Developing Rule-Case-Based Shell Expert System

Hussein H. Owaied, Monzer Moh'd Qasem

***Abstract*— this paper presents framework for developing shell expert system as new environment development for expert systems. The framework is based on the integration of two different knowledge representation formats. The integration consists of the Rule-base and the Case-based formats using the Blackboard. This scheme uses both procedural and declarative knowledge representation formalisms through the application of relational data base. So the rule base and case base formats have been converted into tables. In this paper all the algorithms, for creating, indexing, and checking the availability of a rule and a case, are present. The scheme facilitates combination of forward and backward chaining reasoning, using many problem solving methodologies, and different searching techniques. This view is based on the philosophy of human memory organization and utilization. Also individual uses the common sense, deduction and analogical reasoning activities in order to be more efficient for solving problems. Therefore, the proposed scheme facilitates the common sense, deduction and analogical reasoning activities in the inference engine, because rule base provides the deduction, case base provides the analogical reasoning, and the blackboard provides the common sense. The scheme makes the proposed Rule-Case-based shell expert system more flexible, efficient, and more powerful for the development of the expert systems in future.**

Index Terms — **Computer Science, Artificial Intelligence, Expert Systems, Knowledge Engineering, and Information Technology.**

I. Introduction

Expert systems are computer-based software applications which embody some non-algorithmic expertise for solving certain types of problems. Also the expert system can be defined as specific type of knowledge based system with the facilities of correctly deduct and making decision, in other words the knowledge based system that can answer the two questions How and Why. For example, expert systems are used in diagnostic applications servicing both people and machinery. They also play chess, make financial planning decisions, configure computers, monitor real time systems, underwrite insurance policies, and perform many other services which previously required human expertise [1]. There are many implementations of expert systems using various tools and various hardware platforms, from powerful LISP machine workstations to smaller personal computers. Many expert systems are built with products called shell expert systems [2]. The shell is a piece of software which contains the user interface, a format for representation of the knowledge base in narrow and specifics domains, and an inference engine. The knowledge engineer uses the shell to build an expert system for a particular problem domain. There continues to be a debate as to whether it is best to explore the technology and experiment for write expert systems or using shell expert systems [3]. One of the major bottlenecks in building expert systems is the knowledge engineering process. The coding of the expertise into the previously chosen format, such as rule base, frame, semantics nets, case-base, or others, can be a difficult and tedious task. The integration of (two or more) different knowledge representation methods is a very active research area in Artificial Intelligence. The aim is creates hybrid formalisms benefiting from each of their components. It is generally believed that complex problems can be easier solved with hybrid systems. The effectiveness of the various hybrid approaches has been demonstrated in a number of application areas [4]. In most of the hybrid approaches, two knowledge representation methods are being integrated. This is due to the fact that the integration of three or more knowledge representation methods is more complicated. One of the most popular types of integration involves the combination of rule-based with case-based reasoning approaches [5]-[6]. The efforts to combine symbolic rules and cases have yielded advanced knowledge representation formalisms. The effectiveness of those approaches stems from the fact that rules and cases are alternatives in representing application domains and solving problems [7]-[9]. Rules represent general knowledge of the domain, whereas cases specific knowledge. Rule-based systems solve problems from scratch, while case-based systems use previously stored situations to deal with similar new instances, therefore, the integration of both approaches turns out to be natural and useful [10].

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II. Structure of Shell Expert System

The shell expert system is a complete development environment for building and maintaining knowledge-Based Applications and Expert Systems. It provides a step-by-step methodology for a knowledge engineer that allows the domain experts themselves to be directly involved in structuring and encoding the knowledge [11].

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Most expert systems are developed via specialized software tools called shell expert systems. These shells come equipped with an inference mechanism (backward chaining, forward chaining, or both), and require knowledge to be entered according to a specified format, user interface, explanation facilities and editing facilities as seen in Fig. 1.

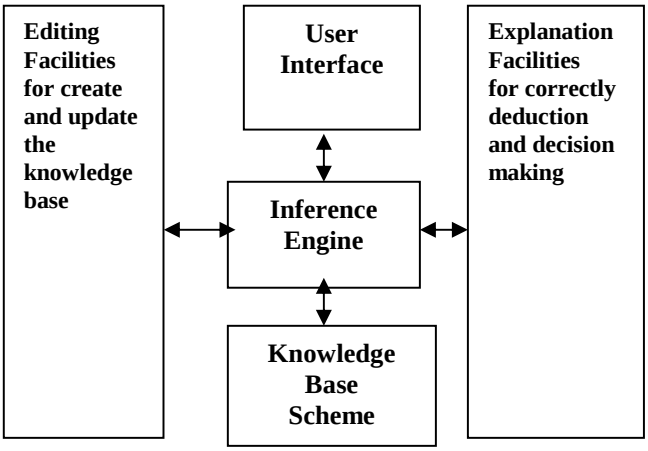

Fig. 1 Architecture of Rule-Case-Based Shell Expert System

A.The Proposed Knowledge Base Scheme (Format)

