Decision Support Framework Using Karnaugh map and Conditional Probability

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Abstract— Preserving knowledge for future use is an important concern for every organization. Knowledge is extracted from various sources and added to the application's knowledge base for later use. Even though knowledge can be represented in various forms, the representation in the form of production rules is more practical and easy to understandable for the users. In production rules, knowledge represented in the form of antecedents and consequences. So the action will be performed when the condition is satisfied. Here propose a framework to assign the conditional probability to each occurrence of actions which will help the users in their decision making. The important enhancement of decision making system is, if the knowledge base can list out the possible actions for a particular condition will help them to choose the best one in decreasing order of the probability.

Keywords— Decision table; Production rules; Decision making system

I. INTRODUCTION

Preserving knowledge for future use is an important concern for every organization. Knowledge is extracted from various sources and added to the application's knowledge base for later use. The well equipped knowledge database without any anomalies will help the organization in business need forecasting and decision making[1]. Also helps to save the revenue for the organization by decreasing the amount of employee time spent while making the best solution among the various possibilities. And if the information is stored in the form of rules should make the interaction simpler for both customer and organization. Even though knowledge can be represented in various forms,the representation in the form of production rules is more practical and easy to understandable for the users[2]. The available framework for converting the knowledge represented in decision table to production rules is explained in literary review. In production rules, knowlededge represented in the form of antecedents and consequences. So the action will be performed when the condition is satisfied. Here propose a framework to assign the conditional probability to each occurrence of actions which will help the users in their decision making. The important enhancement of decision making system is if the knowledge base can list out the possible actions for a particular condition will help them to choose the best one in decreasing order of the probability

II. LITERATURE REVIEW

Knowledge representation schemes The various knowledge representation schemes are available[2].Here authors consider representation in the form of decision table and production rule.

A. *Decision Table:* Knowledge of relations can be represented in decision tables .The representation of knowledge in decision table is as like a table like structure with columns and rows. The table conditions and actions are stored in the table. The number of columns in the table depends on the number rules which can be created out of the possible combination of conditions. Similarly the number of rows depends on the total sum of conditions and actions of the scenario. Once constructed, the knowledge in the table can be used as input to other knowledge representation methods. The four quadrants of decision table is as below . A decision table's four components are, condition stubs, condition entries, action stubs and action entries. The upper left quadrant contains conditions. The upper right quadrant contains condition rules or alternatives. The lower left quadrant contains actions to be taken and the lower right quadrant contains action rules. Each decision corresponds to a variable, relation or predicate whose possible values are listed among the condition alternatives [2]. Each action is a procedure or operation to perform, and the entries specify whether (or in what order) the action is to be performed for the set of condition alternatives the entry corresponds to. The upper right quadrant of the decision table is conditional alternatives. This is usually represented with the yes or no flags. The rules are generated in association of conditions along with conditional alternatives. And corresponding actions are performed true or false values to represent the alternatives to a condition. And can also use binary values for representing conditional alternatives which will be explained later in this paper.

B. *Production Rules:* Production rules are the most popular form of knowledge representation for expert systems. Knowledge is represented in the form of condition-action pairs: IF this condition (or premise or antecedent) occurs, THEN some action (or result or conclusion or consequence) will (or should) occur [1][2]. Each production rule in a

knowledge base implements an autonomous chunk of expertise that can be developed and modified independently of other rules. When combined and fed to the inference engine, the set of rules behaves synergistically, yielding better results than the sum of the results of the individual rules. In reality, knowledge based rules are not independent. They quickly become highly interdependent. For example, adding a new rule may conflict within existing rule, or it may require a revision of attributes or rules [1].

III. AVAILABLE FRAMEWORK

A decision table can be represented in binary format (with 0 or 1) and with integers. As we know, the upper right quadrant of the decision table is the conditional rules or alternatives. The action rules of decision table are represented with the help of integers. Each integer represents the pointer to the corresponding action. Such decision table can be represented as in the format of karnaugh map[3].The switching theory of karnaugh map will be used to generate and reduce the rule set defined by the decision table. This will give reduced rule set and reduction or optimization of the rules can be performed easily by the appropriate grouping techniques of karnaugh map.

