Research of requirements selection method on trustworthy constraints

Shu-Cheng Xiao *, Hong He, Xin Shen and Zhen-Dong Yang
Chongqing Logistical Engineering University, China
xiaosc@cqu.edu.cn

Keywords: Trustworthy software requirements; Requirements selection; Trapezoidal fuzzy number; Goal-oriented requirements; Functional requirement (FR)

Abstract. Trustworthy requirements analysis and selection of Software is an important part of trustworthy software research. Our paper based on the view of interdependency entity between FR and TS. By means of establishment of Trustworthy evaluation index system, analysis of goal-oriented requirements, trapezoidal fuzzy number evaluation model, we proposed a requirements selection method based on trustworthy constraints.

Introduction

Among the many needs of software products, FR is the most core requirements. Currently, there are several methods for analyzing software functional requirements, such as domain abstractions[1], ontology[2], user's manual[3],view[4], scenarios[5-6], requirements gathering[7-10],and Applying social-technical approach for COTS[15]. However, these methods were not mentioned how filtering software functional requirements under credible constraint, which is currently worthwhile study in trustworthy software requirements.

Interactions of the trusted attribute of the software[13], the author of this paper, by building the Software credible evaluation index, analysis of goal-oriented requirements, puts forward a method using trapezoidal fuzzy number evaluation model . Section 1 introduced credible evaluate index system. Section 2 built the demand decision model of the trapezoidal fuzzy number evaluation based on the credible evaluates index system and solves the model.

Credible evaluate index system

The quality model presented in the first part of the standard, ISO/IEC 9126-1, [14] classifies software quality in a structured set of 6 characteristics and 21 sub-characteristics. Kunda and Brooks [15] thinks that the standard is not enough comprehensive. With the development of software technology and the expansion of the application field, scholars [16-20] have added some other credible attributes economic factors. Based on the above literature, this paper sums up put forward a credible evaluation index is shown in fig. 1.

© 2015. The authors - Published by Atlantis Press

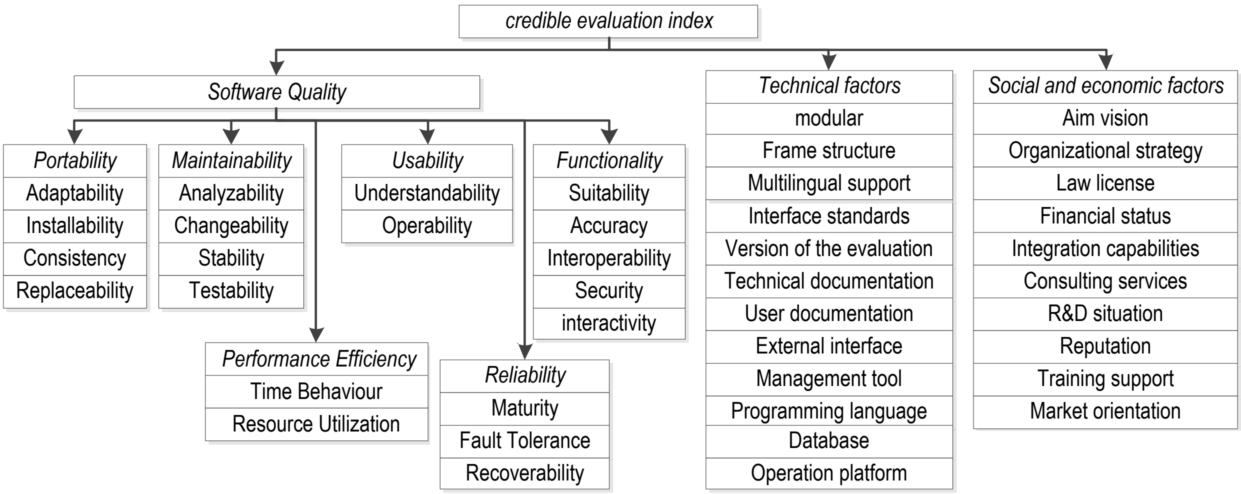

Figure. 1 credible evaluation index

Any software project initially needs to determine the need to implement the software project and achieve the basic goals set, namely the initial goals set. In many cases, these initial targets are sketchy, unable to directly implement, need to keep these goals decomposition and refining, until finally can pass code to achieve the ultimate goal of this process is called requirement analysis based on object-oriented. Related research [21] showed that the target oriented requirements decomposition method can more truly reflect the nature of the requirements engineering work, more conducive to access and manage the user's actual demand.

