RESEARCH ARTICLE

RSP Science Hub

International Research Journal on Advanced Science Hub
2582-4376
Vol. 04, Issue 09 September
www.rspsciencehub.com

Check for updates

http://dx.doi.org/10.47392/irjash.2022.056

Introducing Fuzzy Logic for Software Reliability Admeasurement

Vishnupriya [1], Nirsandh Ganesan[2], Piriyanga [3], Kiruthiga Devi[3]
[1]Research Engineer, KEDS GROUP R&D, Coimbatore, Tamilnadu, India
[2]Research & Design Engineer, KEDS GROUP R&D, Coimbatore, Tamilnadu, India
[3]Research Intern, KEDS GROUP R&D, Coimbatore, Tamilnadu, India

Emails: vishnupriyabiomed@gmail.com, nirshanthkodai@gmail.com, priyabharu2511@gmail.com, kiruthigadevi226@gmail.com

Article History

Received: 2 August 2022
Accepted: 16 September 2022

Keywords:
Software reliability;
fuzzy logic;
defuzzification;
admeasurements

Abstract

Software reliability estimation using fuzzy logic is shown in this article. The suggested approach tries to assign target dependability to each of its parts. The initial stage in estimating reliability is to combine the aspects of the experts in this proposed method. The system's element of proportionality is evaluated in the second phase. Employing the equations of defuzzification, the system elements undergo the process of defuzzification. We must compute the weightage of subset of the framework (i.e. module) when we have obtained precise data. The subset's reliability is estimated, at the root of its weightage. By testing the most often used functions first and less frequently used functions second, the portrait of operational status is determined, which is one of the most important criteria for ensuring successful testing and increased reliability (Ebeling) . Efficiency has improved in comparison to the prior results obtained. It aids in the assignment of reliability to every subsets prior to the frame working of real system. This even takes Operation status into account as element of proportionality, which assists in providing reliability to the subsets frequently used, designing a framework for reliability admeasurements, advantageous for all the subsets present.

1. INTRODUCTION

It's more important than ever to assign reliability, with the rise in human reliance on software. Possibility of successful operation for a specific duration of a particular domain is expressed as reliability. The assigned resources is challenging since a variety of parameters must be taken in analysis on the process of developing the framework, and system's function of reliability is influenced by reliability of the subset. As a result, at the initial stage, admeasurement of reliability becomes a crucial need, is an essential aspect of reliability assigning. The next stage is to allocate reliability to its subsets after determination of the entire reliability. Total system reliability can be attained if subset reliability requirements are met and further there are a variety of reliability admeasurement techniques are present. The method of equal proportions was the first technique to be presented, which allocates reliability to be achieved to its modules. Some cost effective techniques, on the other hand, don't really take into account a variety of reliability parameters such as intricacy, maintenance and duration of function, and some others, encompasses all of these aspects as well as numerous mathematical computations to obtain element of proportionality criteria. Professionals employed level-based estimation for several view in this research. Obtaining an output value by incorporating all perspectives is extremely challenging, as professionals will have a viewpoint according to their experience. In addition, this research does not address pre - reliability function assigning based on the subjective views. Various academics have utilized the notion of fuzzy logic for assigning of reliability, over the last decade (Zhang and Jia) (Sriramdas, Chaturvedi, and Gargama) . It has shown how to assign reliability by employing techniques such as fuzzy and the techniques for analyzing complex decisions. For choosing criteria of control and the corresponding weight, it used decision of the professionals and the probability of risk. The suggested engine fuzzy reliability assigning is on the basis of experience of different software professionals. Nevertheless, while there is a variety of reliability assigning techniques, admeasurement of software reliability has attracted scant attention. In order for a system to function effectively, it must assign reliability to each subset individually for achieving the reliability of the whole framework (Yadav Gayathry and Selvi) . As a result, this study suggests assigning reliability to all subsystems of a system based on a variety of technical factors, comprising of the Operation status. There really is no indication of the Operation status being taken into account. Nevertheless, from the perspective of the user, it is a critical criterion for assigning of reliability. As a result, the suggested approach takes into account certain parameters to analyze the performance. To assign a fuzzy grade to the different criteria stated above based on the computation, professional standards are employed (Gu and Tang Gargama and Chaturvedi Molani, Ghaffari, and Jafarian) . For determine the weighting of each subset, the element of proportionality, is computed by taking into account all elements. The weightage of each subset is used to assign reliability.

2. ASSIGNING OF RELIABILITY IN CONSIDERATION OF DIFFERENT CRITERIA

The following connection between expected reliability and reliability of all subsets is the prior assigning of reliability approach yielded.

$$R_S = [R_E]^W \qquad (1)$$

Where R_S is the reliability of the subset, R_E is the expected reliability and W is the weightage of the subset. The element of proportionality can be expressed in coordination with all the functional parameters, helps in the estimation of the weightage of the subset.

$$W = E_P / \sum E_P \qquad (2)$$

Where E_P stands for element of proportionality, it may be used to compute the weightage of a subset.

