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A Mathematical Conflict Resolution Methodology using Logic Scoring of Preference sampled in a Theoretical Medical data

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Abstract

In certain areas like Network Based Control Systems, Communication Systems and Medical Diagnosis there are problems that are encountered. The problems that are encountered are either recurrent or new ones. Recurrent problems have well defined structured solutions and they also represent majority of the problems. The new ones do not yet have solutions and requires investigations to discover their roots. New problems are not the primary concern in most systems since they rarely occur. The major concerns are the recurrent problems; they are often mistaken as new ones. The solutions to new problems are rediscovered after much trial and error in which time is wasted costing the company valuable resources.

An Expert System can be used for problems that keep on occurring. This system can reproduce a valuable technician's. The system can give an accurate recommendation on the source of the problem for effective troubleshooting before going to the mobilization of resources.

One predicament in Expert Systems is that their knowledge base may contain numerous data and suggest different types of solutions to a certain problem. The Expert System may have narrowed out the cause of the problem but it still must give a weight to the ones it has suggested to what the most probable cause.

This paper proposes a Conflict Resolution methodology using Logic Scoring of Preference which can be used in several applications like Expert Systems. A sample application is also shown in the medical field. This will greatly help for the user to

sequence its diagnostic procedures and solve a problem efficiently

Keywords: Mathematical Model, Conflict Resolution, Expert Systems, Logic Scoring of Preference

1. Introduction

The implementation of Information Technology is an evolving concern for companies trying to maintain a competitive edge in the industry. A distinctive medium of Information Technology are Expert Systems [1]. The term Expert System can be referred to computer a program that applies extensive knowledge to detailed areas of expertise to the process of diagnostics. Human experts have varying levels of expertise this also comes for Computer systems [2].

According to [3] Expert Systems are indented to provide their users with answers in specific problem situations. The beliefs regarding their development together with the tools that support and implement them focus almost entirely on providing the exact answer in the most efficient way. In order for the system to be efficient it must give a weight to the solutions it has presented in order for its user to sequence and prioritize its diagnostic procedures and save time in solving the problem.

2. Expert Systems

In the research for artificial intelligence Expert Systems were the first to emerge. In the selection of natural language, expert system reasoning is one of the subjects that emerged from it . [4].

The definition of an Expert System according to [5] is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. An expert system operates like an interactive system that responds to questions, asks for clarification, makes recommendations, and guides the user in the decision process. Expert Systems are domain specific. The programmer of an Expert system must limit the scope of the system to just what is needed to solve the target problem. Specialized tools are often available to accomplish objectives of the system.

Intricate decisions involve complex combinations of heuristic and factual knowledge. The data or knowledge must be organized in an easily accessible format that distinguishes among data, knowledge, and control structures in order for the computer to be able to retrieve and effectively use heuristic knowledge.

This is the reason why Expert Systems are organized in three distinct levels according to [5]:

1. Knowledge base consists of problem-solving rules, procedures, and intrinsic data relevant to the problem domain.
2. Working memory refers to task-specific data for the problem under consideration.
3. Inference engine is a generic control mechanism that applies the axiomatic knowledge in the knowledge base to the task specific data to arrive at some solution or conclusion.

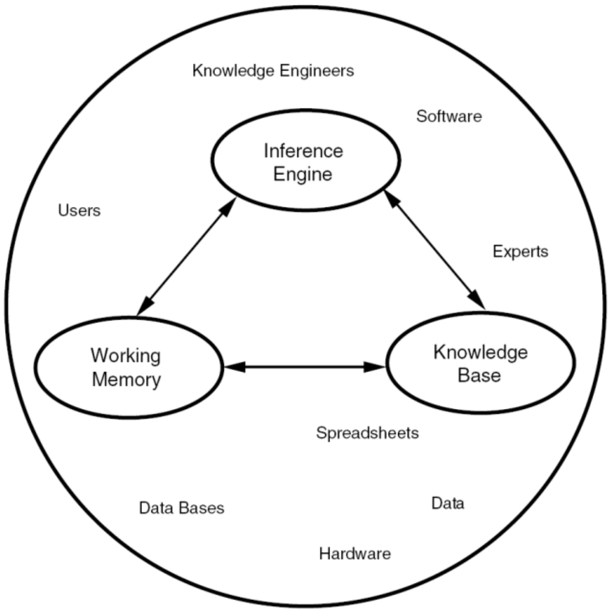

Figure 1: Expert systems organization and operating environment [5]

