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Fuzzy Modeling tool for Creating a Component Model of Information System

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***Abstract*—**This paper focuses on creating a component model of information system under uncertainty. The paper identifies problem in current approach of component modeling and proposes fuzzy tool, which will work with vague customer requirements and propose components of the resulting component model. The proposed tool is verified on specific information system and results are shown in paper. After finding suitable sub-components of the resulting component model, the component model is visualised by tool.

***Keywords*—**component, component model, fuzzy, fuzzy rules, fuzzy sets, information system, modeling, tool

I. Introduction

DURING the modeling process of a new information system we need to capture as big an area of requirements on the information system as possible in the first stage of the system analysis. At this initial stage, the communication between the analyst (an expert) and the customer (a contracting authority) is essential. To ensure the success of the subsequent system design and its implementation, it is thus essential to properly model these requirements for both the customer and for those who will be creating and implementing the system itself. The component model, which shows the individual components of the IS, is one of the appropriate models that allows to view the future functionality.

II. Problem Domain

The currently most adopted approach is based on processing the input requirements of the customer by the analyst (an expert), who then, with the basis of these requirements and his own experience, creates this system component model.

It is also necessary to use expert knowledge in the specific domain in which the IS is formed and will operate to ensure the correct understanding of the requirements for the subsequent system implementation. This approach will minimize the misinterpretation of any vague requirements given by the customer for both the analyst and the customer, but still leaves a lot of key responsibility and space for the analyst.

This approach is therefore very dependent on the knowledge of the expert and from their work the quality of the future IS (or parts of the IS) is unfolded, which can be somewhat undesirable and dangerous (especially in the case where the given analyst becomes unavailable during the analysis process for any reason or has suspend his participation at anytime during the process).

The goal is therefore to reduce the role of the expert or to completely eliminate the need for his use in the analysing process of the IS and partly pass his role on to the contracting authority. In this case, the contracting authority will be able to design and interconnect components and generate the component model of the new IS (the term new is here used to define the design) on the basis of vague requirement definitions with the help of an expert system. It is essential to understand here that this process is not only about the implementation of the new IS, but also about verifying the existing functionalities of the IS for possible (or necessary) adjustments.

III. Problem Solution

The solution of the problem domain is an expert system design (from here on abbreviated ESX), which will formally process the vague requirements, where the contracting authority will however still use his own vague language to describe the problem domain (i.e. he is not using the formalisms; he is working with language concepts). The expert system will also contain generic technology-based components and components that are bound to a given problem domain. The list of designed components taken from this base and rated by importance will be presented to the customer based on the vague requirements. The user then can form a final version of the component model based on the proposed components, which can subsequently be visualised in a graphical form. Thanks to the ESX, part of the design of the component model will be transferred to the customer and the customer himself can affect the resulting model. ESX uses a general model of decision support system, which is described in [2] and is used in [1], [3], [4], [6], [7], [9].

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The proposed procedure thus includes the creation of an expert system (EXS) for the contracting authority. The actual analysis of the IS and the resulting component model can be described as follows:

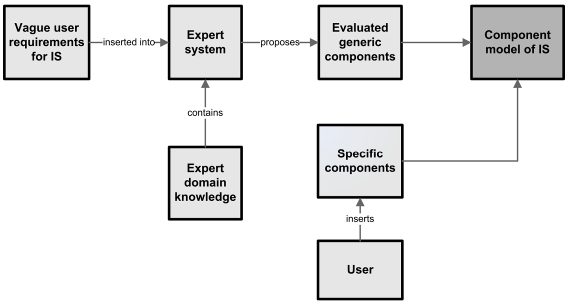


Fig. 1 The proposed procedure of component modeling

IV. Fuzzy Tool

Fuzzy utility will process the vague requirements of the contracting authority for IS and the output will be the proposed component model. In the intermediate steps the LFLC tool will be used, which is described in [5], [8].

The main steps are:

1. 1st step – the customer enters the input functionality requirements and defines their importance,
2. 2nd step – the tool searches through the knowledge base based on the input data (customer data) for the existing individual suitable components (implemented modules supporting a given business process),
3. 3rd step – based on the importance of each individual functionalities, the tool evaluates the sub-components
4. 4th step – the sub-components are then visualized in the component model together with their colour distinction (the colour represents relevance).