Demand decision model on the trapezoidal fuzzy number evaluation

Natural language estimation fuzzed. Due to the complexity of software systems often structure, implementation way is diversiform, and the requirements of the program evaluation is lack of unified evaluation criterion, so the evaluators can only according to their own experience or intuition to evaluate demand plan. In order to objectively and accurately reflect the evaluation of each objective, the attribute vectors of decision sets in the model will be expressed in the form of trapezoidal fuzzy numbers vectors[22].

Based on this consideration, this article will set the evaluation of natural language expression as a magnitude 7{C_1, C_2, C_3, C_4, C_5, C_6, C_7}, Demand for each scheme, using the language variable set {Very low, Low, Rather low, Middle, Rather high, High, Very high } for each evaluation index of non-functional requirements in trusted requirement attribute model, In language variables set {Not important, Least important, Less important, general, important, more important, Most important} to evaluation of trusted requirement attributes important degree of each index of non-functional requirements (i.e., weight). The language is more suitable for fuzzy number to represent the variable set. Both weights and evaluation attributes, using standard trapezoidal fuzzy number to express decision maker gives linguistic assessment, can reflect the fuzziness of language assessment. Trapezoidal fuzzy membership function of level 7 language variable set as shown in fig. 5, Interval [0, 1] is divided into 13 pieces, (0.077, 0.154, 0.231,...., 0.846, 0.923, 1). The natural language variables of trapezoidal fuzzy Numbers are shown in table 1.

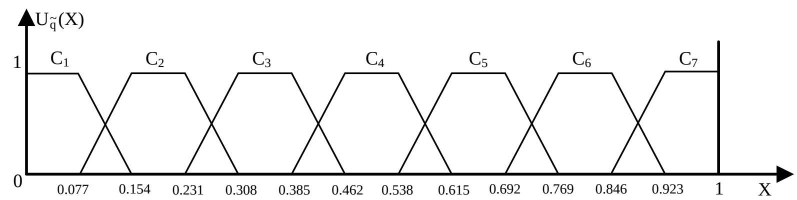

Figure. 2 Trapezoidal fuzzy membership function of level 7 language variable set

Table 1 the natural language variables of trapezoidal fuzzy Numbers

Natural-language classification	Natural-language variables	Natural-languag e variables	trapezoidal fuzzy number
C_1	Very low	Not important	（0,0,0.077,0.154）
C_2	Low	Least important	（0.077,0.154,0.231,0.308）
C_3	Rather low	Less important	（0.231,0.308,0.385,0.462）
C_4	Middle	general	（0.385,0.462,0.538,0.615）
C_5	Rather high	important	（0.538,0.615,0.692,0.769）
C_6	High	more important	（0.692,0.769,0.846,0.923）
C_7	Very high	Most important	（0.846,0.923,1,1）

Evaluation of the selection process. (1) The natural language evaluation criteria into trapezoidal fuzzy Numbers

Assume that the user according to the actual situation to select reliable L root indicators into the indicator system as a specific software credible constraints of the project, and get n feasible alternatives X_1, X_2, X_3, …,X_n by the target demand decomposed. The user (u), the developer (d), and system maintenance personnel (m) respectively according to the L credible constraint indexs (G_1, G_2, G_3,…,G_L) evaluate independently the n demand alternatives. Use $w^u=\{w_1^u,w_1^u,\ldots,w_L^u\}$、$w^d=\{w_1^d,w_1^d,\ldots,w_L^d\}$、$w^m=\{w_1^m,w_1^m,\ldots,w_L^m\}$ to describe users, developers, and system maintenance personnel to select the evaluation index weight. That $\tilde{q}_{ij}^{\,u}$、$\tilde{q}_{ij}^{\,d}$、$\tilde{q}_{ij}^{\,m}$ said respectively language evaluation of trapezoidal fuzzy Numbers of the j index G_j in plan X_i that users, developers, system maintenance personnel selected. So get three fuzzy evaluation decision matrixes respectively:

