SIMPLIFIED RULES BASE OBTAINED WITH LOGIC MINIMIZATION METHOD FOR DIAGNOSIS OF MEASLES DISEASE REALIZED WITH EXPERT SYSTEMS

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Abstract: This paper describes a knowledge based system employing certain expert system rules to detect kind of measles disease. A rule based expert system is designed for early diagnosis of measles disease. Simplified rules were used to determine the base of rules. In order to simplify the rules, Boolean simplifying method was used. Front diagnosis plays an effective role in determining and therapy. Front diagnosis gives an easy position to the doctors during the therapy and diagnosis. With an expert system that will be applied as an example before the patient does not come to the doctor, a test will be applied and front information will be taken from the patient. In this study, a logic system was developed to diagnose the measles and diseases showing symptoms similar to the measles.

1 INTRODUCTION

Sub acute Scalloping Pan Encephalitis (SSPE) is caused by variants of wild type Measles Virus (MV). MV is a contact infection that develops with a specific virus. It doesn't have a specific treatment. It is a disease that makes lung complication and breaks allergy. (Onul, 1980). MV is common childhood infectious diseases that can have serious complications. (Hilleman, 2002, Plotkin, 2001). It isn't observed in adults since they transmit the disease in their childhood. Actually all human beings are sensitive to this disease. There is no role of race, gender, age even climate on this disease. Every person who catches the virus is infected with measles. (Onul, 1980).

This study introduces an expert system for early diagnosis of measles disease to detect by the basic disease symptoms.

2 MATERIALS

Expert Systems (ES), in a specific field and only that area with information about problems that people bring in experts as a solution can be described as computer programs that can bring. Improve the system to the development of the system is the person or persons expert in the field of mutual interests to exchange ideas and information as a result, the system's knowledge base is inserted in the proper format. The completed systems, the knowledge base of information to him by the end users are used to solve the problem. ES are designed and created to facilitate tasks in the fields of accounting, medicine, medical expert (MA), process control, financial service, production, human resources etc. Indeed, the foundation of a successful expert system depends on a series of technical procedures and development that may be designed by certain technicians and related experts. (Gary, 2002). Medical Experts are designed to give expert-level, problem-specific advice in the areas of: Medical data interpretation, patient monitoring, disease diagnosis, treatment selection, prognosis, and patient management.

Research in medical expert and knowledge-based systems and the development of such systems has been most significant to the broad realm of quality assurance and cost containment in medicine.

As shown in Fig. 1, the proposed ES contains a knowledge base, an inference engine, and a man-machine interface. The knowledge base, in turn, consists of the data base and the rule base. (Hsu, 1991., Ibrahim, Basheer, Jaais and Taib, 2001).

The production rules which are essential for the

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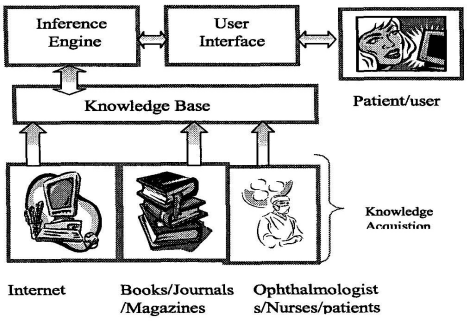

Figure 1: The architecture of the ES for measles.

inference engine to perform deductive reasoning are stored in the rule base. Rules are expressed as IF – THEN statements.

IF (premise) THEN (conclusion)

In a rule-based ES, the domain knowledge is represented as sets of rules that are checked against a collection of facts or knowledge about the current situation. When the IF portion of a rule is satisfied by the facts, the action specified by the THEN portion is performed. (Ibrahim, Basheer, Jaais and Taib, 2001).

2.1 Symptoms of MV Disease

Symptoms of MV had been given in Table 1 input cases section.

Special symptoms for MV are: *1)* When someone presses the points, they fade and they are not seen. *2)* Points wrap up all of the body. *3)* To appearing points in body, these points are red and separate with a strong skin with each other. *4)* These occurred points must be gray- white and must be as big as head of pin. And its round takes the color of dark red. *5)* Temperature change is seen daily. Immediate temperature decrease, temperature increase and immediate high temperature can be seen.

Output symptoms for MV had been given in Table 1 output cases section.

