Evaluating Option-related Text Descriptions for Decision Aiding

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This short paper presents an approach for evaluating the meaning of text descriptions regarding the appropriateness of a method, a tool, or, in general, of an approach, for solving ill-structured, ill-defined problems. This evaluation approach is based on the framework of fuzzy sets and in particular, test score semantics [9]. The text descriptions are descriptions of problems which correspond to a number of (sub)problems belonging to human activity systems elicited and represented through the use of soft systems methodology (SSM)[1,2,6]. A number of papers [3,4] have described the overall approach through specific problem spaces. An implemented decision support system to support computer system designers in the area of human computer interaction, which was based on the above approach is also described in a previous paper. The specific theme of this paper is to present and discuss some further aspects of the reasoning of such a system.

The system of relevant activity subsystems is the main vehicle for providing a representation of the problem space useful for the purpose of aiding the decision maker in his decision making as to which approach, tool etc. to use to tackle his problem.

This system is defined here as the space which consists of activity subsystems S_j, and their relationships as follows:[4]

$$[S_j,\ R_{S_j}^{mt_i},\ \lozenge,\ mt_i,\ x]$$

$$[S_j,\ R_{S_jS_k}^{mt_i},\ S_k,\ mt_i,\ x]$$

where, S_j is the activity subsystem j, j = 1..N, mt_i is the tool i, i = 1..k, $R_{S_j}^{mt_i}$ is the relationship identified within S_j which could also be in relation to a tool, in this case i. (◊ denotes that the relationship is actually an attribute of S_j which stems out of the properties of mt_i).

$R^{mt_i}_{S_jS_k}$ is the relationship between S_j, S_k again possibly in relation to mt_i, e.g. corresponding to pre and post-condition. Finally x is an empirical measure of how much $R^{mt_i}_{S}$ is satisfied by mt_i.

The relevant activity subsystems S_j are elicited using Soft Systems Methodology (SSM) [1,2].

The resulting attributes associated with subsystems (subproblems) selected by the designer, can be separated into groups according to the tools they are associated to. Each of these groups can now be evaluated in order to provide recommendation as to which tools are more appropriate to be used for the particular problem. The evaluation of these groups of attributes is carried out with the aid of test score semantics and is described in the next section.

Use of test score semantics and fuzzy sets.

The relationships R are usually expressed in text form and are considered as a collection of fuzzy constraints. That is, a number of propositions constituting the meaning of the relationship between the subsystem Sj and the tools in terms of relevancy of those tools identified and S_j.

Assume that the user requesting decision aid has settled with a set of subsystems as being relevant to his concern at the current stage of problem tackling. The real decision problem will be to evaluate the meaning of the usefulness of each tool which, via the relationships to the subsystems selected by the user, will appear suitable. Following the test score semantics procedure to evaluate each relationship (fuzzy constraint) the user will provide a score ts_i for each relationship, which will describe the degree to which the relationship is satisfied. Constraint satisfaction means how much the values of the linguistic variables implied in the proposition representing the user's concern satisfy the relationship (fuzzy constraint).

According to this approach his test scores assigned to every relationship will give overall test scores for the groups of attributes discussed elsewhere [3], which correspond to each tool. The highest of these overall test scores may be taken as a very good indication that the corresponding tool is the most appropriate currently.

However it must be noted that the suggested approach is an attempt to evaluate the meaning of relationships in terms of a proposition expressing concern. In other words it is an attempt to identify the most "meaningful" action to be taken by the designer in terms of using a tool to proceed with solving his problem. In that context it is worth mentioning that Zadeh [9] suggests that the overall score by itself does not represent the meaning of the proposition of concern, but one has to consider the actual process leading to that score. As a result the overall scores here cannot always reflect the appropriateness of a tool over another in relation to a design situation. For example a tool may be moderately appropriate but it may satisfy (moderately) a large number of links (fuzzy constraints), while another one may strongly satisfy one or two constraints only. The fact that only a few constraints are very much satisfied, may be enough to overpower the case of the great number of constraints moderately satisfied in a fuzzy environment.

[A, $R_{A1}^{mt_1}$, ◊, mt_1, x]	[ts_1]	a bit
[A, $R_{A2}^{mt_1}$, ◊, mt_1, x]	[ts_2]	a quite
[B, $R_{B1}^{mt_1}$, ◊, mt_1, x]	[ts_3]	so & so
[A, $R_{AB1}^{mt_1}$, B, mt_1, x]	[ts_4]	substantially

The table above gives as an example some partial scores which, instead of being crisp numbers selected within a range, could also be expressed linguistically through fuzzy quantifiers, or they could be expressed as fuzzy numbers. As a consequence, the partial scores are also fuzzy sets with corresponding membership functions.