The knowledge base represents the repository of knowledge for specific and narrow domain for the knowledge based system. So, the most important part of knowledge based system is the knowledge base and the power of any knowledge based system and Expert System inherently in the adequate and integration of knowledge representation forms used for the particular domain. In this sense, the most important phase, in building knowledge based system and the expert systems, is the building of the knowledge base; this process is part of knowledge engineering which is an important field at present century. Usually, expert systems are designed and implemented for dedicated narrow and specific domain, while sell expert system can be used for developing expert system in any domain, but shell expert system are also governed by the format used for representation of the knowledge base. The proposed scheme consists of the Rule-base and the Case-based formats using the Blackboard. The scheme facilitates combination of forward and backward chaining reasoning, using many problem solving methodologies, and different searching techniques. The scheme makes the proposed Rule-Case-based shell expert system more flexible, efficient, and more powerful for the development of the expert systems in future. This view is based on the philosophy of human memory organization and utilizing for solving problems. Usually human uses more than one form for knowledge representation in his long term memory in order to be more efficient for solving problems, also the knowledge of any domain can't be in one format. In the literature survey, found that many publications have covered the development of knowledge-based systems into expert system, using case-based reasoning in the areas of conceptual design, aircraft conflict resolution, military decision support systems, help-desk operations, customer service management, legal systems, diagnosis, design, and planning [12]-[14]. It is seen that the applications of Case-Based Reasoning in developing knowledge-based systems and the expert systems have been widely adopted in various industries and other application areas [15]. Furthermore some applications have been incorporate other knowledge representation methods besides rule-based and case-based reasoning, such as neural networks and fuzzy logic [16]. Combination of forward chaining reasoning and backward chaining reasoning makes expert systems more flexible and efficient and also the use of more than one knowledge representation forms makes the expert system more powerful. Therefore, the mixing of rule-base and the Case-based forms using Blackboard has not been used before for the shell expert systems. The proposed scheme facilitates the common sense, deduction and analogical reasoning activities in the inference engine, because rule base provides the deduction, case base provides the analogical reasoning, and the blackboard provides the common sense, as seen in Fig. 2 [17].

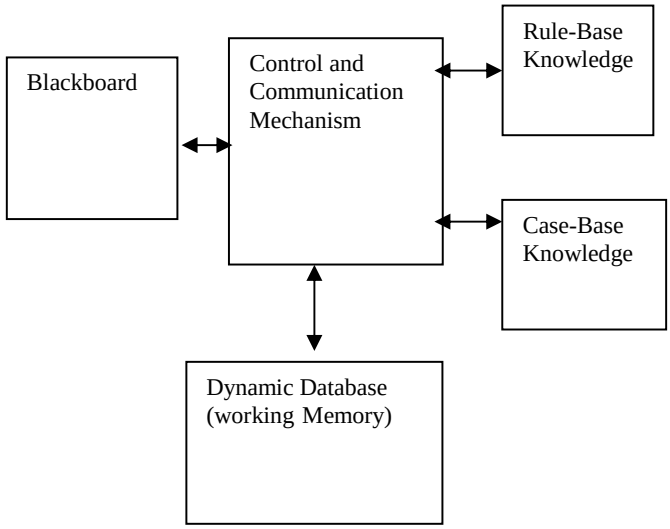

Fig. 2 the Architecture of Hybrid Knowledge Scheme

B.User Interface

The user interface simulates the communications facilities available to be used for interaction with the Rule-Case-Based shell expert system. This means an information processing system of one of (vision, speech, hearing, touching, tasting) or specified protocol many be used to connect the shell expert system to another computerized system.

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Usually the chosen method or methods to interact with the shell expert system will be based on format used for the representation of knowledge in the knowledge base. Since, the formats used in the proposed system will be a scheme of the integration of two formats, which are rule-base and case-base, so the user interface will be the appropriate communication facilities between the proposed Rule-Case-Based shell expert system and the domain expert peoples. These facilities allow the user (the domain expert peoples) to create and update the knowledge-base during the development of the expert system. But if the proposed Rule-Case-Based shell expert system connected to a computerized knowledge acquisition system then the interaction between two computer-based systems will be through the special protocols between them and should be appropriate with the proposed scheme for representation of the knowledge base.

C.The Inference Engine

The inference engine was playing the most important role in the construction of functional model of human system as mentioned in [18]. But its implementation depends on the representation of knowledge in the knowledge base of the shell expert system. Therefore, the implementation of the inference engine will be regarded as a combination of problem solving method, reasoning agent and search technique. Unfortunately, it is difficult to implement general problem solving method for any field, or a general search technique for any field also. The reasoning agent is responsible to accept sophisticated queries concerning general knowledge to deduct specific knowledge in order to use by the problem solving method and the searching technique. The power of the solver reasoning agent can be increased by implementing a larger number of solvers and by enhancing their capabilities to solve complex tasks. The use of case base format will be facilitates the analogical reasoning and the use of rule base format will facilitates the deduction during the process of solving a problem. The use of blackboard and dynamic memory together with analogical reasoning will a simulation of the common sense of human beings. Therefore the inference engine is a simulation of human behavior for solving a problem using the activities of deduction, analogical reasoning and common sense.

III.IMPLEMENTATION OF THE PROPOSED SCHEME

In reality, usually human have two types of knowledge which are Procedural and Declarative, so the proposed scheme will use both types of knowledge, which are the Rule base presents as Procedural and Case based presents as declarative. The following subsections present the detail description for the implementation of the proposed scheme. The description present the methodologies used for creating, retrieving, and updating of both Rule-base and Case-base.