In order to identify the vague requirements of the authority, a questionnaire that allows the transfer of these requirements into a simple text file is created. This questionnaire relates to the following legend which classifies the various types of queries into the following categories:

1. *Functionality of the IS, the main processes:*
   a) users - user management
   b) co-operation - support for user collaboration
   c) customer_relationship - customer relationship management
   d) documents - document management
   e) data_security - data security (secure login, backup, data protection)
2. *The importance of functionality:*
   a) very important - very significant
   b) significant – significant
   c) important – important
   d) less important - less important
   e) marginally important – marginally
   f) unimportant – unimportant
3. *Number of employees:*
   a) few
   b) medium
   c) many
4. *The complexity of the solution (the sophistication of the solution is directly proportionate to the cost of the said solution):*
   a) small
   b) medium
   c) high

Based on these categories, the questions in the questionnaire that the customer fills will be created. Example of a questionnaire:

TABLE I
Questionnaire for Customer

Functionality	Importance	Number of employees	Complexity
users	very significant	medium	medium
co-operation	significant	X	high
documents	important	many	X
data_security	marginally	many	medium
customer relationship	important	few	small

When defining fuzzy sets that define the individual functionality, these are converted into numerical terms where each number always represents the functionality. The functionality “users” is for instance represented by the number 1, etc.

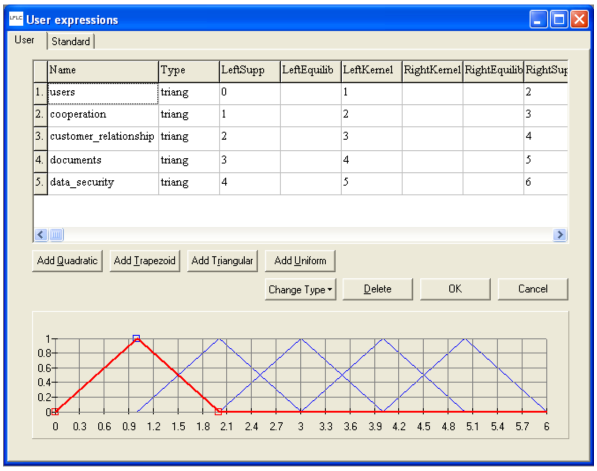


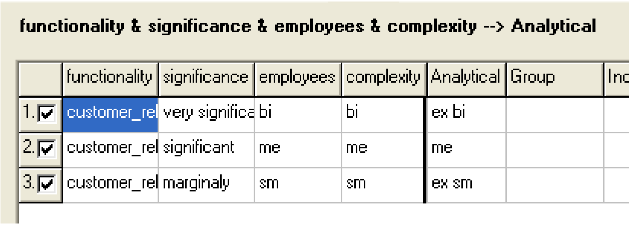
Fig. 2 Definition of the fuzzy sets for each area

The expert system then provides the basis of IF-THEN rules that evaluate the individual sub-components of the IS based on functionality and the system processes filled in the questionnaire:

Examples of the IF-THEN rules:

```
IF (functionality is USERS AND
significance is VERY SIGNIFICANT AND
```

```
employees are MANY AND complexity is
MEDIUM) THEN Central-user-directory IS BIG
IF (functionality is CUSTOMER_RELATIONSHIP
AND significance is VERY SIGNIFICANT AND
employees are MANY AND complexity is HIGH)
THEN Analytical IS EXTREMELY BIG
```


functionality & significance & employees & complexity --> Analytical

	functionality	significance	employees	complexity	Analytical	Group	Inc
1.	customer_rel	very significa	bi	bi	ex bi		
2.	customer_rel	significant	me	me	me		
3.	customer_rel	marginaly	sm	sm	ex sm		

Fig. 3 Definition of IF-THEN rules

The basic components, which can act as sub-components and reflect the degree of sophistication (complexity) can be defined below [8].

The basic components of the resulting component model are:

1. User management
2. Document management
3. Customer relationship
4. User interface

Within the range of the expert system, hierarchical bases are created for the actual processing of the IF-THEN rules for each sub-component [1] [3].