$$\tilde{A}_u^{ij} = \left(\tilde{q}_{ij}^{\,u}\right)_{n\times L},\ \tilde{A}_d^{ij} = \left(\tilde{q}_{ij}^{\,d}\right)_{n\times L},\ \tilde{A}_m^{ij} = \left(\tilde{q}_{ij}^{\,m}\right)_{n\times L}$$

Then simple weighted average method is used to calculate three evaluation group preference and weights, and reliable demand attribute model of trapezoidal fuzzy Numbers decision matrix $\tilde{A}$ and the index weights $\tilde{W}$, the calculation formula is:

$$\tilde{A} = \frac{1}{3}(\tilde{A}_u^{ij} + \tilde{A}_d^{ij} + \tilde{A}_m^{ij}), \tilde{W} = \frac{1}{3}\left(\tilde{W}_j^{\,u} + \tilde{W}_j^{\,d} + \tilde{W}_j^{\,m}\right)$$

if

$$\tilde{q}_{ij} = \frac{1}{3}\left(\tilde{q}_{ij}^{\,u} + \tilde{q}_{ij}^{\,d} + \tilde{q}_{ij}^{\,m}\right), \tilde{W}_j = \frac{1}{3}\left(\tilde{W}_j^{\,u} + \tilde{W}_j^{\,d} + \tilde{W}_j^{\,m}\right)$$

so

$$\tilde{A} = \begin{bmatrix} \tilde{q}_{11} & \tilde{q}_{12} & \cdots & \tilde{q}_{1L} \\ \tilde{q}_{21} & \tilde{q}_{22} & \cdots & \tilde{q}_{2L} \\ \tilde{q}_{31} & \tilde{q}_{32} & \cdots & \tilde{q}_{3L} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{q}_{n1} & \tilde{q}_{n2} & \cdots & \tilde{q}_{nL} \end{bmatrix}, \tilde{W} = \left(\tilde{W}_1, \tilde{W}_2, \cdots, \tilde{W}_L\right)$$

(2)Trapezoidal fuzzy number vectors normalized

To eliminate dimensions of evaluation results, the influence of the need of decision matrix for standardized treatment:

$$\bar{q}_{ij} = \begin{cases} \left(\dfrac{a_{ij}}{d_j^{\max}}, \dfrac{b_{ij}}{d_j^{\max}}, \dfrac{c_{ij}}{d_j^{\max}}, \dfrac{d_{ij}}{d_j^{\max}}\right), j \in J_1 \\ \left(\dfrac{a_j^{\min}}{a_{ij}}, \dfrac{b_j^{\min}}{b_{ij}}, \dfrac{c_j^{\min}}{c_{ij}}, \dfrac{d_j^{\min}}{d_{ij}}\right), j \in J_2 \end{cases}$$

Here $d_j^{\max} = \max\{d_{ij}\}$, $a_j^{\min} = \min\{a_{ij}\}$; J_1 represents earnings class indicators (such as security, reliability and other indicators), J_2 represents the cost indexes(such as development costs, program running time and take up the space and other indicators), after normalization as evaluation matrix $\overline{A}$ 。

$$\overline{A} = \begin{bmatrix} \overline{q}_{11} & \overline{q}_{12} & \cdots & \overline{q}_{1L} \\ \overline{q}_{21} & \overline{q}_{22} & \cdots & \overline{q}_{2L} \\ \overline{q}_{31} & \overline{q}_{32} & \cdots & \overline{q}_{3L} \\ \vdots & \vdots & \vdots & \vdots \\ \overline{q}_{n1} & \overline{q}_{n2} & \cdots & \overline{q}_{nL} \end{bmatrix}$$