A.The Rule Base

In this project the relational database will be used to represent the rule as table. The rules will be stored in a table format with the maximum of number of column are k, for example if k=6, then (Col-1, Col-2 … Col-6), as shown in table 1. The first column represents the left-hand-side of the rule, which is the conclusion of a rule usually called action (A) and from column-2 to column-6 are used to represent the conditions of the rule (C1, C2… C5), so this rule will be as Horn clause presented as follows:

A ⟵ C1, C2, C3, C4, C5

Table-1 presents layout of a rule in the table

Col-1	Col-2	Col-3	Col-4	Col-5	Col-6
A	C1	C2	C3	C4	C5

In this view assume that any rule has maximum conditions are 5, but if a rule has more conditions, then the sixth column will be sub-action which has the reset of the conditions and so on. In this case the representation of knowledge is procedural representation not declarative representation. Some examples will show how the conditions are going to be stored in the table depend on the number of conditions.

B.Creating Table

The following Fig. 3, Fig. 4.a and, Fig. 4.b present the flowchart and pseudo code respectively used to create table with 6 columns and to check the availability of a rule in the table or not before saving it, which means checking the Action of a rule and its Conditions.

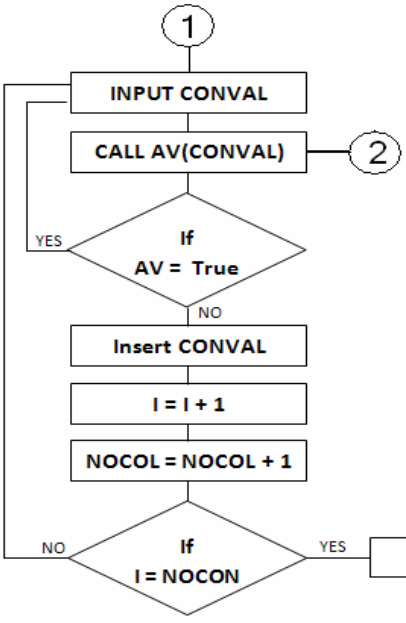

Fig. 3 presents the flowchart for creating table

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```
10   CREATE MATRIX (NUMBER OF ROWS, 6)
20   INITILIZE I TO ZERO
30   INITILIZE NUMBER OF COLOUMN TO
     ZERO
40   INPUT THE ACTION NAME  GO
       TO AVALIABILITY ALGORITHM
60   IF THE AVALIABILITY IS EQUAL TO TRUE
70   GO TO 40
80   ELSE
90   SAVE ACTION NAME TO TABLE
100  SET NUMBER OF COLUMN IS
     EQUAL TO NUMBER OF COLUMN
     PLUS ONE
110  INPUT THE NUMBER OF CONDITION
120  IF NUMBER OF CONDITIONS IS LESS
     THAN  OR EQUAL TO FIVE
130  GO TO CONDITION ALGORITHM
140  ELSE GO TO FURMULA ALGORITHM SET
     VALUE TO J IS EQUAL TO NUMBER OF
      ROWS
170  INITILIZE I TO ZERO
180  INITILIZE NUMBER OF COLUMN TO ONE
190  GO TO CONDITION ALGORITHM
200  IF NUMBER OF COLUMN IS EQUAL TO
      FIVE
210  SAVE ACTION NAME CONCATONATE
      WITH  NUMBER OF ROWS
220  SET NUMBER OF COLUMN IS EQUAL TO
     ZERO
230  SAVE ACTION NAME CONCATONATE
     WITH NUMBER OF ROWS
240 SET NUMBER OF COLUMN IS EQUAL TO
    ONE
250  NUMBER OF ROWS IS EQUAL TO
     NUMBER OF ROWS MINUS ONE  GO TO
     CONDITION  ALGORITHM
270    ELSE GO TO CONDITIN ALGORITHM
```

Fig. 4.a presents the pseudo code for creating table

```
10   INPUT THE CONDITION VALUE
20   GO TO CHECK AVALIABILITY
      ALGORITHM
30   IF AVALIABILITY IS EQUAL TO TRUE
40   GO TO 10
50   ELSE SAVE CONDITION VALUE IN
      TABLE
70   SET I IS EQUAL TO I PLUS ONE
80   SET NUMBER OF COLUMN IS EQUAL TO
      NUMBER OF COLUMN PLUS ONE
90   IF I IS EQUAL TO NUMBER OF COLUMN
100  EXIT
110  ELSE  GO TO 10
```

Fig. 4.b presents the pseudo code for creating table

C.Checking Availability of a Rule

The following Fig. 5 and Fig. 6 present the pseudo code and flowchart respectively used to check the availability of a rule in the table or not before saving it, which means checking the Action of a rule and its Conditions.