According to [6] during the development of expert systems, the designing and the acquisition of knowledge by interviewing experts or using more advanced techniques has revealed a new horizon for the diffusion of expertise. The process of selecting useful knowledge in the development of an expert system thus has a positive impact in the study of the knowledge domain to be represented. Developing an expert system take years and usually requires teamwork. A group usually consists of people with different specialization that could relate to one another to support the explanation of expert systems.

The post development of expert system deals with the maintenance and the integration of existing systems available. The people behind the research regarding expert systems usually had a hard time with these two. An expert system that cannot be integrated with the latest technology does not have a value. Because of this, the expert systems builders were encouraged to add user-friendly interfaces to provide abstract shell which could be used in various application domains and remove the domain knowledge of the previous systems.

An Expert System is Capable of working with inexact or imprecise data. An expert system lets the program user to assign, certainty factors or confidence levels to the inputted data. This feature of an expert system represents how most problems are handled in real life applications. This type of system can take all relevant factors into account and make a recommendation based on the best possible solution rather than the only exact solution [5]. This paper’s conflict resolution methodology can be positioned in the Interference engine of an Expert System. In case different recommendations are given, it can give a weight on the most probable cause.

3. Logic Scoring of Preference

In Logic Scoring of Preference (LSP) is a modern evaluation methodology with theoretical foundations in continues logic and advance optimization systems. It was proposed by J. Dujmovic in 1996 and it is used for evaluating complex hardware and software systems [7].

In an LSP process a checklist is obtained which are a list of dimensions, factors, properties and components. The presence or quantity is separated and considered in order to perform the specific task. There are various types of checklist which have at least one definitional common function. The nature of the evaluation calls for a systematic approach to determine the value of the complex entity. The bottom of the checklist is almost entirely a mnemonic device. The entry of the entities in the right place is crucial to avoid the equivalent of keyboarding errors in the empirical entry of data. Another important factor is the grouping of items when constructing the list. In the sequential checklist order is important. The first type is a strong sequential kind and must be followed to get valid results. In a weak sequential checklist order is still important but it focuses more in efficiency of reasons rather than logical or physical necessity. A checklist that is iterative is sequential but requires multiple passes in order for each checkpoint to have a stable reading. Another kind of checklist that is not always sequential is in the form of flowcharts. [8].