There are some diseases like MV because of symptoms and specialties. These diseases are; rubella, variola, cold disease, red skin eruption and serum illness. With our programme, the MV can be distinguishing from these similar diseases.

3 METHODOLOGY

In this study, we used to Logic Minimization Method. Symptoms of disease formed input values of function. Also, similar diseases and possibilities of MV formed like output values of function. According to this information formed a logic function that has 16 input variables (2^{16}=65536 different case) and 8 outputs. In this function, 65536 different cases evaluated for each one output function. Table 1 show below input and output values for function.

We have 65536 different output cases for 16 inputs values. If we want to interrogate each 16 inputs value, we must make 65536 different questions and must ask these questions each patient. For this we must have much time. So, to interrogate 65536 different case is will be difficult. For this problem we developed the simplified rules base obtained with logic minimization method for diagnosis of measles disease realized with ES.

3.1 Minimization Method

In order to simplify the formed function, Exact Direct Cover Minimization Algorithm has been developed. This algorithm is explained in. (Kahramanlı, Güneş, Şaban and Başçiftçi, 2007., Başçiftçi, 2007., Başçiftçi and Kahramanlı, 2007). Exact Direct Cover Minimization Method algorithm is given in below.

1. Put $I=0$, $C=0$, $SW=\varnothing$
2. Take out the first minterm from S_{ON} set, mark it by λ,
3. Transform one by one all of elements of S_{OFF}. Mark it by $Q0$,
4. Apply the absorption operation to $Q0$. Mark the result by $Q1$,
5. Coordinate Subtract the set $Q1$ from the n dimensional full cube $xx...xx$. Where n the number of variables of Boolean Function. Mark the result by S_{PI},
6. Apply the Great or Less operation to the elements of S_{PI} set. Note that element α is greater than element β if the set of S_{ON} # α is powerless than the set of S_{ON} # β,
7. Save only the most greatness *Prime Implicant (PI)*,
8. If the result is not single element then $SW=SW \cup \lambda$ and go to 2
9. If the result is single element then mark it by *Essential Prime Implicant (EPI)*, $I=I+1$, $C=C+1$,
10. Put $S_{ON}=S_{ON}$ # EPI, $SW=SW$ # EPI, $S_{EPI} = S_{EPI} \cup EPI$
11. If $S_{ON} \neq \varnothing$ then go to 3
12. If $SW = \varnothing$ then END else $S_{ON} = SW$
13. If $S_{ON}=\varnothing$ and $SW \neq \varnothing$ then go to 40
14. go to 1
15.

Table 1: Input and output values for function.

Input	Input Cases	Output	Output Cases
x1	To appear little pink red spots behind ears, forehead and hair bottom.	y1	MV
x2	These points are dark red and one by one in first days	y2	Primer MB
x3	These points spread all of the body in 24-48 hours.	y3	Not MV
x4	These occurred points must be dark red and these must separate with strong skin each other.	y4	Cold Disease
x5	When any one impress on these points. Their colors must be fade and must not seeing any spot.	y5	Rubella
x6	These occurred points must be gray- white and must be as big as head of pin. And its round take the color of dark red.	y6	Red Skin Eruption
x7	The high temperature that has seen at the first day is decrease following day. The day after this day the temperature decrease immediately.	y7	Variola
x8	Hoarse and strong cough	y8	Serum Illness
x9	Seeing hoarse voice.		
x10	The patient can not look at the light		
x11	Increase the tear of patient. Sometimes these tears take an inflammation position.		
x12	Cover of eye swell		
x13	Eye conjunctive gets red.		
x14	Change of daily temperature.		
x15	Tongue is rusty and wet at the first term, İn following terms the tongue is red.		
x16	At the end of the illness the body scuffs.		

Table 2: Simplification output values for function.