2.1. Costs Effective

In the process of assigning dependability, cost is a significant criterion. A firm of in-house can be used to create a subset or component. So, if a system has four in-house products and two off-the-shelf products, the cost will be significant. (Molani, Ghaffari, and Jafarian Aggarwal and Singh) However, it is well understood that cost and reliability are linked. As a result, the module with the highest cost should have worse reliability, because the greater the cost, the less attention that module will receive. As a result, there will be a higher risk of having a defective module with a high cost.

$$F_n \alpha\, C \qquad (3)$$

Where F_n is the number of failure events and C is the cost of the subset.

2.2. Level of complexity

Baisley describes difficulty as the amount of resources a system expends when dealing with a piece of software. The difficulty factor for various modules may vary. There's also a link between dependability and complexity. As a result, the dependability of various complexity modules varies. High complexity modules have the lowest dependability because they tend to create highly abrupt code that is difficult to alter or apply, according to cyclomatic complexity, which is one of the metrics used to assess complexity. A very complicated module, on the other hand, will have a high failure rate. As a result, a module's failure rate is related to its complexity. This relationship may be formally expressed if failure rate is represented by Z and complexity is indicated by,

$$F_n \alpha\, C_l \qquad (4)$$

Where C_l represents the level of complexity.

2.3. Level of Maintainance

It is other important factor for reliability allocation. Module, which is checked or repaired on regular basis, will have high availability. So, highly maintained software tends to have lower reliability value and having higher failure rate.

$F_n \alpha M_l$ (5)

Where M_l represents the level of maintenance.

2.4. Specificity

Another significant aspect in reliability allocation is criticality. Assume we have an aviation operation that is extremely rare yet extremely important, and it is also connected to human life. As a result, this functionally essential module will have a high level of reliability. It implies that a highly specific subset will be extremely reliable and have a low failure rate.

$F_n \alpha (1/ S)$ (6)

Where S is denoted as the specificity of the subset.

2.5. Operation Status

For dependability assignment, the operation status is a critical element. The Operation status is a set of actions with their likelihood of occurrence. Among other things, modules based on Operational Profile based testing have the most commonly utilized operations. As a result, modules with a high Operational Profile will be more reliable and have a lower failure rate.

$F_n \alpha (1/ O_S)$ (7)

Where O_S is the status of operation.

2.6. Establishing Occurance Function

It is proposed that the potential of introducing occurrence function should be included in the reliability assigning process. When it is possible to employ redundant modules, a level can be reached where a greater reliability allocation is possible. Its mathematical formula is given below.

$F_n \alpha O_F$ (8)

Where O_F is the occurrence function.

By adopting this assigning technique, the above-mentioned elements may be successfully employed for reliability assigning. This approach may be used to do reliability admeasurement for any software system with subsets.

3. PROPOSED METHODOLOGY

The fuzzy division technique will be explained, initially. Let X and Y be two parametric fuzzy numbers (a1, m1, b1) and (a2, m2, c2), correspondingly, in which the one end, midpoint, and the other end points are a1, a2, m1, m2, c1, c2. As a result, two fuzzy values can be divided into the following categories:

N = X / Y (9)

Where N (Na, Nm, Nb) is a fuzzy number, the solution of the linear problem is as follows:

Max f(N) = Nb- Na (10)

Na $\geq$ (m1/m2) – [(m1-a1)/(m2-a2)] (11)

Nb$\leq$ (m1/m2) – [(m1-b1)/(m2-b2)] (12)

Na $\leq$ m1/m2 (13)

Nb $\geq$ m1/m2 (14)

The classification of fuzzy numbers can be expressed as,

N = X / Y (15)

Where N (Na, Nm, Nb) is a fuzzy number, the solution of the linear problem is as follows:

Max f(N) = Nb- Na (16)

Na$\geq$(m1/m2) – [(m1-a1)/(m2- a2)] (17)

Nb$\leq$(m11/m22) + [(b1-m11)/(b2- m22)] (18)

Na $\leq$ m1/ m22 (19)

Nb $\geq$ m11/ m2 (20)

The method is aimed to assign target reliability to each of its component parts. The element of proportionality of the software system is the first step in calculating dependability. Calculating the element of proportionality, on the other hand, is complex. It's a problem similar to proactive way of assessing a process to determine where and how it could fail, as well as the relative impact of certain failures and a methodical approach to assessing potential risks when implementing fuzzy logic to evaluate risk variables. The suggested technique will make the very same attempt while assessing element of proportionality. All assignment factors have additional processes, which is compatible with Table 1's traditional assigning technique. These values are called fuzzy numbers since the estimation is uncertain. We'll apply our method for triangular numbers.

Using the fuzzy operations, we combine the opinions of all experts for the framework. Calculate the Fuzzy element of Proportionality for each module separately. Equation can be used to calculate the weight of each module. Equation can be used to calculate the reliability of subset.