```
10   INITILIZE NUMBER OF COLOUMN TO ZERO
20   INITILIZE NUMBER OF ROWS TO ZERO
30   SET STATUS IS EQUAL TO "FALSE"
40   IF VALUE IS NULL
50   SET NUMBER OF ROWS IS EQUAL TO
      NUMBER OF ROWS PLUS ONE
60   IF COLUMN1 IS EQUAL TO ACTION NAME
70   SET STATUS TO TRUE
80   ELSE GO TO 50
100  ELSE  SET NUMBER OF ROWS IS EQUAL
     TO  NUMBER OF ROWS PLUS ONE
120  SET NUMBER OF COLOUMN IS EQUAL TO
      NUMBER OF COLOUMN PLUS ONE
130  GET COLUMN CONCATONATE WITH
      NUMBER OF COLUMNS
140  IF  COLUMN CONCATONATE WITH
      NUMBER
      OF COLUMNS IS EQUAL TO VALUE
150  STATUS IS EQUAL TO TRUE
160   EXIT
170   ELSE
180   IF  COLUMN CONCATONATE WITH
      NUMBER OF COLUMNS IS EQUAL TO NULL
190   STATUS IS EQUAL TO FALSE
200   EXIT
210   ELSE
220   IF  NUMBER OF COLUMNS IS EQUAL TO
SIX
230   EXIT
240   ELSE
250    IF STATUS IS EQUAL TO TRUE
260    EXIT
270    ELSE
280    SET STATUS TO TRUE
```

Fig. 5 present the pseudo code used to check the availability of a rule in the table

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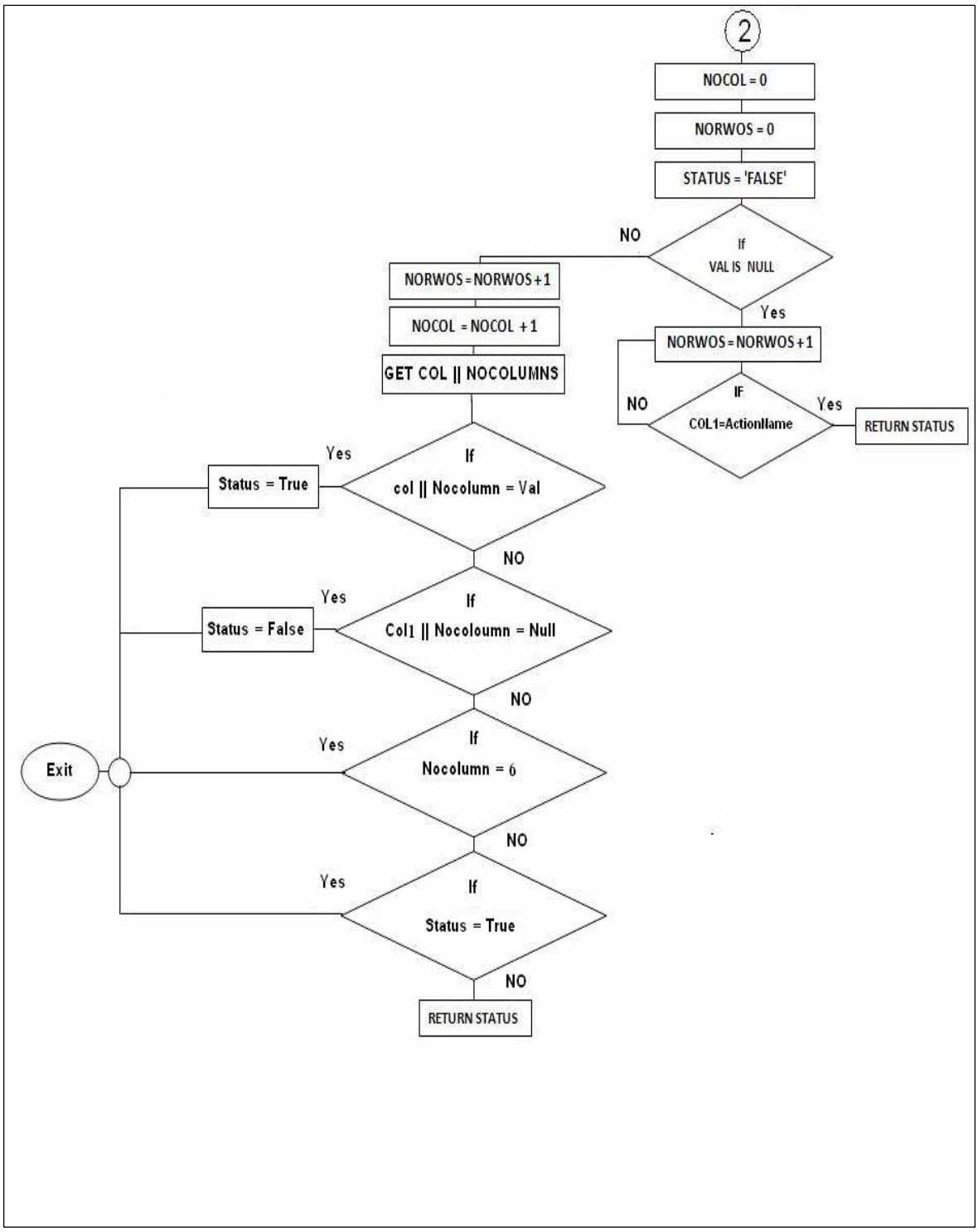

Fig. 6 presents the flowchart to check the availability of a rule in the table

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D.Algorithm of Calculating Number of Rows

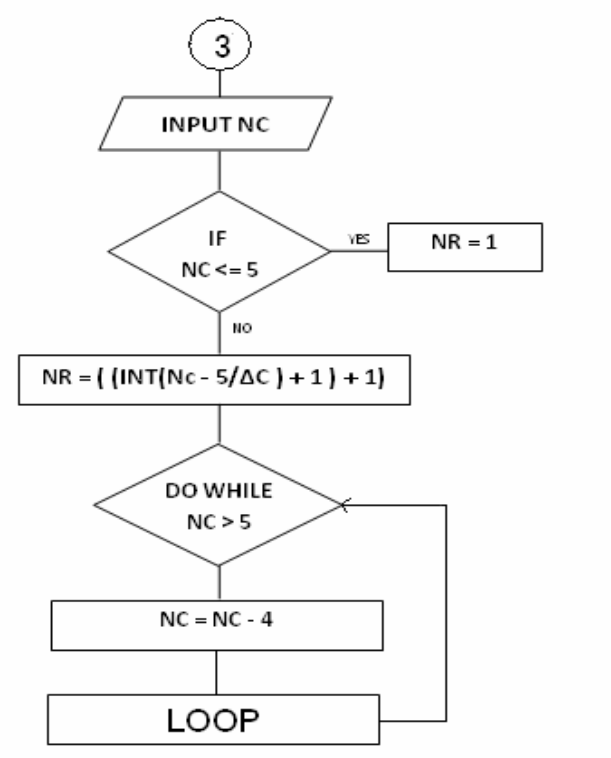
The following formula is used to determine the number of rows required for a particular rule according to the number of conditions in the rule.

$$\text{Number of Rows} = \begin{cases} \left\lceil \frac{Nc-5}{\Delta C}+1 \right\rceil +1 & : Nc > 5 \\ 1 & : Nc <= 5 \end{cases}$$

Where: Nc is Number of conditions

Δc: the difference between the conditions to be stored in each row, its value 4 because the table contains 6 columns and the maximum conditions to be stored is 5.

Fig. 7 and Fig. 8 below present the flowchart and pseudo code respectively. They are used to calculate the number of rows, for store a particular rule in the table, according to the number of conditions.



Fig, 7: presents the flowchart used to calculate the number of rows