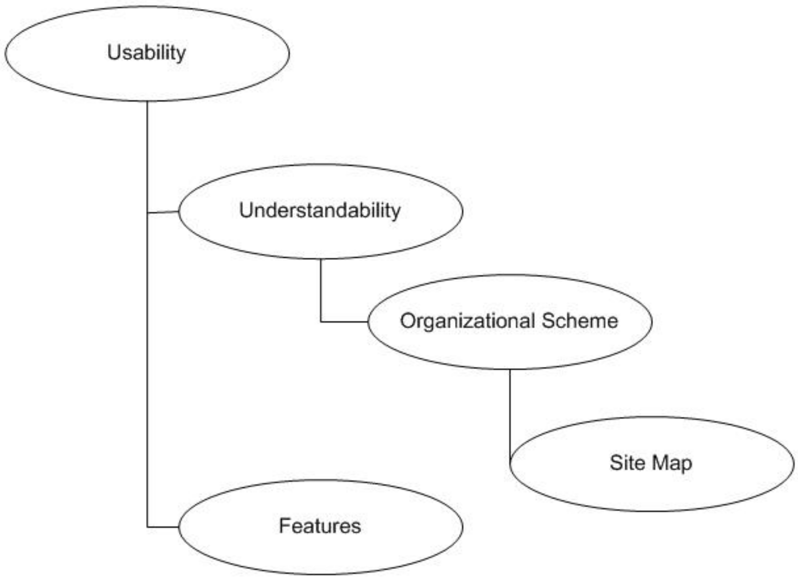

Figure 2: Aggregation Blocks of Logic Scoring of Preference

The following explanations about the LSP are taken from [9]. This research will construct an aggregation tree that will have a number of aggregation blocks. In Figure 2 the results of a higher level with lower level features are illustrated. The elementary criterion can be defined.

In the equation:

$$E_i = G_i(X_i)$$

i is the number of a particular feature.
G is the function for calculating E
X is the score of a feature
E is the global preference
A preference scale can to evaluate the elementary criterion. The higher feature score can be obtained by using the Elementary preference in aggregation reference. The results in the higher feature will again be used to calculate the preference for a much higher feature in the block hierarchy. This process continues until we reach the global preference .The representation of the global preference is:

$$E = L(E_i \ldots .E_n)$$

In the equation:
E_n is the feature n of the elementary preference
n is the number of features in the aggregation block. *L* is a function for evaluating E
The function *L* generates output preference e_0 for the global preference *E* or any of its sub features E_i. This system can be represented by the equation:

$$e_0 = (W_1 E_1{}^r + \ldots W_k E_k{}^r)^{1/r}, W_1 + ..W_k = 1$$

In the equation:
L is the function for evaluating E
W is the weight of a specific feature
n is the number of features in the aggregation block *k* the number of features in the aggregation block *r* can either be a conjunctive or disjunctive of the aggregation block
The weight *W* can be defined for a corresponding feature of each E_i. The weight used is a fraction of 1 representing the importance of a particular feature in the aggregation block [10].
The degree of simultaneity for a group of features within an aggregation block is represented by the conjunctive and disjunctive feature of the aggregation block K.

4. Conflict Resolution Methodology using Logic Scoring of Preference

The theoretical foundations of the Logic Scoring of Preference model will be the basis of our conflict resolution methodology. Basically the LSP model is used for evaluating complex hardware and software systems we will use it to give a weight to the ones an Expert System has suggested to what the most probable cause.
This can be used on Expert Systems which have a Problem and Symptoms relationship. Different input parameter may give different probable cause of problems. As in real applications given different symptoms a human expert may have different suggestions to a problem and give weight to might have caused the problem. The conflict resolution methodology will give the weight the aid of LSP foundations.

Table 1: Symbols and Parameters of the and or function, [7]

Operation	Symbol	d	r2	r3	r4	r5
DISJUNCTION	D	1.0000	+infty	+infty	+infty	+infty
STRONG QD (+)	D++	0.9375	20.630	24.300	27.110	30.090
STRONG QD	D+	0.8750	9.521	11.095	12.270	13.235
STRONG QD (-)	D+-	0.8125	5.802	6.675	7.316	7.819
MEDIUM QD	DA	0.7500	3.929	4.450	4.825	5.111
WEAK QD (+)	D-+	0.6875	2.792	3.101	3.318	3.479
WEAK QD	D-	0.6250	2.018	2.187	2.302	2.384
SQUARE MEAN	SQU	0.6232	2.000			
WEAK QD (-)	D--	0.5625	1.449	1.519	1.565	1.596
ARITHMETIC MEAN	A	0.5000	1.000	1.000	1.000	1.000
WEAK QC (-)	C--	0.4375	0.619	0.573	0.546	0.526
WEAK QC	C-	0.3750	0.261	0.192	0.153	0.129
GEOMETRIC MEAN	GEO	0.3333	0.000			
WEAK QC (+)	C-+	0.3125	-0.148	-0.208	-0.235	-0.251
MEDIUM QC	CA	0.2500	-0.720	-0.732	-0.721	-0.707
HARMONIC MEAN	HAR	0.2274	-1.000			
STRONG QC (-)	C+-	0.1875	-1.655	-1.550	-1.455	-1.380
STRONG QC	C+	0.1250	-3.510	-3.114	-2.823	-2.606
STRONG QC (+)	C++	0.0625	-9.060	-7.639	-6.689	-6.013
CONJUNCTION	C	0.0000	-infty	-infty	-infty	-infty