The procedure of the hierarchical processing itself is captured in the following diagram:

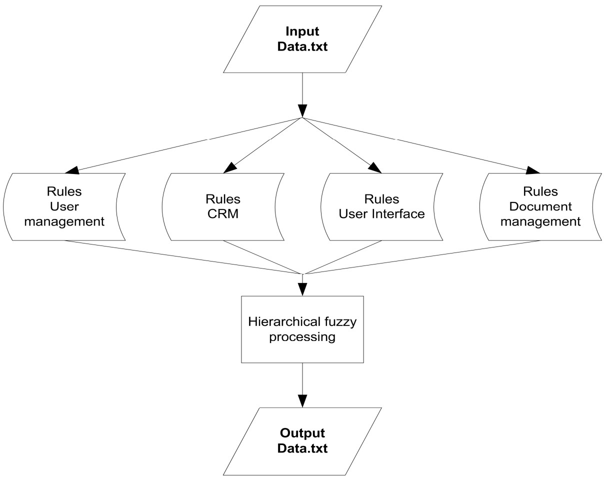


Fig. 4 Hierarchical stucture processing

Reference example of data processing is shown bellow. This is the content of input questionnaire (data.txt):

TABLE II
INPUT DATA FROM QUESTIONNAIRE FOR CUSTOMER

functionality	significance	employees	complexity
1	1	90	90
3	2	90	90

After processing, the expert system is generating the output file output.txt containing the individually rated sub-components:

TABLE III
OUTPUT FILE OUTPUT.TXT

functionality	significance	employees	complexity
1	1	90	90
3	2	90	90
Client	User directory	Public	Storage
0.036667	0.5	0.5	0.5
0.5	0.5	0.5	0.5
Workflow	Integration	Analytical	Collaborative
0.5	0.5	0.5	0.5
0.5	0.5	0.893333	0.423333
Datawarehouse	Web_access	Central user directory	
0.5	0.94	0.893333	
0.066667	0.5	0.5	

This output is afterwards visualized. The resulting model – containing rated sub-components within the basic components on the basis of a questionnaire [6] described above – is shown below:

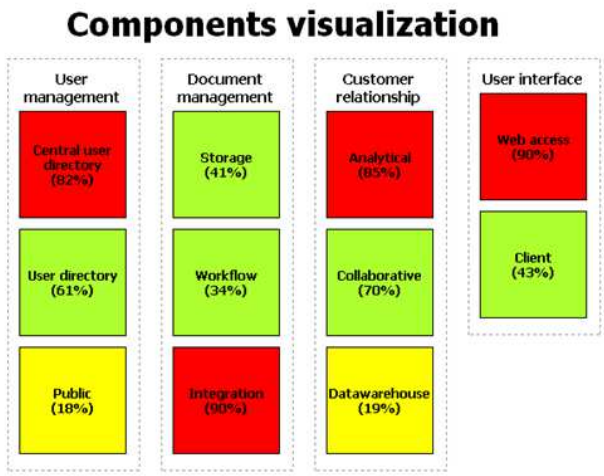


Fig. 5 Visualization of the resulting component model

The components marked with a red colour are the selected system components that are essential and needed to be implemented (i.e. they reflect best and by far the original customer vague requirements and are fundamental). The ratio of red and green labelled, as well as the sheer number of red-marked, may lead to a qualified decision on whether to implement a new information system, or just modify the components of the existing one.

The actual components are filled with base component atoms, which represent the design patterns implementation. We can cite as an example an atom called workflow:

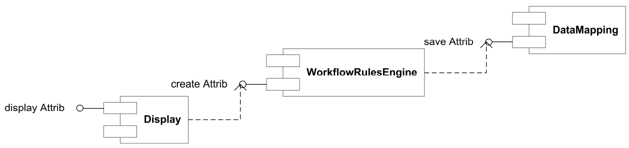


Fig. 6 Atom workflow

V. Conclusion

The article summarizes a practically designed and implemented approach to the acquisition of relevant materials during the implementation of the information system (or reimplementation of the existing one), and also simplifying the system design of system partial parts or system itself.

The methodology and the tool created to support this methodology is accordingly based on the collection of vague requirements for the functionality of systems. These inputs are then processed by the tool using a hierarchically built fuzzy system and afterwards seeking through the design patterns, which are evaluated on the basis of relevance in relation to the original requirements.

One of the outputs is thus the simplification of the implementation process or the modification of the system using actual diagrams, which can be used during the actual implementation and the background to help the organization with deciding whether to implement (develop) a new system or rather modify an existing one if available – this decision can be taken on basis of the ratio of red and yellow labeled components in the visualized output.

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