Output Symbols	Output Cases	Simplification function
y1	MV disease	x11xxxxxxxxxxxxx 1xx1xxxxxxxxxxxx x1x1xxxxxxxxxxxx xx11xxxxxxxxxxxx xxx11xxxxxxxxxxx xxx1x1xxxxxxxxxx 0x1x1xxxxxxxxxxx
y2	Primer MV	10x0xxxxxxxxxxx x100xxxxxxxxxxx xx001xxxxxxxxxxx x0100xxxxxxxxxx 000100xxxxxxxxx x0x001xxxxxxxxx 000x001xxxxxxxx 000x00x11xxxxxx 000x00x1x1xxxxx 000x00x1xx1xxxxx 000x00x1xxx1xxxx 000x00x1xxxx1xxx 000x00x1xxxx11x 000x00xx0x11111x 000x00xxx011111x 000x00xxx01111x1 000x00xx1xx11111 000x00xxx1x11111
y3	Not MV	00000000xxx0xxxx 00000000xxxx0xxx 00000000xxxxx0xx 00000000x1xxxx0x 00000000xx0xxx0x 00000000xx0xxxx0 00000000xxxxxx00 00000000000xxxxx 0000000011xxxxx0 0000000x000000xx
y4	Cold Disease	00000x1xxxxxxxxx 0000x01xxxxxxxx 00000xx1xxxxxxxx 0000x0x1xxxxxxxx 00000xxx1xxxxxxx 0000x0xx1xxxxxx 00000xxxxx1xxxxx 000001xxx1xxxxxx 0000x0xxx01xxxxx 00000xxxx1x1xxxx 000000xxx0xxx1xx 000x0000000001xx 00001100000001xx 00000xxxx1xx01xx 00000xxxx1xxx11x
y5	Rubella	1000xxxxxxxxxxx 1x000xxxxxxxxxx x00001xxxxxxxxx 0010000xxxxxxxxx x0001001xxxxxxxx x000100x1xxxxxx x000100xx1xxxxx x000100xxx1xxxx x000100xxxx1xxx x000100xxxxx1xxx
y6	Red Skin Eruption	1100xxxxxxxxxxx 1x00000xxxxxxxx x100000xxxxxxxx xx00000000111xxx xx0000000011x1xx
Y7	Variola	1010xxxxxxxxxxx 10x00xxxxxxxxxx 01000xxxxxxxxxx 0000xx1xxxxxxxxx 00001xx1xxxxxxxx 00001xxx1xxxxxx 00001xxxx1xxxxx 00001xxxxx1xxxx 00001xxxxxx1xxxx x0100000xxxxxxxx 000010xxxxxx1xx 00001xxxxxxxxxx x0000xx11xxxxxx x0000xx1x1xxxxx x0000xx1xx1xxxxx x0000xx1xxxx1xxx x0000xx1xxxxx1xx 0000xxxxx00x1xxx 0000xxxxx0x01xxx x0x0000011xxxxxx x0x000001x1xxxxx x0x00000x11xxxxx x0x000001xx1xxxx x0x00000x1x1xxxx x0x000001xxxx1xx x0x00000xx01x1xx x0x00000xx10x1xx x0x00000x1xx01xx x0x00000xxx0111x x0x00000xxx011x1
Y8	Serum Illness	0000000000x0x0x1 0000000000x0xx01 0000000000xx0x01 0000000000000xx1 00000000000x00x1 00000000000xx001 0000x00000000001

40. CALL BS (Branching Subroutine)
41. go to 3

BS

1. Take out the first minterm from S_{ON} set, mark it by λ and $I=I+1$,
2. Transform one by one all of elements of S_{OFF} set. Mark it by $Q0$,
3. Apply the absorption operation to $Q0$. Mark the result by $Q1$,
4. Coordinate Subtract the set $Q1$ from the n dimensional full cube $xx...xx$.
5. Apply the Great or Less operation to the elements of S_{PI} set.
6. If the result is single element then mark it by EPI, Otherwise select one of them and mark it by EPI, $C=C+1$,
7. Put $S_{ON}=S_{ON}$ # EPI, $S_{EPI} = S_{EPI} \cup EPI$,
8. **RETURN**

S_{ON} : The set of ON minterms any of that make the function equal to 1. S_{OFF} : The set of OFF minterms any of that make the function equal to 0,
#: Coordinate Subtraction (Sharp Product) Operation.

4 RESULTS

There are 105 simplified results for 8 output cases. The cases are showing in Table 2. We used this simplified rules for to determine the base of rules. In order to simplify the rules, Boolean simplifying method was used. So we studied to guess the measles disease with 105 simplified results.
has 16 input variability and 8 output function with the developed method, the values in Table 2 have

Table 3: Disease probabilities for y8 output and have been results.