The strength the model of an LSP over merely additives ones reside in the power to deal with different logical relationships and operators to reflect the evaluation needs [9]. This strength is advantageous to Expert Systems which have a Problem and Symptoms relationship. The final product of these systems are Problems with different types of symptoms. These symptoms are related with each other.
The basic relationships modeled are replacability, neutrality and simultaneity [9]. A variety of 20 functions was represented by J. Dujmovic in Table 1.These functions can be used in formulating the relationships of the symptoms of the problems. In which symptoms have sub symptoms with different credence relationships.

5. Test application

A test application that we will use is an Expert Systems with Problem and Symptoms relationship that have a subsist function. If these symptoms existed then there maybe 3 different problems and therefore different solving patterns. The LSP can give weights to the troubleshooting sequence. The key is to determine the andor function of the system and how stalwart their relationship. Like in getting the quality of Web Sites the basis the the IEEE Standard for a Software Quality Metrics Methodology [11],[12]. The Elementary preference *E* will depend on the archetype of the Expert System.

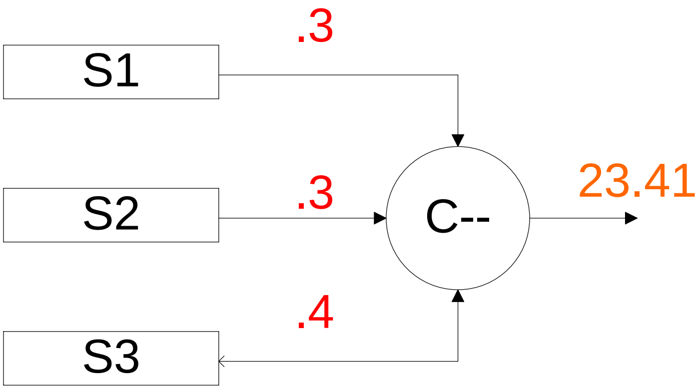

Figure 3: 3 Symptoms with Weak QC (-)

Figure 3 Shows the 3 symptoms with a Weak QC (-). An LSP of 23.41 was the outcome of the methodology

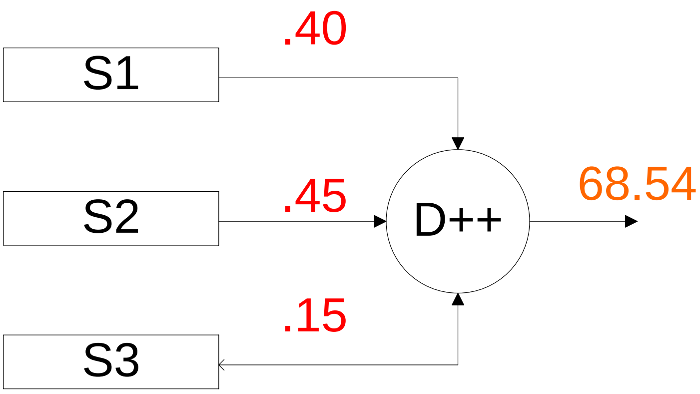

Figure 4: 3 Symptoms with Strong QC (+)

In Figure 4 the 3 same symptoms have a Strong QD (+). An LSP of 68.54 was the outcome of the methodology. If the system gives a final evaluation it will conclude that the problem in figure 4 is more probable than the one in 3. The user of the system can first attempt to solve the solutions attached in problem 4.

