. Implementation Environment

Proposed system is written in Microsoft C#.NET 2005 under .NET Framework 2.0. The EXE file of the system can be run on every machine which installed window XP service pack 2, .NET Framework 2.0 and Microsoft SQL Server 2005 Express Edition. To view the source code file or to make a modification, Microsoft Visual Studio 2.0 is needed to install. For the database, Microsoft SQL Server 2005 is used as the database server which is easy to use, install, and the hardware requirements for installation are not too high.

8. Conclusion

This paper is a brief overview of a very broad field of Rule-Based/Expert Systems. Rule-Based Systems are more reliable and interactive to the user and can response to the user with sensible and possible data by combining with Expert System. Therefore, this paper would present the features of the Rule-Based/Expert System. Moreover, this paper will also evaluate the Rule-Based/ Expert systems and also study why the Forward Chaining and Possibility methods are needed to add in the development of the system for improving the system processes.

9. References

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