The available framework is divided as two modules.

1) Rule translation phase: The binary represented karnaugh map will be given as input to this phase. Here the binary 1 indicate that Y (yes) indicates a condition must be true for the rule to be satisfied, and 0 indicate N (no) that it must be false[5]. The output of this phase will be the production rules which were represented in the decision table with 0 or 1 value.

2) Rule Execution phase: The Rule execution phase will create a decision making system with the rules available in knowledge base. The output of rule translation phase will be set of rules and update them in knowledge base after optimization of the rules. The rule execution phase will take these rules as input and generate decisions. The identified infrastructure requirement for rule execution phase is PROLOG [6]. PROLOG is an interactive language for supporting decision making among the possible set of possibilities. This is a declarative programming language which will make decisions as per the facts and relations already defined based on the rules generated out of rule translation phase [4].
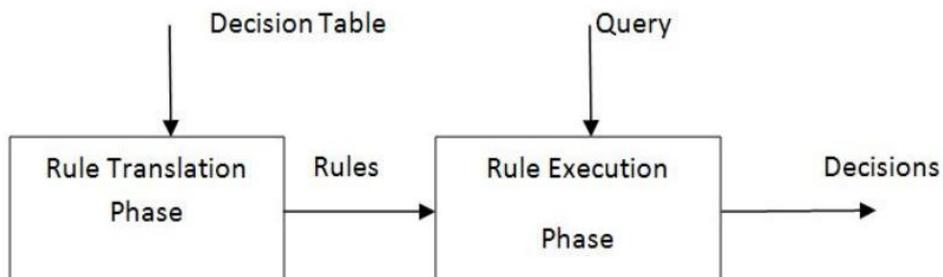

Fig 1: Architecture

IV. CASE STUDY

Consider the following decision table shown in figure. There exist multiple rules for a single Decision. This is 4x4

CONDITIONS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
WORKING DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
RAINY DAY	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0
HARTHAL	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
NOT FEELING WELL	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
ACTIONS	0	3	0	0	0	3	0	0	1	0	0	2	1	0	0	2

Fig 2: Binary Representation of Decision Table

decision table with four conditions and four actions can be taken according to the combination of four conditions. The Conditions are
  WORKING DAY
  RAINY DAY
  HARTHAL
  NOT FEELING WELL
The actions are
  STAY AT HOME
  GO TO SCHOOL
  WALK

GO TO HOSPITAL

Here notice that the integer mappings of corresponding actions are as below

STAY AT HOME-0
GO TO SCHOOL-1
WALK-2
GO TO HOSPITAL-3

The cell positions in the karnaugh map will be decided according to the conditional alternatives[3]. The grouping of actions as per switching theory of karnaugh map as below figure 3 The rules which are extracted from the table are

Fig 3: Karnaugh map Representation

R1:If Working= YES and Harthal= NO and Not feeling well= NO then GO TO SCHOOL
R2:If Working= YES and Harthal= NO and Not feeling well= YES then STAY AT HOME
R3:If workingday= NO and Not feeling well= NO then STAY AT HOME
R4:If Working= NO and Harthal= YES then STAY AT HOME
R5:If Harthal= YES and Not feeling well= NO then STAY AT HOME
R6:lf Working= YES and Harthal= YES and Not feeling well= YES then WALK
R7: If Working= NO and Harthal= NO and Not feeling well= YES then GO TO HOSPITAL

V. ENHANCEMENT

The important enhancement of decision making system is if the knowledge base can list out the possible actions for a particular condition will help the users to choose the best alternative to perform in order to achieve desired result. Here as an enhancement, the system will ask the conditions and list out the actions that satisfying the conditions. This enhancement will be implemented based on the optimized rules generated by the karnaugh map. As per the current strategy, each condition in each rule will be assigned some probability value. So the total probability of that particular rule for achieving the action will be product of probability of each condition included in the rule. Finally the actions will be list out according to the decreasing order of the total probabilities of the conditions involved in the rule. If same action with different probabilities is listed, then the maximum total probability among them will be displayed along with the action.