The aggregation of test scores is the key to exploiting the degrees of freedom of expression offered by fuzziness. So far a number of aggregation operators [7,8] have been tried for evaluating the meaning of a problem description, that is aggregation of the value (score) of a constraint of satisfaction given by an expert with the value (score) given by the user (usually of the degree of importance to him of a problem description) as well as the aggregation of the scores corresponding to the subproblem associated to each tool. The recommendation given by the system is based on that particular score.

A number of experiments are planned to identify the most appropriate aggregation operators for the purpose. These experiments will be based on subjects who will be asked to evaluate individual subsystems as well as combinations of them from a number of domains. It is expected that, as has been found by others [11] not all specific operators are appropriate for all cases but that combinations of them depending on a number of operators.

Also in the quest for the appropriate operators to support efficient fuzzy reasoning mechanism combinations of fuzzy rules are currently used in the following fashion.

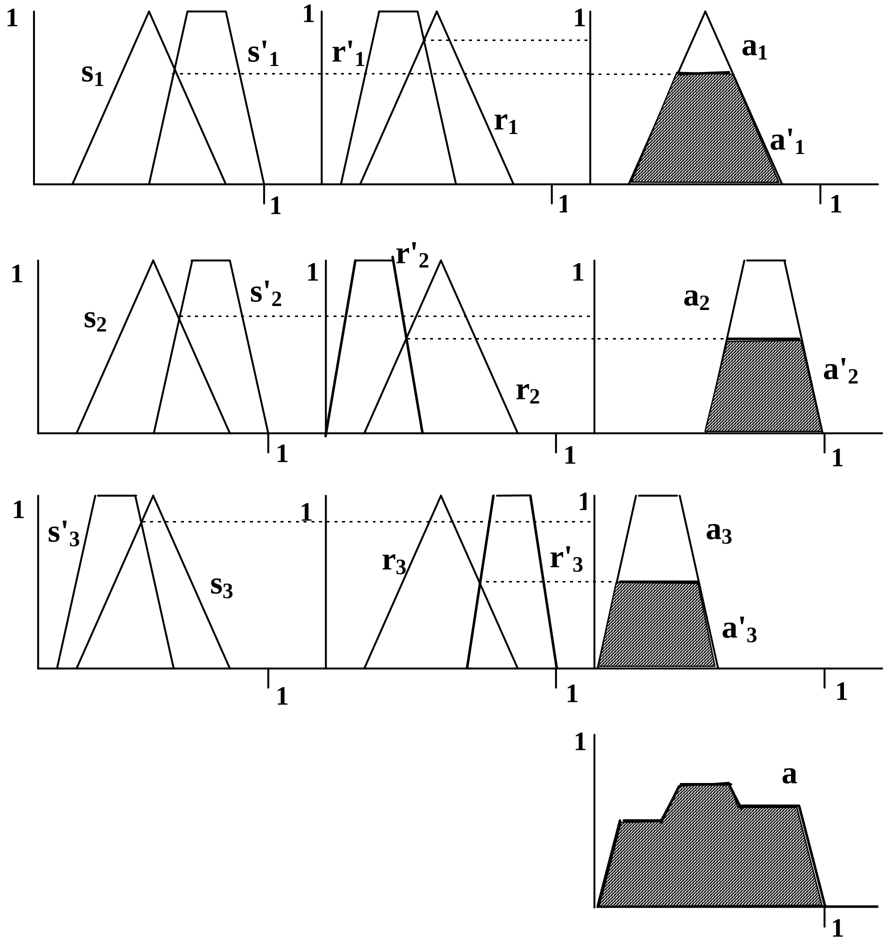
In a general case of problem description by a user [3] for which when R is the generic relationship "satisfaction" the overall score (evaluation) of the user's problem in relation to specific tools is calculated as follows:

Every subproblem (activity subsystem) is associated with a generic fuzzy rule of the type:

IF	{satisfaction of tool's potential to tackle subproblem}	**AND**	{relevancy of the subproblem to users' overall problem}	**THEN**	{appropriateness oftool}

In the following figure this generic rule is represented via the membership functions $\mathbf{s_i}$, $\mathbf{r_i}$, and $\mathbf{a_i}$. A user may evaluate satisfaction and relevancy with fuzzy quantifies etc. with corresponding membership functions the $\mathbf{s_i}$, and $\mathbf{r_i}'$. The appropriateness, represented via the membership function $\mathbf{a_i}'$, is then calculated in the same fashion as in fuzzy control [5]. For satisfaction and relevancy Zadeh`s sup-min operator [9] is used, while Mamdani`s minimum operation rule is used for calculating the appropriateness [5] i.e. the THEN. For the AND the minimum operator is used.

A user selects a number of subproblems from those spanning the overall problem space. Also each subproblem`s rule corresponds possibly to more than one tool. Hence for the selected subproblems the rules are applied for each tool separately to calculate its appropriateness. The rules are combined via the also operator i.e. the union. Other operators might possibly be used.



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