```
10  INPUT THE NUMBER OF CONDITIONS
20  IF NUMBER OF CONDITIONS IS LESS THAN
    OR EQUAL TO 5
30  SET NUMBER OF ROWS IS EQUAL TO ONE
40  ELSE
50  SET NUMBER OF ROWS IS EQUAL TO
    INITIAL (NUMBER OF
    COLUMNS-5/ΔC)+1)+1)
60  WHILE NUMBER OF COLUMNS IS
    GREATER THAN FIVE
70  SET NUMBER OF COLUMNS IS EQUAL TO
    NUMBER OF COLUMNSMINUS FOUR
```

Fig. 8: The pseudo code for calculate the number of rows

E.The Representation of General Form of a Rule

The following is the procedure for representing a rule in a table using the algorithm for calculating the number of rows required according to the number of conditions of the rule.

1) Applying the algorithm for calculate number of rows, n.
2) If n<=5, then the representation as shown in table 2.

Table-2: The layout of the rule with conditions <= 5

Col-1	Col-2	Col-3	Col-4	Col-5	Col-6
A	C1	C2	C3	C4	C5

3) If n>5, then the representation as shown in table 3.

Table-3: The layout of the general form of a rule

Col-1	Col-2	Col-3	Col-4	Col-5	Col-6
A	C1	C2	C3	C4	$A_{\text{number of rows-1}}$
$A_{\text{number of rows-1}}$	C5	C6	C7	C8	$A_{\text{number of rows-2}}$
$A_{\text{number of rows-2}}$	C9	C10	C11	C12	$A_{\text{number of rows-3}}$
$A_{\text{number of rows-3}}$	C13	C14	C15	C16	$A_{\text{number of rows-4}}$

F.Illustration Examples for Rule Base

The following are three examples, which are demonstrating the layout of the rules.

Example (1):

Pregnancy ← Missed one male,
Nausea,
Generalized weakness,
Pregnancy test positive

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Table-4: The layout of the rule in example (1)

Cl-1	Cl-2	Cl-3	Cl-4	Cl-5
Pregnancy	Missed one male	Nausea	Generalized weakness	pregnancy test positive

The example in table 4, shows that the numbers of conditions are four which are stored in columns from Col-2 to Col-5 and the Col-6 not used, the action will be stored in Col-1.

Example (2):

Sinusitis ⟵ Headache,
Itching in nose,
Sneezing,
Watering of eyes,
X-Ray show dizziness in the sinus

Table-5: The layout of the rule in example (2)

Col-1	Col-2	Col-3	Col-4	Col-5	Col-6
Sinusitis	Headache	Itching in nose	Sneezing	watering of eyes	x-ray show dizziness in the sinus

The example in table 5, shows that the numbers of conditions are five which are stored in columns from Col-2 to Col-6 means that all the columns in the table being engaged. The action will be stored in Col-1.

Example (3):

Tonsillitis ⟵ Fever,
Generalized fetid,
Pain in throat,
On examination redness,
Follicular,
Some time pus

Table-6: The layout of the rule in example (3)

Col-1	Col-2	Col-3	Col-4	Col-5	Col-6
Tonsillitis	**Fever**	**generalized fetid**	**pain in throat**	**On examine redness**	Tonsilitis1
Tonsilitis1	**Follicular**	**some time pus**			

The example in table 6 shows that the numbers to conditions are six, which are exceeding the numbers of columns, are allocated to store the conditions.

So the four conditions of the rule stored in Col-2, Col-3, Col-4, Col-5 and the head of the rule is stored in Col-1 and pretend that sub-action as a condition and store the sixth condition of the rule in Col-6 which has the same name of the head together with the index, in this example the index is 1. After that store the pretended condition in a new row as a new action and continue store the remaining conditions that have numbers five and six.

That is A ⟵ C1, C2, C3, C4 ,A1

A1 ⟵ C5, C6

Note that:

If we have a number of eleven conditions, the solution is

A ⟵ C1, C2, C3, C4, A1
A1 ⟵ C5, C6, C7, C8, A2
A2 ⟵ C9, C10, C11

G.Case Base

Usually, the human experiences for solving problems in a certain domain present the collections of cases; each case presents a problem and its solution. Organizing the storage of the cases and retrieval of cases is central for effective case-based reasoning method. Cases can be organized by the goal and retrieved when the case has the same goal as the current situation. Another organizing method is to use cases with most important features matched or the most number of features matched. The matching may first look for exactly matched case before looking for a more general case. Using the cases most frequently matched or most recently matched is also used when retrieving cases to match a new situation. Another method is to use the case that matches without much adjusting. Using these heuristics a similar case is retrieved.

The proposed method to organize the cases will be in three tables, each table consists of two columns. The first table: column one presents the case number and column two presents the case name. The second table: column one presents condition number and column two presents condition name while the first column of the third table presents case number and the second column presents condition number. Fig. 9 and Fig. 10 present the relationships between tables and the pseudo code used to create and determine them respectively. Also all types of relationships are presented in table 7 and table 8.

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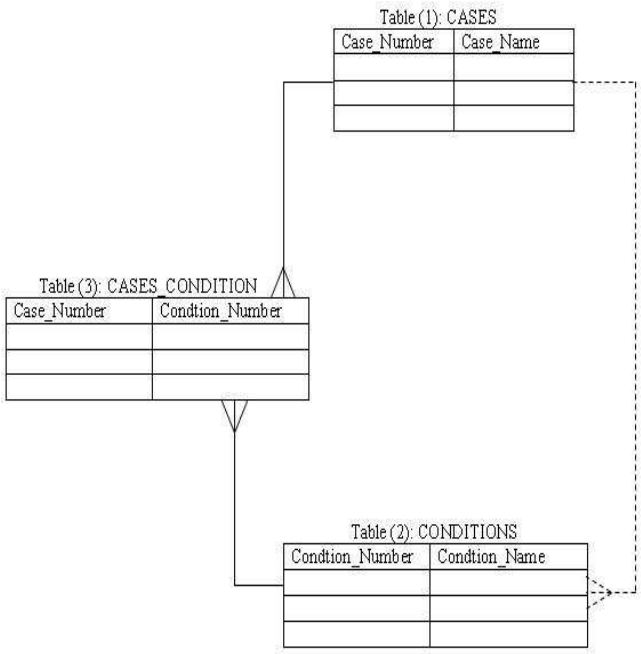

Fig. 9 presents the relationships between tables

Table-7: The relationships between tables

Table (1) To Table (3)	One – To – Many
Table (2) To Table (3)	One – To – Many
Table (1) To Table (2)	One – To – Many

Table-8: The keys types used for tables

Table (1) The Column (Case_Number) is Primary key
Table (2) The Column (Condition_Number) is Primary key
Table (3) The Columns (Case_Number, Condition_Number) is Primary key
Table (3) The Column (Case_Number) is foreign key
Table (3) The Columns (Condition_Number) is foreign key

