Approach to Prioritize the Requirements Using Fuzzy Logic

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Abstract: **Software Engineering (SE) is one of the most resourceful building areas rising and creating inside recent decades or somewhere in the vicinity. Still, an exploration work has gone into forming it the way we see it working today. The point of SE is to make programming items, administrations or their ancient rarities with a specific end goal to meet the requirements postured by stakeholders while meeting quality imperatives forced on them. Prioritization and Classification is an exceptionally basic however regularly dismissed territory of prerequisite designing. Experience has demonstrated that without legitimate prioritization and arrangement of prerequisites displayed by different partners, the final item more often than not neglects to meet its targets ideally. Indeed in numerous occasions, the resultant is viewed as a disappointment in light of the fact that it neglects to meet its centre targets. A few prerequisite prioritization systems have been displayed by different specialists over the previous years. In this work, we have designed a novel multi-level quality based insightful prerequisite requirement elicitation procedure utilizing fuzzy rules and as an encouraging procedure, we have applied the "programming to better meet evaluate the destinations that predicts completeness and understandability of provided requirements. We have presented and connected the idea of prerequisite quality to organize necessities. We have performed broad experimentation utilizing our proposed system alongside existing methods. The tests have likewise demonstrated that proposed system is equipped for conveying noteworthy prioritization under changing and regularly clashing circumstances.**

***Keywords*- Requirement Engineering, Requirement Elicitation Process, Fuzzy rule, Completeness, Understandability.**

I. INTRODUCTION

A. Requirements Engineering

Requirement engineering can be viewed as process of effectively finding and specifying objectives and purposed of the proposed solution. Zave [1] has defined RE in the following words:

"*Requirements engineering is the branch of software engineering concerned with the real-world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior, and to their evolution over time and across software families."*

Software Test & Evaluation Panel (STEP) defines requirement engineering [9] as:

"The disciplined application of scientific principles and techniques for developing, communicating, and managing requirements"

B. Requirement Elicitation

Requirement elicitation is a process of articulate the requirements of users/buyer/stakeholders of an organization/system. Requirement elicitation is one of the process of requirement engineering.

Elicitation is the procedure of looking for, revealing, procuring, and explaining prerequisites for PC based frameworks. It is by and large comprehended that necessities are evoked instead of just caught or gathered. This infers there are disclosure, rise, and advancement components to the elicitation process.

1) According to IEEE software requirements are defined as [6]-

- A condition or capability needed by a user to solve a problem or achieve an objective.
- A condition or capability that must be met or possessed by a system or system component to satisfy a contract, Standard, specification, or other formally imposed document;
- A documented representation of a condition or capability as in (1) or (2).

Requirements are not limited to the functionality of the system, as often supposed, but include other aspects. Different definitions have been presented by different authors. There are both functional and nonfunctional requirements in the system.

Davis [5] classifies requirements as:

- Functional requirements
- Nonfunctional requirements
- Performance/reliability
- Interfaces
- Design constraints

Optimization of needs is that the method of obtaining absolute best set of needs. for this purpose several improvement algorithms square measure used. several search primarily based package ways square measure wont to confirm the requirement of users for choosing {the needs|the wants|the necessities} and optimize the necessities to urge the optimum attainable set of requirements. Unambiguous or precise needs may be a most distinguished issue that affects the success of a comes. totally different improvement

algorithms like metaheuristic search techniques like genetic algorithms, simulated hardening and tabu search square measure employed in package engineering drawback.

2) Requirement Elicitation Process:

Requirement Elicitation is a process of extracting requirements form different stake holders that are directly or indirectly related to the system and is a sub process of requirement engineering. Requirement elicitation contain following process-

1. Requirement discovery
2. Requirement classification and organization
3. Requirement prioritization and negotiation
4. Requirement specification

3) Elicitation Risk and Problems-

- **Scope**
  -Inadequately defined system boundaries and non-essential technical details.
- **Understanding**
  -hurdles in communication and ill-defined need of stakeholders and domain constraints.
- **Volatility**
  -lack of commitment of stakeholders for written predefined requirements.

Customer/clients,domain experts, buyer, user, software engineer and other stakeholders who are directly or indirectly affected by the project are the sources of requirement.