(3)The decision matrix weighted processing

In the face of different application requirements of the software system, also have different requirements for reliable properties of lay particular stress on. Factor for different applications, also need to decision matrix weighted processing, if the weighted decision matrix to Y, there are:

$$Y = W \otimes A = \begin{bmatrix} w_1\overline{q}_{11} & w_2\overline{q}_{12} & \cdots & w_L\overline{q}_{1L} \\ w_1\overline{q}_{21} & w_2\overline{q}_{22} & \cdots & w_L\overline{q}_{2L} \\ w_1\overline{q}_{31} & w_2\overline{q}_{32} & \cdots & w_L\overline{q}_{3L} \\ \vdots & \vdots & \vdots & \vdots \\ w_1\overline{q}_{n1} & w_2\overline{q}_{n2} & \cdots & w_L\overline{q}_{nL} \end{bmatrix} = \begin{bmatrix} \tilde{Y}_{11} & \tilde{Y}_{12} & \cdots & \tilde{Y}_{1L} \\ \tilde{Y}_{21} & \tilde{Y}_{22} & \cdots & \tilde{Y}_{2L} \\ \tilde{Y}_{31} & \tilde{Y}_{32} & \cdots & \tilde{Y}_{3L} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{Y}_{n1} & \tilde{Y}_{n2} & \cdots & \tilde{Y}_{nL} \end{bmatrix}$$

(4) Calculating the fuzzy ideal indicator set $\tilde{M}^+$ and fuzzy negative ideal indicator set $\tilde{M}^-$

Demand for reliable property L credible constraint indexes in the model, calculating the fuzzy ideal indicator set $\tilde{M}^+$ and fuzzy negative ideal indicator set $\tilde{M}^-$ in n optional plans:

$$\tilde{M}^+ = (\tilde{M}_1, \tilde{M}_2, \cdots \tilde{M}_L), \quad \tilde{M}^- = (\tilde{m}_1, \tilde{m}_2, \cdots \tilde{m}_L)$$

In the formula, $\tilde{M}_j = \max\{\tilde{Y}_{1j}, \tilde{Y}_{2j} \cdots \tilde{Y}_{nj}\}$ and $\tilde{m}_j = \min\{\tilde{Y}_{1j}, \tilde{Y}_{2j} \cdots \tilde{Y}_{nj}\}$ respectively corresponding sets of fuzzy maximum and minimum of weighted values $\tilde{Y}_{ij}$ of j attribute.

(5) Calculating the difference in $\tilde{M}^+$ and $\tilde{M}^-$ requirements

Demand for each feasible scheme X_i, L credible constraints after calculating the weighted normalized index number of fuzzy sets and fuzzy ideal index and fuzzy negative ideal indicator sets the distance between the difference, and said d_i^+ and d_i^-:

$$d_i^+ = \sum_{j=1}^{n} d\left(\tilde{Y}_{ij}, \tilde{M}_j^+\right), d_i^- = \sum_{j=1}^{n} d\left(\tilde{Y}_{ij}, \tilde{M}_j^-\right)$$

(6)Demand Scheme selection decisions

To calculate fuzzy negative ideal solution X_i, relative closeness degree D_k between indices, and the demand plan in accordance with the principle of maximum relative closeness degree of choice, in n feasible alternatives plans $X_1, X_2, X_3, \ldots, X_n$, if the X_K plan is relatively close to the largest degree, is the X_K plan for the best, computation formula of relative closeness degree D_k is as follows:

$$D_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

Summary

In this paper, on the basis of literature research, by building a credible evaluation index system, puts forward a kind of demand analysis technology based on the goal orientation and the trapezoid fuzzy decision-making evaluation model of software requirements selection method. The method is based on the demand goal decomposition to credible evaluation index as constraint, by trapezoidal fuzzy decision-making evaluation model, solve the problems in the software requirements development process needs to choose and make technical personnel to ensure that in the software requirement development demand. In this paper, the proposed method is close to the actual application, choose provides a credible method for software requirements, as in the process of software design for reliable software requirements to implement all-round guarantee provided support.