```
10   CREATE TABLE NAME CASES WITH TWO  FIELDS
10.1 FIELD NAME: CASE_NO AND   FIELD TYPE: NUMBER(4)
10.2  FIELD NAME:  CASE_NAME AND  FIELD TYPE:
      VARCHAR2(100)    NOT NULL
10.3  CREATE UNIQUE INDEX CASES_BRW_P1
      ON CASES TABLE BY FIELD (CASE_NO)
10.4   CREATE PRIMARY KEY ON TABLE CASES
        USING FIELD CASE_NO ALTER TABLE
        CASES ADD ( CONSTRAINTCASES_BRW_P1
        PRIMARY KEY (CASE_NO));
20      CREATE TABLE NAME CONDITIONS WITH
       TWO FIELDS
 20.1  FIELD NAME: CONDITION_NO AND   FIELD
       TYPE: NUMBER(4)
20.2    FIELD NAME: CONDITION_NAME AND
        FIELD TYPE: VARCHAR2(100)  NOT NULL
 20.3   TO MAKE RELATION FROM TABLE(1) TO
        TABLE(2) USING FIELD NAME: CASE_NO
        NUMBER(4)
20.4   CREATE UNIQUE INDEX
        CONDITIONS_BRW_P1 ON CONDITIONS
        TABLE BY FIELD (CONDITION_NO)
20.5   CREATE PRIMARY KEY ON TABLE
        CONDITIONS USING FIELD CONDITION_NO
      ALTER TABLE CONDITIONS ADD
      (CONSTRAINT CONDITIONS_BRW_P1
      PRIMARY KEY (CONDITION_NO));
20.6   CREATE FOREIGN KEY ON TABLE
        CONDITIONS USING FIELD CASE_NO
       ALTER TABLE CONDITIONS ADD
       (CONSTRAINT CONDITIONS_BRW_F1
       FOREIGN KEY (CASE_NO)   REFERENCES
       CASES (CASE_NO));
30      CREATE TABLE NAME CASES_CONDITIONS
         WITH TWO FIELDS
30.1    FIELD NAME: CASE_NO  AND  FIELD TYPE:
        NUMBER(4)   NOT NUL
 30.2   FIELD NAME: CONDITIONS_NO AND  FIELD
        TYPE:  NUMBER(4)    NOT NULL
 30.3    CREATE UNIQUE INDEX
        CASES_CONDITIONS_BRW_P1 ON
        CASES_CONDITIONS TABLE BY      FIELD
        (CASE_NO, CONDITIONS_NO)
 30.4   CREATE PRIMARY KEY ON TABLE
        CASES_CONDITIONS USING FIELDS
        CASE_NO, CONDITIONS_NO ALTER TABLE
        CASES_CONDITIONS ADD (CONSTRAINT
        CASES_CONDITIONS_BRW_P1 PRIMARY
        KEY (CASE_NO, CONDITIONS_NO));
30.5    CREATE FOREIGN KEY ON TABLE
        CASES_CONDITIONS USING FIELD
         CASE_NO ALTER TABLE
         CASES_CONDITIONS ADD (CONSTRAINT
          CASES_CONDITIONS_BRW_F1 FOREIGN
          KEY (CASE_NO) REFERENCES CASES
          (CASE_NO));
 30.6    CREATE FOREIGN KEY ON TABLE
        CASES_CONDITIONS USING FIELD CONDITIONS_NO
        ALTER TABLE CASES_CONDITIONS ADD
         (CONSTRAINT CASES_CONDITIONS_BRW_F2
         FOREIGN KEY (CONDITIONS_NO) REFERENCES
        CONDITIONS (CONDITION_NO));
```

Fig. 10 presents pseudo code to create tables and the relations

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H.Illustration Examples for Case Base