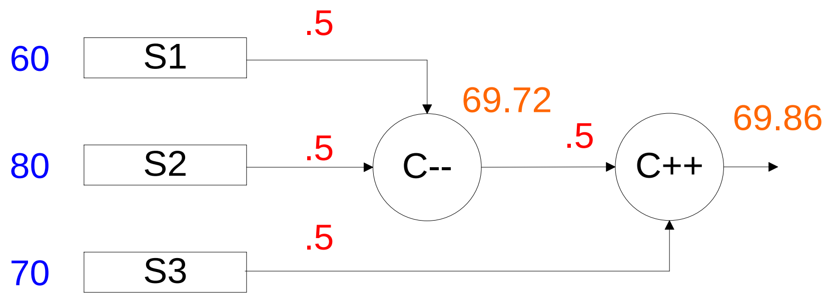

Figure 5: 3 Symptoms with different andor functions

In real life applications, not all symptoms have the same relationships. In the example in Figure 5 Symptom 1 and 2 have a Weak QC (-) and they have a Strong QC (+) with the third symptom. This amalgamation property of the LSP would be useful in actual applications.

6. Sample application on a theoretical Medical Data

Expert Systems can be used in Medical Data [13]. Several programs can be used to utilize it like visual basic [14]. This section will provide an example in the diagnosis of medical data. For example in the medical field there are three symptoms which corresponds to two different diseases for example let S1 be Symptom 1, S2 be Symptom 2 and S3 be Symptom 3. These set of symptoms corresponds to two separate diseases. Let D1 be Disease 1 and D2 be Disease 2. Its rule will become IF (S1=1) & (S2=1) & (S3=1) THEN D= (D1 OR D2). The question is which one of the two is the most likely possible cause. That is where we use the Conflict Resolution Methodology.

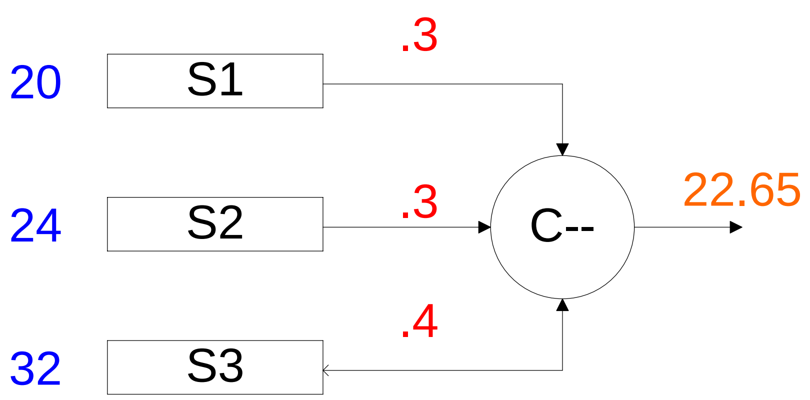

Figure 6: LSP Model of D1

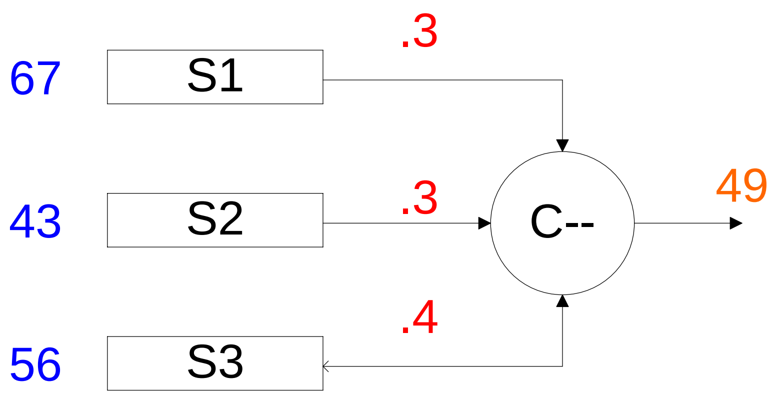

Figure 7: LSP Model of D2

Figures 6 and 7 shows the LSP Model of D1 and D2. In the LSP model the percent sureness is placed as the initial input. For D1 they are 20, 24 and 32 respectively. For D2 they are 67, 43 and 56 respectively. The model above shows that D2 has a higher weight than D1. Therefore D2 is the most likely the disease given the set of symptoms.