II. Requirements Prioritization

In order to develop cost effective quality software, it is really necessary to select the right requirements from the set of all requirements. It would be more beneficial if they are grouped release wise. In this way, we can decide upon which requirements need to be focused in any particular release. One way to categorize the requirements is to prioritize them based on some parameters. But achieving this goal is not usually easy because there are issues that should be addressed properly. These issues include the selection of stakeholders whose suggestion should be used to give priority (value). Similarly, the aspect or criteria, which shall be used as parameters to assign priorities needs to be formalized. Issues such as organization's setup, market value as well as stakeholder's personalities and agendas need to be catered as well when performing requirement prioritization. Working in such a situation requires several trade-offs to be reached between the different stakeholders in conflicting environments. The major objective of prioritization is to help on decision making process about every aspect of system development.

A. Benefits of Prioritization

Followings are some key elements that backer incorporating prioritization process in prerequisite designing:

1) Constraint Driven Methodology

Time and spending plan imperatives as a rule don't permit enthralling all necessities. Consequently, extend supervisor can utilize prioritization as a device to help him in choice of those prerequisites that can be embedded in a sure time and spending plan requirements.

2) Planning the Releases

Prioritization offers the partners some assistance with deciding the kind of necessities of the framework and arrange them in ideal prerequisites sets. In view of these ideal sets an undertaking chief can arrange the arrivals of the item.

3) Balancing advantages against expense

Before beginning execution, key partners ought to distinguish related prerequisites and their comparing advantages. So also, each of these necessities might be assessed for usage cost. Prioritization in light of the advantage and related expense; may help the business to adjust their advantages of every prerequisite against the expense of executing it.

4) Negotiating clashes

Clashes between partners emerge on the grounds that their perspectives for a large portion of the necessities are distinctive. Prerequisites prioritization frequently includes arrangement procedure to handle conflicting necessities. In this manner it likewise helps in determining clashes and contradiction between partners.

5) Better Understanding

Prerequisites prioritization is a costly movement to some degree, in light of the fact that it requires time, partners' association, experts' opinions meeting, etc. On the other hand it helps all the stakeholders to understand all the requirements more closely.

B. Prioritization Parameters

Requirements should be prioritized objectively; i.e., there must be some parameters that shall be used to assign values to each requirement. Following are some important parameters for prioritization:

1) Time

Time is an imperative component in any venture administration process. In this manner, it must be considered when arranging the arrivals of the product. Generally, time limitation helps in recognizing those necessities that could be stimulate in brief length of time and long term.

2) Cost

The estimation of expense of a necessity requires past experience. Normally the creating association assessments

cost which is frequently communicated as far as worker hours. Organizing prerequisites as for cost assists the venture with being inside of spending plan.

3) Penalty:

Punishment can be seen as negative focuses that can be presented on the off chance that a prerequisite is not satisfied. In its typical way, center prerequisites have higher punishment esteem than those that are in second level to center necessities.

4) Risk:

Hazard administration is utilized to adapt to both interior and outer dangers, in this manner it ought to likewise be consider when arranging necessities. Taking into account the danger effect for every necessity, danger level of the undertaking ought to additionally be figured.

5) Functionality

Usefulness in RE identifies with the work/s that the proposed framework has been allocated to perform. Any framework to be produced installs inside of itself a few functionalities which could be pictured as customized representation of different necessities postured by partners. Generally as need of prerequisites shifts, so does the need of functionalities of the framework. That is one of the real motivation behind why both in direct or iterative methodologies, our center is dependably to execute high need functionalities first and lower positioned ones later.

C. Requirement Prioritization Techniques: [2]

There are various requirement prioritization techniques. However, no evaluation of these techniques has been made so far so that their utility and relevance can be determined. In this section, we give a comprehensive overview of various requirement prioritization techniques.

1) Analytical hierarchy process (AHP)

AHP is a relative appraisal based measurable procedure to organize necessities for programming items. On the off chance that we have n number of necessities, AHP makes nx(n−1)/2 examinations at every chain of importance level. All things considered, we are normally working with prerequisites which have numerous targets. AHP fills in as an effective procedure in these sorts of circumstances by making pair savvy correlation to compute relative esteem and cost of every necessity against the other one. This altogether extensive number of examinations makes the method less powerful as expansion in number of correlations dependably happens at the rate of O (n 2).

