Enhanced Decision Support Systems for Medical Applications

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1. Introduction

Decision Support Systems (DSS) are used to suggest solutions and provide advice to people that is going to make a decision. DSS give alternative ways of action and describe the advantages, disadvantages and consequences of each action. DSS are computerized systems that are developed taking into account the experience and knowledge of specific people (experts) in the distinct problem. DSS do not make the decision by themselves but they are used to help human to make the appropriate decision.

How DSS are developed? The basic concepts for the analysis of DSS are:

1) *Identify the decision maker (or makers).*
2) *Identify the alternative courses of action.*
3) *Identify the attributes, which are relevant to the decision problem.*
4) For each attribute, assign values to *measure the performance of the alternatives on that attribute*.
5) *Determine a weight for each attribute.* This may reflect how important the attribute is to the decision maker (through which we will discuss the problem of using importance weights).
6) *For each alternative, take a weighted average of the values assigned to that alternative.*
7) *Make a provisional decision.*
8) *Perform sensitivity analysis* to see how robust the decision is to changes in the figures supplied by the decision maker.

Nowadays with the development of new advanced computers and more powerful software tools, Decision Support Systems are used widely in every scientific field, from the management and operational research sciences to medical applications. Especially DSS play a significant role in medical applications, where decisions include humans (patients and doctors), medical equipment and computers [1][3]. In this specific kind of applications DSS will be able to be used by doctors that do not know the exact field of the science so as to give advices to patient when nobody can help them or must wait days for the field doctor to examine them and give the appropriate suggestion. We can even use them from place to place using a communication cable so as the advice to be delivered even from far away.

In this paper, we will present useful and advanced models for developing DSS and we will pay more attention to their relationship with the decision maker. We are going to examine even the whole reaction with their environment. Especially we are going to focus on the development of DSS for medical applications. After the presentation and examination of the DSS within a medical environment, problems and drawbacks of the existing model will be examined. Afterwards, a new advanced DSS that has dynamic relationship with the environment has been proposed. This new model is more powerful than the primary proposed model and especially it is proposed as an Enhanced DSS model that has learning capabilities and the ability to be improved by using new cases.

2. Existing model for a DSS

The presented DSS is consisted of two main parts. The first one is the Knowledge Base and the second one is the Reasoner. These two parts are closely connected to each other. The Knowledge Base gathers existing knowledge using input cases and their corresponding outputs. The Reasoner is an algorithmic method that process inputs and provides the corresponding outputs. The " right knowledge " means that the system must contain knowledge relevant to the tasks and decisions about which advice is required at the right level of detail. It completely covers the entities and relationships concerned (drugs, diseases, findings, etc). It must be up to date, consistent and correct. A group of experts describe the Knowledge Base, inspect it about the completeness of the knowledge and consider whether the knowledge is sufficient to support safe reasoning for typical scenarios of use.

Figure 1 illustrates [2] the structure of DSS model, and its interactions with the environment.

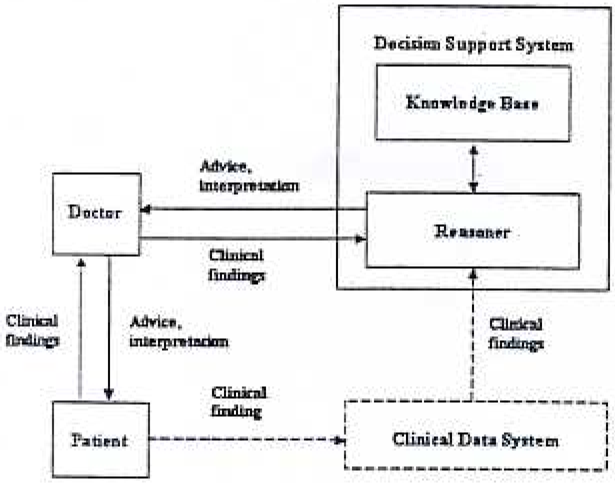

Figure 1: Existing structure for the DSS and its environment

In this paper the writer has not specify the reaction from one concept to the other so we try to present this reaction only by ourselves in the following sentences.
The Reasoner exchange information with the Knowledge Base and then the Reasoner is capable to propose an Advice / Interpretation to the doctor. The doctor afterwards gives the final Advice / Interpretation to the patient.
The Clinical Data System is a Database that keeps all the details of the patient's conditions. The Clinical Data System can be connected to the whole system. It is also possible not to be connected.
Clinical findings are the results of the medical examination of the patient. Clinical findings are information that is added to Clinical Data System utilized by the doctor and the Reasoner.
A thoroughly examination of the structure and the operation of the existing model will reveal the following problems:

a) Doctor: He does not act dynamically as a part of the system. He is seen only to transfer the clinical findings from the patient to the Reasoner so as to take an advice back after the data processing. Then he transfers the Advice / Interpretation from the DSS to the patient.
b) Reasoner: It makes an algorithmic decision using the specific Knowledge Base data. It does not act dynamically as a part of the system. He really has a specific role.
c) Clinical Data System: It only takes and gives Clinical Findings. It does not act dynamically as a part of the system.
d) Knowledge Base: It is specific because it was once developed and never changes. Only after special requirement of reconstruction, experts can add new cases. Therefore, it does not change dynamically.

3. New model for a DSS - Enhanced DSS

A new DSS model is proposed here which will take under consideration the dynamic intervention of the doctor and the Clinical Data System in order to provide dynamically changes to the Knowledge Base. We make also an effort to describe the way that those changes can reflect to the Knowledge Base. This kind of changes is reflected even to the operation of the whole DSS. Our intention is to propose a new system with the ability to improve dynamically by the help of new cases.

In the new model, a concept named COMPARISON is inserted in the structure of the whole system. Clinical Data System receives the Clinical Findings from the patient and compares them with the Enriched Clinical Findings received from the doctor. These two different findings are compared to each other and then compared with the Knowledge Base Findings. By this comparison, we are able to find new Knowledge Base Findings that are renamed as Enriched Knowledge Base Findings and then add them to the Knowledge Base. The Knowledge Base now is becoming bigger, also with better capabilities expecting that this enriching will give as the opportunity to make better decisions for many new cases. We are now able to enrich the Knowledge Base and to have the ability to give a Suggestion to the doctor. We must also highlight that in the proposed model the doctor takes under consideration the Suggestion from the Reasoner and if he thinks it is necessary he has the ability to make the appropriate corrections and transfer the Suggestion to the patient as Medical Advice. Now the Knowledge Base changes dynamically developing a most powerful Knowledge Base.

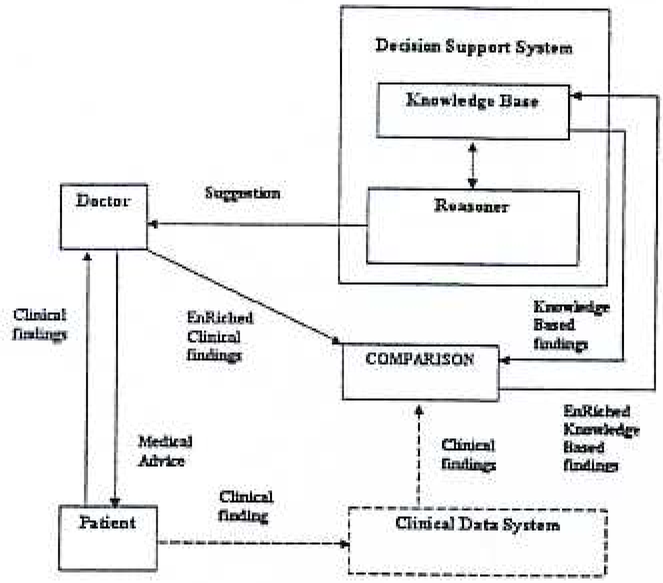

Figure 2: Enhanced DSS structure

In our future work we will develop an algorithmic method for the Comparison that will be able to give the appropriate suggestions for the changing or not, enriching or not of the Knowledge Base. We also have to take into consideration the probability the Knowledge Base to become highly big.