7. Analysis and Conclusions

An Expert System in order to be more functional must give weight to the solutions it has presented. In theory the conflict resolution methodology has presented a way to make it possible by using J. Dujmovic's Logic Scoring of Preference Model. This is done by taking the andor functions of the system and the stalwart degree of the input. This paper presented how to use it on Expert Systems taking advantage the logic multi-attribute decision models and procedures of the LSP theory. This methodology is also tested using Theoretical Medical Data.

A Limitation to this research is the subjective nature of the factor weightings. One idea to counteract this is to use an optimization methodology to make it more objective. This paper also relies upon Elementary preference *E* which will depend on the archetype of the Expert System. The system must have a reliable method in obtaining this preference. Lastly this method still needs further test to verify its validity. It can be done by testing it with live data in a field that has a problem / symptom relationship.

Its rule will become IF (S1=1) & (S2=1) & (S3=1) THEN D= (D1 OR D2). The question is which one of the two is the most likely possible cause.

That is where we use the Conflict Resolution Methodology [15].

References

[1] Hardway D, Will R. A review of barriers to expert system diffusion. Proceedings of the 1990 ACM SIGBDP conference on Trends and directions in expert systems. 1990. 619-639.

[2] Bobrow D, Mittal S, Stefik M. Expert Systems: Perils and Promise. Communications of the ACM. 1986; 29(9); 880-894.

[3] Whitley A. Expert systems: true support for the process of decision making. Proceedings of the 1990 ACM SIGBDP conference on Trends and directions in expert systems. 1990; 123-140.

[4] Flo R, White D. Design Expert: A knowledge-based tool for developing system-wide properties. 1998.

[5] Badiru A, Cheung J. Fuzzy Engineering Expert Systems with Neural Network Applications. John Wiley & Sons; 2002.

[6] Chen Z. Impact of expert systems: the technique dimension Technology and Society Magazine. 1991; 10(3); 18-20.

[7] Dujmovic J.. A Method for Evaluation and Selection of Complex Hardware and Software Systems. 22nd Int´l Conference for the Resource Management and Performance Evaluation of Enterprise CS. CMG 96 Proceedings, 1996; 368-378. 1996.

[8] Scriven M. The Logic and Methodology of Checklist. 2016; http://www.wmich.edu

[9] Olsina L, Lafuente GJ. E-commerce Site Evaluation: a Case Study. 22nd Int´l Proceedings of the First International Conference on Electronic Commerce and Web Technologies. 2000; 239-252.

[10] Yip M, Mendes E. Department of Computer Science publications. 2016; http://www.cs.auckland.ac.nz/~emilia/publications

[11] Olsina L, Rossi G. Web Engineering: A Quantitive Methodology for Quality Evaluation and Comparison of Web Applications. Doctoral Thesis, Facultad de Ciencias Exactas, Universidad Nacional de La Plata; 2000.

[12] IEEE Std 1061-1992. IEEE Standard for a Software Quality Metrics Methodology. 2016.

[13] Ahmed I, Alfonse M, Aref M, Salem A. Reasoning Techniques for Diabetics Expert Systems. 2015; 813-820.

[14] Ali S, Saudi H. An expert system for the diagnosis and management of oral ulcers. Tanta Dental Journal. 2014; 11(1); 42-46.

[15] Africa A, Co C. A Quandary weighting algorithm for Expert System applications. 13th International Conference on Mechatronics Technology. 2009.