AHP can be considered as an exceptionally refined and complex strategy which can build up prioritization at the level of individual necessities. [2]

2) Cumulative voting (CV) -

Likewise alluded to as 100 $ test or 100 point technique some of the time, takes after all that much to voting component of meetings to generate new ideas. Every partner is given 100 focuses that he or she can circulate among the necessities as they appear to be fit. It appears like extremely clear instrument however it gets to be unpredictable as the quantity of prerequisites increments or the partners included turn out to be too much. [2]

3) Numerical task (NA)

It is presumably the most widely recognized prioritization procedure which is likewise simple to utilize. In the initial step, necessities are ordered into diverse gatherings. These prerequisites are given to every partner. Every prerequisite inside of these gatherings is doled out a number on a size of 1 to 5 by individual partners. The last calculating so as to position is dictated normal of all the positioning given to every necessity by each partner. Clear meaning of the gatherings is one noteworthy disadvantage. Second issue is that even with clear definitions, partners will tend to put the vast majority of their necessities into basic gatherings in light of their inclination. Another reality that we must be consider is that inside of every gathering, every one of the prerequisites are at first at the same need level. [2]

4) Positioning

This method is more suitable in the earth where a solitary partner is included. In the event that there are n number of necessities, these prerequisites are positioned from 1 (most critical) to n (minimum huge). This positioning is select in its tendency in light of the fact that necessities are not positioned in respect to different prerequisites similar to the instance of AHP or aggregate voting. There are two noteworthy downsides connected with this method. To start with significant issue is that it can bring about a larger number of contentions than understandings when connected in a domain of numerous partners. The second disadvantage is that prerequisites are seen and positioned in disengagement. The effect of one necessity over the other doesn't assume any part in general prioritization. Since prerequisites can have various measurements. [2]

5) Main Ten Prerequisites

This procedure organizes just the most essential necessities into an arrangement of main ten from a bigger arrangement of prerequisites. Choice of the most imperative prerequisites is subjective to the venture environment thus it can be incorrect if in light of human judgment. Since we make just an arrangement of main ten necessities, no prioritization inside of this set takes place.[2].

6) Hypothesis W

The fundamental defender of this hypothesis is Dr. Barry Boehm who presented this idea in 1989. Famously known as Win-Win show, this strategy depends vigorously on transaction to determine any distinctions of sentiment among different partners. The transactions are led in a manner that every partner is in a "Win" circumstance. The standards of this method are advancement in view of predefined arrangement,

hazard evaluation and danger taking care of. In this strategy, clients are requested that rank their prerequisites before real arrangements begin. Clients are asked to painstakingly consider which prerequisites they are willing to arrange and which they are most certainly not. [2]

III. Proposed Algorithm for Requirement Prioritization Using Fuzzy Logic

There is always certain amount of uncertainty involved in undertaking software engineering activities since these relate in many ways to software projects. Software projects may have several risk, assumption and conflicting requirements associated with them. Such type of problems can be better solved using fuzzy logic [3].

Following steps are executed in this third and final level of prioritization:

In the first and second level of prioritization, we achieve prioritization from the perspective of stakeholders and experts. However, both these steps involve extensive human input which can make the results more error prone. In order to further strengthen our prioritization results and reduce the manual nature of results, we make use of fuzzy logic for third level prioritization. In this approach requirement prioritization is modeled in the form of fuzzy rules. Based on Mamdani method, the approach is described using the following algorithm:

Algorithm-

Start

Define Fuzzy Variables

Determine fuzzy variables,

{cost, design time, performance, response time, stakeholder value as input

completeness and understandability as output}

Completeness and understandability

Establish fuzzy sets for these variables

Fuzzify each value in fuzzy sets using membership function

Generate knowledge Base using fuzzy rules

Build the system

Execute the system

Give input variable values

Get rule strength

Combine rule strength with output membership function

Find consequence of rules

Generate output

{degree of completeness and degree of understandability}

Combine consequences of variant rules

Generate output distribution by conflict resolution process

At every variation degree of completeness is evaluated .

If modified i/p has maximum degree of completeness

then,

modified i/p=Highest priority

original i/p=Lowest priority

else

original i/p=Highest priority

modified i/p=Highest priority

End

IV. Methodology

In this section we are describing the results that are generated by our fuzzy inference system for analyzing the user requirements for software project development. We have discussed the development of fuzzy system in terms of selection of input/output variables, membership functions and the rules for deciding completeness and understandability of requirements.