In the following examples, there are ten cases which are stored in the column two of the table-9, while the first column stores the index numbers for the cases as shown below, each case contains a number of conditions depend on the case given which stored in the second column of the table-10 also the first column of the table-10 shows the index number for the conditions, so the total cases are ten and the total conditions are 54 given. By using the relation called One–To–Many between the tables; it will be produce a new table contains two columns: the first column called Case_Number which is refers to the index number for the cases and the second column called Condition_Number which is refers to the index number for the conditions as shows in table-11. From table-11, it's observed that the number of cases remains as it is while the number for conditions reduced to 43 instead of 54 without deleting any condition, i.e. 9 conditions are repeated in several cases which is not included in table-11. Thus the main advantages of this methodology is to avoid duplication in conditions, flexibility of marinating tables and easy for searching.

Table-9: CASES

Case_Number	Case_Name
1	PREGNACY
2	SINUSITIS
3	OTITIS MEDIA
4	HEMERROID
5	ACUTE COJUCTIVITIS
6	EPIDIDEMOORCHITIS
7	INTESTINSL OBSTRUCTION
8	UPER RESPIRATORY TRACT INFECTION
9	TONSILITIS
10	ABSCESS

Table-10: CONDITIONS

Condition_Number	Condition_Name
1	MISSED ONE MENS
2	NEUSEA
3	GENRALIZED WEEKNESS
4	PREG. TEST POSITIVE
5	HEADECH
6	VOMITTING
7	ITCHING IN NOSE
8	SNEEZING
9	WATERING OF EYES
10	X-RAY SHOW HIZZINESS IN THE SINUS
11	FEVER
12	PAIN IN EAR
13	DISCHARGE FROM EAR
14	REDNESS IN TEMPANIC MEMBRAN AND CANAL
15	PAIN IN ANAL AREA
16	CONSTIPATION
17	ITCHING
18	DISCHARGE
19	BLEEDING
20	REDNESS
21	TENDERNESS
22	DISCHARGE FROM EYES
23	PAIN IN TESTIS
24	HOTNESS
25	SWELLING
26	SOME TIME REDNESS
27	ABDOMENAL PAIN
28	EXAMINATION TENDERNESS ALL OVER ABDOMEN
29	DECREASED OR ABSENT BOWAL SOUND
30	X-RAY SHOW MULTIPLE FLOUD LEVEL
31	BLOOD TEST ELECTROLIT ABNORMALATIES
32	COGHT
33	DEFICULTY OF BREATH
34	CHEST X-RAY SHOW ABNORMALATY
35	PAIN
36	GENERALIZED FETIQ
37	PAIN IN THROT
38	ON EXAMINATION REDNESS
39	FOLICULAR
40	SOME TIME PUS
41	COLLECTION OF PUS
42	HARDNESS
43	EXAMINATION OF THE AREA THERE IS FLUCTUATION

Table-11: CASES_CONDITION

Case_Number	Condition_Number
1	1
1	2
1	3
1	4
1	5
1	6
2	5
2	7
2	8
2	9
2	10
3	11
3	12
3	13
3	14
4	15
4	16
4	17
4	18
4	19

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5	20
5	17
5	21
5	9
5	22
5	5
6	23
6	24
6	25
6	26
7	6
7	27
7	28
7	29
7	30
7	31
8	32
8	33
8	11
8	34
8	35
9	11
9	36
9	37
9	38
9	39
9	40
10	35
10	41
10	20
10	43
10	21
10	24

I.The Blackboard

The blackboard is a shared repository of problems, goals, partial solutions, suggestions and contributed information. The blackboard can be viewed as a dynamic library of requests and contributions that have been recently provided through the cooperation mechanism between the rule base knowledge and the case base knowledge. In a case-based, a problem is matched against cases in the case base, and one or more similar cases are retrieved. Case