Output	Cases	Symptom and Output Cases															
		x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
Y8	Serum illness 0000000000x0x0x1	0	0	0	0	0	0	0	0	0	0	x	0	x	0	x	1
Y8	Serum illness 00000000000x00x1	0	0	0	0	0	0	0	0	0	0	0	x	0	0	x	1
Y8	Serum illness 0000000000x0xx01	0	0	0	0	0	0	0	0	0	0	x	0	x	x	0	1
Y8	Serum illness 00000000000xx001	0	0	0	0	0	0	0	0	0	0	0	x	x	0	0	1
Y8	Serum illness 0000000000xx0x01	0	0	0	0	0	0	0	0	0	0	x	x	0	x	0	1
Y8	Serum illness 0000x00000000001	0	0	0	0	x	0	0	0	0	0	0	0	0	0	0	1
Y8	Serum illness 0000000000000xx1	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	1

been obtained. The mean of 0, 1 and x which shows like simplification function at Table 2 is; For 0; there is not symptom of represent disease who is ill person.

For 1; there is symptom of represent disease who is ill person. For x; it is not importing for symptom of represent disease who is ill person. For example; Disease probabilities for y8 output and results have been given in Table 3.

According to Table 3, the mean of 0000000000x0x0x1 output values; we can say Serum Illness disease a person which has x16 probabilities and has not x1, x2, x3, x4, x5, x6, x7, x8, x9, x10, x12 and x14 probabilities. Example shows one of the production rule implemented that transformed into Expert System syntax using the "production rule" (utilizing IF..THEN statements).

Example: According to Table 3,

IF

The body scuffs Yes, *AND* To appear little pink red spots behind ears, forehead and hair bottom No, *AND* These points are dark red and one by one in first days No, *AND* These points spread all of the body in 24-48 hours No, *AND* These occurred points must be dark red and these must separate with strong skin each other No, *AND* When any one impress on these points. Their colors must be fade and must not seeing any spot No, *AND* These occurred points must be gray- white and must be as big as head of pin. *AND* its round takes the color of dark red No, *AND* The high temperature that has seen at the first day is decrease following day. The day after this day the temperature decrease immediately No, *AND* Hoarse and strong cough No, *AND* Seeing hoarse voice No, *AND* The patient can not look at the light No, *AND* Cover of eye swell No, *AND* Change of daily temperature No

THEN

Most probably you have SERUM ILLNESS. Please consult your doctor for verification in a short time.

5 CONCLUSIONS

In this study; all the probabilities of the 16 symptoms which are the general symptoms of MV disease, had been evaluated and whether there are MV or similar diseases or not were researched as output. In the reduction of symptoms, Logic Minimization Method has been used. By this method, reduced functions for each output have been obtained. In conclusion, we thing that use logic minimization method might be used as a reliable in ascertain to MV to treatment.

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REFERENCES

Başçiftçi, F., Kahramanli, Ş., 2007., "An Off-Cubes Expanding Approach to the Problem of Separate Determination of the Essential Prime Implicants of the Single-Output Boolean Functions"., EUROCON 2007.

Başçiftçi F., "Simplification of Single Output Boolean Functions by Exact Direct Cover Algorithm Based on Cube Algebra" EUROCON 2007, 09-12 September 2007, Warsaw-Poland, pages: 427-431.

Gary, B., 2002., "Expert" Knowledge Module, Biomedical Information's Tutorial.

Hilleman, MR., 2002., Current Overview of the Pathogenesis and Prophylaxis of Measles with Focus on Practical Implications.

Hsu, Y., Su, C., 1991. A rule based expert system for steady state stability analysis,. Taiwan,. IEEE.

Ibrahim, F., Basheer, J., Jaais, F., Taib, M., 2001. Expert System for Early Diagnosis of Eye Disease Infecting the Malaysian Population., IEEE

Jiang, D., Ide, Y., Fujii, M., Shoji, I., Hotta, H., 2009., Single-Point Mutations of the M Protein of a Measles Virus Variant Obtained from a Patient with Subacute Sclerosing Panencephalitis Critically Affect Solubility and Subcellular Localization of the M Protein and Cell-Free Virus Production

Kahramanlı, Ş., Güneş, S., Şahan, S., Başçiftçi, F., 2007., "A New Method Based on Cube Algebra for The Simplification of Logic Functions"., The Arabian Journal For Science and Engineering.

Onul, B., 1980., İnfeksiyon Hastalıkları., Ankara.

Plotkin, SA., 2001., Rubella Eradication. Vaccine.

Tatlı, E., 2000., Uzman Sistemler.