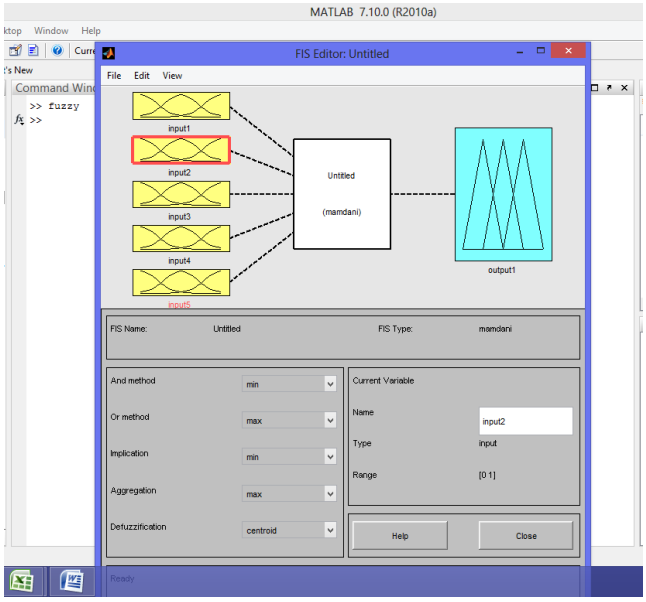

Figure 4.1: Generation of Fuzzy Inference System

Figure 4.1 shows the generation of new Fuzzy Inference System (FIS) file for defining I/O variable in the MATLAB environment by using fuzzy logic toolbox. In the figure 2 input variable 'cost' is defined and thereafter next input variable 'Design Time ' is added as input 2.

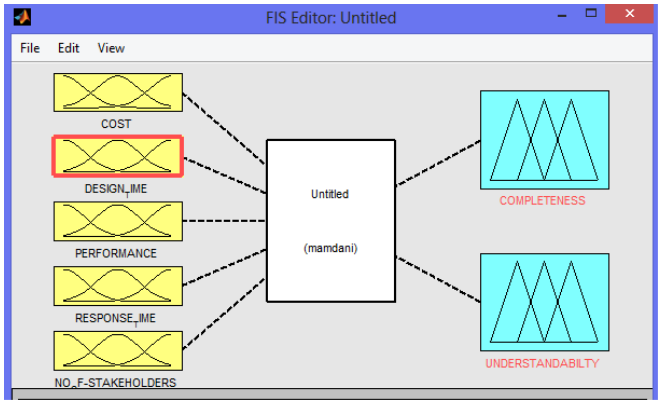

Figure 4.2 : Naming of the input and output variables for FIS system.

Figure 4.2 shows the FIS system after naming the I/O variables , here we can see that 5 input and two output variables are generated. After naming the I/O variables there range and the Member ship functions are defined. Figure 4.4 shows the MF of input variable cost. The variables which are defined in terms of Gaussian MF uses two parameters variance and mean [var mu]. The parameter that are selected for cost input are given below:

L-Low

M-Medium

H-High

A. Input Variables

1) COST-

RANGE: 0 to 10^6
Type-gaussmf
L-[10^5,0]
M- [1.5x10^5, 5.5x10^5]
H-[1.5x10^5, 1x10^6].

2) DESIGN TIME-

RANGE-0 to 8
L-[1, 0]
H-[2.5, 8]

3) PERFORMANCE-

RANGE: 0 to 10
M-[0.5, 5]
H-[1.7, 10]

4) RESPONSE TIME-

RANGE:0 to 180
L-[1, 0]
M-[20, 35]
H-[50, 180]

5) No.of STAKEHOLDERS

RANGE: 1 to 10
L-[.3, 1]
M-[1.2, 3.5]
H- [2.5, 10].

B. Output Variable:

1) COMPLETENESS

RANGE-0 to 10
L- -4, 0, 4
M-1, 5, 9
H-6, 10, 14

2) UNDERSTANDABILITY

RANGE-0 to 10
L- -4, 0, 4
M-1, 5, 9
H-6, 10, 14

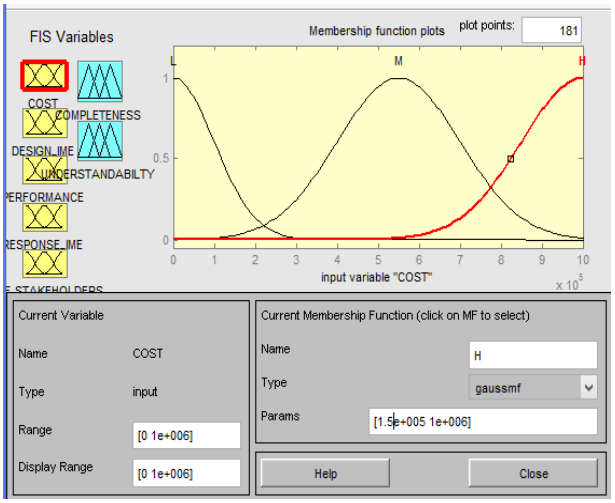

Figure 4.3: Membership function and range for input variable cost.