indexing involves assigning indices to cases to facilitate their retrieval. In order to decide whether or not there is a similar case to retrieve for further processes, witch means check the availability of case to retrieve as a condition or checking the Rule-base. In order to retrieve cases efficiently, it is crucial to decide what the key attributes of a case are and on which attributes the cases should be indexed, see table-8. All these processes will be done in the Blackboard.

A solution suggested by the matching cases is then reused. Unless the retrieved case is a close match, the solution will probably have to be revised, producing a new case that can be retained. The following Fig. 11 and fig. 12 present the flowchart and pseudo code respectively used for processing user query.

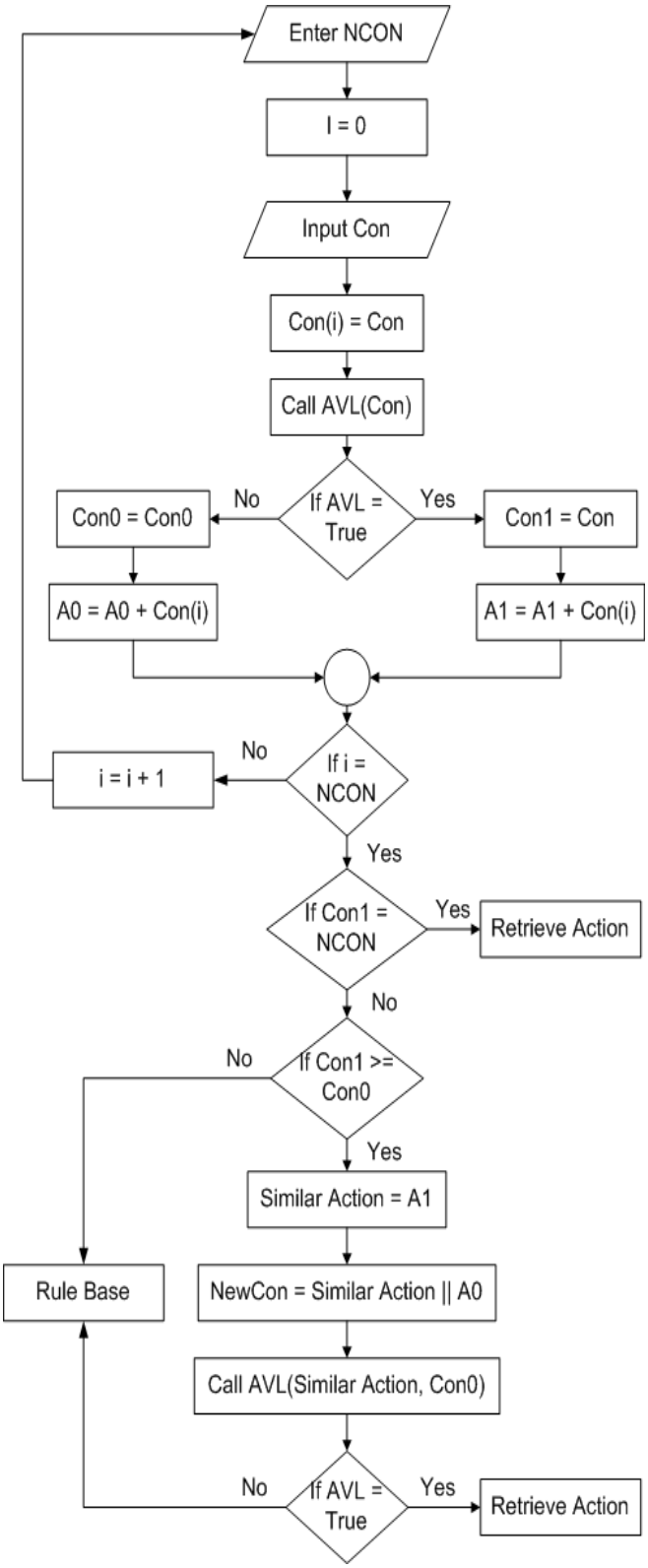

Figure-11 presents the flowchart processes using user query

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```
10   INPUT NUMBER OF CONDITIONS
20   INITILIZE I  TO ZERO
30   INPUT THE CONDITION
40   SET CONDITION OF I IS EQUAL TO CONDITION
50   GO TO CHECK AVALIABILITY ALGORITHM
60    IF THE AVALIABILITY IS EQUAL TO TRUE
70   SET CONDITION1 IS EQUAL TO CONDITION
80    SET A1 IS EQUAL TO A1 PLUS CONDITION OF I
90   ELSE
100  SET CONDITION0 IS EQUAL TO CONDITION
110  SET A0 IS EQUAL TO A0 PLUS CONDITION OF I
120  IF I IS EQUAL TO NUMBER OF CONDITIONS
130  IF CONDITION1 IS EQUAL TO NUMBER OF
     CONDITIONS  RETRIEVE ACTION
150  ELSE IF CONDITION1 IS GREATER THAN OR
     EQUAL TO CONDITION
170  SET SIMILAR ACTION IS EQUAL TO A1
180  SET NEW CONDITION IS EQUAL TO SIMILAR
     ACTION CONCATONATE WITH A0      GO TO
CHECK
     AVALIABILITY ALGORITHM FOR NEW
      CONDITION
200  IF AVALIABILITY IS TRUE  PRINT ACTION
220   ELSE GO TO RULE BASE ALGORITHM
240   ELSE   GO TO RULE BASE ALGORITHM
260  ELSE    SET I IS EQUAL TO I PLUS ONE
280  GO TO 30
```

Fig.12 The pseudo code for processes using user query

J.Control and Cooperation Mechanisms

The control mechanism is to control and reorganize the knowledge bases and used them in the most effective and coherent fashion. The cooperation mechanism is the activities of passing the appropriate part of knowledge from one knowledge base to another and converting from one representation form into another. Control and cooperation mechanisms make use of the dynamic data base, the knowledge bases (Rule base and Case base) and the blackboard in order to decide whether there is a similar case to retrieve for further processes or not. This means check the availability of case to retrieve as a condition in a particular rule or checking the rule base to find a particular rule to apply. All these processes have been done in the Blackboard.

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