For example, we have assigned different probability for each condition accordingly. As an example, assigned below probability to each condition involved in the rule set.

TABLE I
PROBABILITY ASSIGNED

Conditions	Probability Assigned
Working Day=Yes	0.75
Working Day=No	0.25
Harthal=Yes	0.20
Harthal=No	0.80
Not Feeling Well=Yes	0.20
Not Feeling Well=No	0.80

Here, WORKING DAY= YES is given as a condition to check among the rules to see whether it is included in the rule set. So will list those rules as which contains the WORKING=YES condition.

R1:If Working= YES and Harthal= NO and Not feeling well= NO then GO TO SCHOOL
R2:If Working= YES and Harthal= NO and Not feeling well= YES then STAY AT HOME
R3:lf Working= YES and Harthal= YES and Not feeling well= YES then WALK

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The actions involved in the above rules are
   GO TO SCHOOL
   STAY AT HOME
   WALK
And the total probability for each action will be calculated by multiplying probability of each condition included in the rule.
   For example, the below actions are listed.

TABLE IIIII
RESULT

Actions	Total Probability
Go To School	0.4800000000000001
Stay At Home	0.12000000000000002
Walk	0.030000000000000006

Thus we can see that the action GO TO SCHOOL is selected with highest probability

C. *Implementation Methodology*
The implementation of rule translation phase is done using Java. Representation of the decision table is realized using matrix in Java.This matrix is given as input to the rule translation phase and output is those rules represented as in the decision table. The input matrix is converted to karnaugh map representation using java program. Then grouping of the karnaugh map is carried out based on the well defined rules of karnaugh map theory. In this case, the four input conditions can be combined in 16 different ways, so the truth table has 16 rows, and the Karnaugh map has 16 positions. The Karnaugh map is therefore arranged in a 4x4 grid. The table is simplified in the sense that each set of rules with the same action pointer is optimized by applying the usual simplification techniques of switching theory.
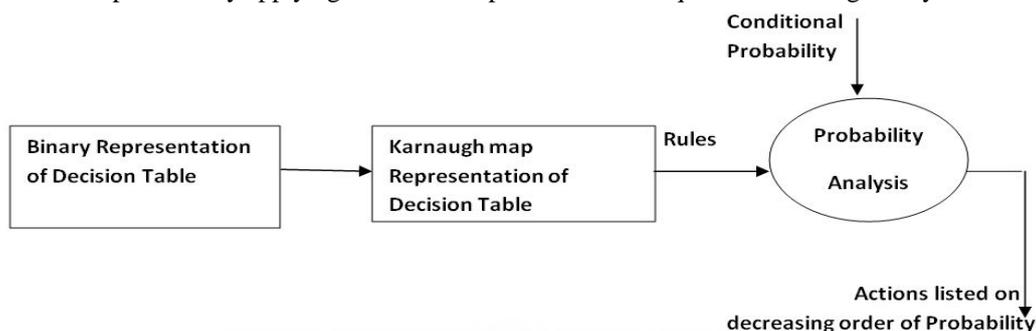

Fig 6: Architecture of Implementation

When the java program is executed the user will be prompted to select the condition for which the actions need to be listed. Then the actions with decreasing order of probability values are listed and user can select the best one among them.

VI.   CONCLUSION
So,a framework to transform the knowledge presented in decision table into knowledge base is described in this paper. Even though knowledge can be represented in various forms,the representation in the form of production rules is more Practical and easy to understandable for the users. Thus knowledge represented in decision table is converted to production rules using karnaugh map and added to knowledge base for decision making The important enhancement of decision making system is if the knowledge base can list out the possible actions for a particular condition will help the users to choose the best among them to perform. So that to achieve desired result. The important enhancement of decision making system is, if the knowledge base can list out the possible actions for a particular condition will help them to choose the best one in decreasing order of the probability. This output looks promising

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