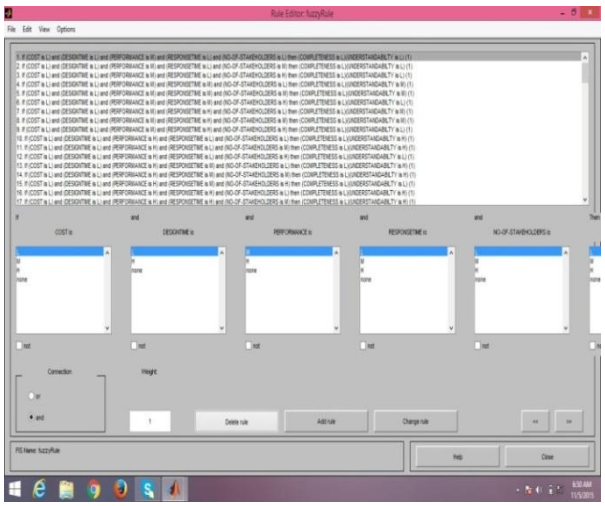

Figure 4.4: Fuzzy Rules

by varying the input values degree of completeness and understand ability varies. Hence a designer and stakeholder may select for the input value that can maximize the out degrees by bringing a negotiable variation in inputs. For this purpose we have developed a prioritization of input requirement algorithm at the basis of fuzzy evaluation results. In this case a slight variation in input requirements is performed and then at every variation the degree of completeness are evaluated and at the end the value of input at which output reaches its maximum is selected.

That updated optimized output is then observed with respect to original input value. The input requirements which remain unchanged in modified and original input are treated as low priority requirements and others as high priority requirements.

The variation in inputs requirements are given below:

1) variation in cost(delc)=-200000 to 200000/- Rs.
2) variation in development time(delt1)=-3 to 3 weeks
3) variation in performance(delp)=-3 to 3
4) variation in response time(delt2)=-40 to 40 secs
5) variation in no. of stakeholders(dels)=-2 to 2

C. Tool Support

The Fuzzy Logic Toolbox is a collection of functions built on the MATLAB numeric computing environment, It provides tools for you to create and edit fuzzy inference systems within the framework of MATLAB, or if you prefer you can integrate your fuzzy systems into simulations with Simulink, or you can even build stand-alone C programs that call on fuzzy systems you build with MATLAB [5]. This toolbox relies heavily on graphical user interface (GUI) tools to help you accomplish your work, although you can work entirely from the command line if you prefer. The toolbox provides three categories of tools:

- Command line functions
- Graphical, interactive tools
- Simulink blocks and examples

The first category of tools is made up of functions that you can call from the command line or from your own applications. Many of these functions are MATLAB M-files, series of MATLAB statements that implement specialized fuzzy logic algorithms. [5]

MATLAB is an interpreted language for numerical computation. It allows one to perform numerical calculations, and visualize the results without the need for complicated and time consuming programming. MATLAB allows its users to accurately solve problems, produce graphics easily and produce code efficiently.[6]

V. CONCLUSION AND FUTURE SCOPE

In this work we have focused on requirement completeness and understandability prediction in the activity of requirement engineering phase in software development.. This new technique for requirement prioritization is based on fuzzy logic as a multilevel approach. In this technique, stakeholders, experts and fuzzy logic based system perform prediction of requirement completeness and understandability. A descriptive analysis based on experimental results conducted on several input has also been presented. This analysis shows that in almost all different environments, intelligent requirement prioritization is able to exhibit better and impressive results. To extend this work towards classification of the prioritized requirements so that it can automatically classify requirements as critical, essential, peripheral etc. In this work we propose an approach to get optimized fuzzy inference system for the requirement elicitation process. Work can also be done in such a way that prioritized requirements can be classified as non-negotiable and negotiable requirements. This new technique for requirement prioritization and classification is based on fuzzy logic. By this approach prioritized requirements can be classified as sufficient and appropriate requirements.

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