We are now able to describe how does the mechanism of the Comparison works and which is the algorithmic method that describes this procedure. So we have this occasions for the operation of the comparison process:

1) When Clinical findings are totally equal to the Enriched Clinical findings and totally equal to the already register Knowledge Based findings. In this case we do not have any reason to readjust the Knowledge Base, so the Suggestion that the Reasoner transfer to the doctor can be used without any changes for the patient.
2) When Clinical findings are totally equal to the Enriched Clinical findings but they are totally unequal to any of the already register Knowledge Based findings. Then the Clinical findings (or the Enriched Clinical findings) are added as Enriched Knowledge Based findings to the Knowledge Base. After the enriching of the Knowledge Base, one last thing is to produce the algorithmic method that is capable to propose the appropriate Suggestion.
3) When Clinical findings are not totally equal to the Enriched Clinical findings so as the mechanism of the comparison will have to find if any of them are equal with any of the already register Knowledge Based findings.

   3a) The one of the two is totally equal to the Knowledge Based findings. This means that the other one is not valuable and we don't have to take it under consideration. This one is subjected from the whole process and the Knowledge base will remain as it was.

   3b) The one of the two is not totally equal but is comparable with subsample of the Knowledge Based findings (sample) and the other one is also comparable with another subsample of the Knowledge Based findings (sample) then we will have to compare the number of the comparable subsamples of the one with the number of the other.

   If for the first the number of the comparable subsamples is N1 and for the second is N2, then:

   3b1) If N1>>N2 we have to accept the one that corresponds to N1 and to reject the other one. The designer has decided the luck of the Knowledge Base:

   3b1a) The Knowledge Base has to remain identical the same, if the designer decided that this kind of detail (type a) wasn't his first goal, which is acceptable.

3b1b) It is also possible to be enriched if the designer decided that this kind of detail is basic for the collection of newer elements, which is acceptable.

The only thing that remains it the algorithmic methodology which will be capable to produce corresponding results to the enriching data. The fact is that we have the incoming signals and we want to find the corresponding outgoing signals.

3b2) If N2>>N1 we have to except the one that corresponds to N2 and the other one to be rejected, as we did upper.

3b3) If N1 ≡ N2 or N1 ≅ N2 we don't have any reason to enrich the Knowledge Base. In this cases the Knowledge Base is dangerous to become very detailed (type b). Anybody can say that we might have to enrich the Knowledge base, this is possible if the designer designed the whole system.

3b4) If N1<N2 (equal the same for N2<N1) then N2=N1+Nx (similarly Ni=N2+Nx). Nx plays the basic part. Nx is among the space [Na , Nb]. We have to take under consideration the number that corresponds to N1 and the one that corresponds to N2. The lower border for the above space is N1 using N2=N1+Nx. The space now becomes [N1, Nb]. As long as Nx draws away from N1 and comes closer to Nb, means that N2 becomes bigger and bigger. As long as N2 becomes bigger the situation crears out. In such conditions the second subsample will be exceptable and the Knowledge Base will be enriched.

Two other problems that we have to examine in case to produce an algorithmic method appropriate to produce the optimal conclusions / output signals (Enriching of the Knowledge Base, optimal Suggestions):

1) We must have the ability to specify a stundard number in the space of [Na, Nb]. By using this spesific number we are going to enrich or not the Knowledge Base. It will be also better to be able to specify an algorithmic method so as for this number not to be standard but to be changeable taking under consideration the importance of the subsample in this space.
2) It would be better to examine the way the system is going to react to the newcoming Enriched Clinical findings. In case to find the algorithmic method to produce the appropriate Suggestion, has to be found an appropriate way of training/education for the whole system so as to produce such kind of results. He might be able to propose methodologies capable to accomplish the adove subject of research.
3) In subsamples that has great difference between them, when we are talking for detail (type a) there is virtually adding of useful signals capable to enrich positively the Knowledge Base. The Knowledge Base then is capable to correspond in great variation of patient cases. In subsamples that does not have great differences between them, when we are talking for detail (type b) there is not virtually adding of useful signals capable to enrich positively the Knowledge Base, but they only examine somewhat similar patient cases.

4. Conclusion

Proposing this new advanced model for the DSS system and examining its reflection with the environment, has given us a good aspect for such models. In the final paper an algorithmic method capable to enrich the Knowledge Base in the DSS will be presented. That system we believe is appropriate to be used in medical applications and even to many other.

5. Acknowledgement

This research was supported by the Greek GSRT and European Social Fund under the PENED'99 project 99ED514

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