4. RESULT & DISCUSSION

In this part, we'll use mathematics as an example. Our job is to attribute reliability to the different components of the technology. As a result, we'll use a modular smart phone with multiple components as an example. Our study aims to look into how much reliability should be given to a module. The soft-

TABLE 1. Performance rate for different assigning criteria

LEVEL	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	FOURTH LEVEL
COST EFFECTIVENESS	LOW	AVERAGE	HIGH	VERY HIGH
LEVEL OF COMPLEXITY	LOW	AVERAGE	HIGH	VERY HIGH
LEVEL OF MAINTENACE	LOW	AVERAGE	HIGH	VERY HIGH
SPECIFICITY	LOW	AVERAGE	HIGH	VERY HIGH
OPERATION STATUS	LOW	AVERAGE	HIGH	VERY HIGH

TABLE 2. Result obtained for the subset

SUBSET	LEVEL OF COMPLEXITY	LEVEL OF MAINTENANCE	COST EFFECTIVENESS	LEVEL OF OCCUREN	OPERATI SATUS	ELEMENT OF PROPORTIONALITY
LIGHT SENSOR SUBSET	160.5	502	1090	2030	3750	1.45
GAS SENSOR SUBSET	650	1300	2390	4080	3056	2.75
HUMUDITY SENSOR SUBSET	730	1250	2352	4014	3942	2.09
THERMISTOR SUBSET	890	1900	3260	5278	3950	2.76

TABLE 3. Admeasurements of reliability for the subset

SUBSET	LIGHT SENSOR SUBSET	GAS SENSOR SUBSET	HUMUDITY SENSOR SUBSET	THERMISTOR SUBSET
DEFUZZIFIED VARIABLE	1.75	1.26	1.78	0.62
WEIGHTAGE	0.34	0.26	0.35	0.14
RELIABILITY ASSIGNED	0.86	0.89	0.97	0.99

ware programming and management team is comprised of three software developers and managers. In this article, we'll look at different subsets. This study, on the other hand, considers the four essential modules of this software system and utilizes the presented framework to assign target reliability to each module.A fuzzy logic-based software reliability apportionment approach is discussed in this paper. Many factors are offered in order to calculate the element of proportionality for a software application, covering complication, expense, management, duplication introduction, singularity, renewability, time of operation, and Operational Profile. Operational Profile is now considered a key component of software reliability. It's a list of all procedures along with their probability of occurring. The Operational Profile is important since it identifies the most often performed operations as well as the likelihood of their occurrence. We can discover which module, out of all the modules, has the highest dependability value by looking at this aspect.

The above table provides the result for the parameters such as level of complexity, maintenance, effectiveness, occurrence, operation status and element of proportionality for the subsets taken under analysis.The table admeasurements of reliability for the subset represents the value obtained for weightage, defuzzified variable and reliability assigned.

5. CONCLUSION

The experts calculated software module assignment information using linguistic features in this study, which gives fuzzy based system testing reliability assignment. The weighted average of all modules is then determined. The weighting of each module and the intended dependability are used to assign reliability to each module.

References

Aggarwal, K K and Yogesh Singh. "Software reliability apportionment using the analytic hierarchy process". *ACM SIGSOFT Software Engineering Notes* 20.5 (1995): 56–61. 10.1145/217030.217041.

Gargama, Heeralal and Sanjay Kumar Chaturvedi. "Criticality Assessment Models for Failure Mode Effects and Criticality Analysis Using Fuzzy Logic". *IEEE Transactions on Reliability* 60.1 (2011): 102–110. 10.1109/TR.2010.2103672.

Gayathry, G and R Thirumalai Selvi. "Classification of Software Reliability Models to Improve the Reliability of Software". *Indian Journal of Science and Technology* 8.29 (2015). 10.17485/ijst/2015/v8i29/85287.

Gu, Yingkui K and Shuyun Tang. "A Fuzzy Reliability Allocation Method for the Product Based on the Knowledge". *2010 International Conference on Measuring Technology and Mechatronics Automation* (2010): 2005–2014.

Molani, M, A Ghaffari, and A Jafarian. "A New Approach to Software Project Cost Estimation using a Hybrid Model of Radial Basis Function Neural Network and Genetic Algorithm". *Indian Journal of Science and Technology* 7.6 (2014): 838–843.

Sriramdas, V, S K Chaturvedi, and H Gargama. "Fuzzy arithmetic based reliability allocation approach during early design and development". *Expert Systems with Applications* 41.7 (2014): 3444–3449. 10.1016/j.eswa.2013.10.048.

Yadav, D K. "A novel method for allocating software test cases". *Procedia Computer Science* 57 (2015): 131–138. 10.1016/j.procs.2015.07.389.

Zhang, Hong-Bin B and Zhi-Xin X Jia. "Complex System Reliability Allocation Based on Fuzzy Decision Method". *2009 International Workshop on Intelligent Systems and Applications* (2009): 1–4. 10.1109/IWISA.2009.5072787.

Embargo period: The article has no embargo period.

To cite this Article: , Vishnupriya, Nirsandh Ganesan, Piriyanga , and Kiruthiga Devi. "Introducing Fuzzy Logic for Software Reliability Admeasurement." International Research Journal on Advanced Science Hub 04.09 September (2022): 222–226. http://dx.doi.org/10.47392/irjash.2022.056