References

[1] Maiden N. Requirements Critiquing Using Domain Abstractions[C]. Los Alamitos, CA: IEEE Computer Society Press, 1994, 184-193.

[2] ZHI JIN, LU RU-LING,David A.Bell. More sample demand automatically modeling and analysis: A method based on ontology [J].Science of China (Series E), 2003, 33(4):297~312

[3] Howes N. On Using the User's Manual as the Requirements Specification[C]. Los Alamitos CA: IEEE Computer Society Press, 1990, 164-169.

[4] Sommerville I. Software Engineering [M], Boston: Addison-Wesley,2006.

[5] Anton A, Potts C. A representational framework for scenarios of system use[J]. Requirements Engineering Journal, 1998(3): 219–241.

[6] Breitman K, Leite J, Berry D. Supporting scenario evolution[J]. Requirements Engineering, 2005(10): 112–131.

[7] Hull E, Jackson K, Dick J. Requirements Engineering [M]. Springer, 2005.

[8] Kans M. An approach for determining the requirements of computerized maintenance management systems [J]. Computers in Industry, 2008, 59(3): 32–40.

[9]Nilsson V, Fagerstro B. Managing stakeholder requirements in a product modeling system[J]. Computers in Industry, 2006, 57(2):167–177.

[10] Shen H, Wall B, Zaremba M, et al. Integration of business modeling methods for enterprise information system analysis and user requirements gathering [J]. Computers in Industry, 2004,54(4):307–323.

[11]Tran T，Js S，1995. Quality function deployment (QFD): An effective technique for requirements acquisition and reuse [C]. In: Proc. Of the 2nd IEEE Software Engineering Standards Symp. Los Alamitos: IEEE Computer Society Press.

[12]Xiong W， Wang X T， Wu Z X. 2008. Study of a customer satisfaction-oriented model for outsourcing software quality management using Quality Function Deployment (QFD) [C]. 2008 4th International Conference on Wireless Communications，Networking and Mobile Computing，Vols 1-31， 7959-7963，13133.

[13]Karlsson J.Managing software requirements using quality function deployment. Software Quality Journal, 1997(6), 311–325.

[14] ISO/IEC 25010:2011.International Standards Organization[S]. Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- System and software quality models,2011

[15]Kunda L,Brooks D. Applying social-technical approach for COTS selection[J]. In 4th UKAIS conference proceedings: Information systems–The next generation, University of New York,1999,pp: 552-565.

[16] Illa X B, Franch X, Pastor J A. Formalising ERP selection criteria[C]. In Proceedings of the 10th international workshop on software specification and design, Shelter Island, San Diego, California,2000，pp: 115－123.

[17] Ochs M A, Pfahl D, ChrobokG, Nothhelfer-Kolb B. A COTS acquisition process: Definition and application experience[C].In Proceedings of the 11th ESCOM conference, Shaker, Maastricht, 2000 pp: 335-343.

[18] Vanegas L V,Labib A W. A fuzzy quality function deployment (FQFD) model for deriving optimum targets[J]. International Journal of Production Research,2001,1(39), 99-120.

[19]Erol I, Ferrell W G. A methodology for selection problems with multiple,conflicting objective and both qualitative and quantitative criteria[J]. International Journal of Production Economics, 2003, 86, 187–199.

[20] Wei C C, Wang M J. A comprehensive framework for selecting an ERP system[J]. International Journal of Project Management, 2004, 22, 161–169.

[21]YANG HONG, YANG DE-LI. Research on goal-driven modeling method of software architecture [J, Application Research of Computers, 2007, 24(9):16-21.

[22]Shu-Cheng Xiao etc, An Emergency Logistics Transportation Path Optimization Model by Using Trapezoidal Fuzzy, 2014 11th International Conference on Fuzzy Systems and Knowledge Discovery, FSKD 2014, p 199-203