A method for building software credibility metric system based on credible evidence

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Abstract. In order to comprehensively measuring software credibility, a method for establishing credibility metric system is proposed in this paper. The method first determine the structure of the metric system, analysis the relationship between the established credibility evidence structure and the metric system structure. On the basis of correlation analyses result, a reasonable metric system construction method is established.

1. Introduction

As the growing demand for software function, the software system is difficult to control, so software maintenance work is gradually becoming a tough problem, not only software defect and holes are difficult to avoid, but all kinds of software failure and failure problems occur frequently [1]. Furthermore, the application situation is also hard to attain expectations of customers, these problems cause a lot of loss to the customers directly or indirectly [2]. Whether the software is safe and stable, whether it can run successfully and provide users with expected services has become the most concerned issue, named "software credibility problem". The ISO/IEC 15408 standard [3] defines credibility as the behavior of a trusted component, operation, or process that is predictable under arbitrary operating conditions and well resistant to damage caused by applications, viruses, and certain physical disturbances. Credible software refers to its Safety, Reliability, Confidentiality, Integrity, Availability, and Maintainability. According to IEEE 982.1-2005, credibility includes the attributes of reliability, maintainability, availability, security, confidentiality, and integrity [4].

For the credibility evidence of software, the evidence proof process cannot be perfect. Therefore, goal-based assurance and certification has high requirements on the quality of evidence, and the construction of evidence should be able to withstand the review and refutation. Such review and refutation can be attributed to the credibility assessment activity based on evidence. Software reliability evaluation involves many aspects, many problems existing in the field of knowledge, the biggest difficulty is the lack of the corresponding historical data, resulting in the presence of large amounts of uncertainties, such as how importance of the different metrics are, what relationship between metrics, whether credibility analysis results are reliable and so on. Problems above are lack of the corresponding historical data for analysis, therefore, the quantitative evaluation method is of great value and significance.
2. Methodology
Credible evidence, credible metric and credible goal and their corresponding relationship are get together and we call these "credibility evaluation metric system". Credibility evaluation metric system is credible evidence for analysis the degree of software credibility, so solving the quantitative evaluation of credibility is the first step to build the evaluation metric system. Process to build the metric system can be generalized as the figure below.

![Figure 1. Process of metric system construction](image)

First of all, we should make clear the target composition and connotation of the metric system. The evaluation metric system is an information system, which reflects the quantity, scale and quantity level of evaluation objects from multiple perspectives and levels. Every single metric is a system element, and the interrelation among all metrics is the system structure. The evaluation objective is multi-level, and it is important to straighten out the hierarchical relationship to improve the efficiency and effect of evaluation.

2.1. Structural Analysis of Comprehensive Evaluation Metric system
To construct the comprehensive evaluation metric system, the logical relationship and expression form of metrics should be formed at first. In this research, the hierarchical structure is constructed by means of the method of "hierarchical construction of metrics", the hierarchical structure with multi-layer objectives is adopted, and the metric system is divided into "general objective layer - criterion layer - metric layer".

Among this hierarchical structure, the top layer of the metric system is the general objective of the software credibility evaluation, the middle layer is the multi-sub-objective layer of the total objective decomposition, the non-leaf node of the multi-sub-objective layer is the criterion layer, and the leaf node is the metric layer. The criteria layer and the metric layer are different when evaluating whether to utilize the results of other evaluations. The metric layer does not refer to the results of other evaluations, but only evaluates the credibility based on the actual data. The criterion layer does not directly rely on the actual data, but only evaluates the credibility based on the evaluation values of the metric layer and other criteria. The hierarchical structure sample with multi-layer objectives is shown in the figure below.
Hierarchical structure of metrics

General objective layer

Criterion layer

Metric layer

Data layer

Figure 2. Hierarchical construction of metrics

2.2. Measures of Elements in the Comprehensive Evaluation Metric System

The purpose of the evaluation metric system is to analyze the how degree the credible evidence support to the software reliability. The measurement of the top-level target in the metric system can be calculated by the metric value. For different types of metrics, the units of measurement used to represent these metrics and corresponding values are different, so some measures should be normalized for calculation. In view of the differences among various metrics, various metrics need to be converted into forms that can be directly calculated or measured, the relationship between evidence and credibility level should be mapped. A series of evaluation metrics and corresponding calculation formulas and reference criteria are formulated to calculate the metric values.

In this study, the final result of the comprehensive evaluation of software credibility is defined as the credibility grade of the software, which is a quantitative scale of software credibility. According to the credible evidence for users expect trusted attribute and satisfaction of software process, this method gives a model of software credibility grade by views of software users, the model defines that software
credibility can be divided into six levels, and respectively named: unknown A0, available A1, complete A2, confirmed A3, flexible A4, high credible A5. The levels are defined as follows:

- **A0: unknown**
  No evidence of the credibility of the software has been obtained to determine whether the software can meet users' expectations for the credible attributes and software processes of the software. The trust level of the software is defined as A0 unknown.

- **A1: available**
  The fact that the software entity is accessible and can operate in a pattern specified by the software provider implies that the software meets the basic expectations of the user for the software category. The trust level of the software is defined as A1 availability level.

- **A2: complete**
  The complete level of the software means that on the basis of the availability level of the software, the selected trusted attributes can be supported by evidence to prove that these attributes meet the user's expectations and that the functions provided by the software resources can be completed accurately, and the functions of the software can be performed according to the description of the software functions by the software provider.

- **A3: confirmed**
  When the software process is proved to be complete while satisfying the complete level, the software is said to have reached the A3 confirmed level under the current evidence.

- **A4: flexible**
  On the basis of satisfying the confirmed level, this level means that the software not only meets the requirements of users in each selected credible attribute, but also has a good evaluation in structure design and code implementation, so the software resource is considered to have reached A4 flexible level.

- **A5: high credible**
  On the basis of the flexible level, the credibility of the software has passed the authoritative software credibility rating agency. The evaluation conducted according to the specific written evaluation specifications shows that the software can meet the users' high expectations for the trusted attributes of this kind of software, and the users' expected credible attributes have been evaluated by the authoritative agency. The credible level of the software is defined as A5 high credible.

### 2.3. Element Analysis of Comprehensive Evaluation Index System

Based on the merits of Dependability Case, this paper explains how the evidence meets the goal through the evidence to guide the construction of the metric system for the comprehensive evaluation of software credibility, and converts the elements of Dependability Case into the metric system for evaluation, which helps to better explain the rationality and adequacy of the metric system. In this process, the credibility of evidence could be enhanced by providing auxiliary information related to evidence, such as reasonable explanation, background and hypothesis.

In the Dependability Case, arguments and can further include strategy, background, the rationality of interpretation, assumption, sub-goal and so on, strategy provides method for dividing goal into sub-goals, background can be used for explaining the method, the rationality of interpretation provide the reason for the method, assumption is the instructions on certain assumptions and premise condition. This paper converts the goal and solution in the Dependability Case into structural elements in the indicator system to facilitate the next evaluation activity. Therefore, by comparing the comprehensive evaluation metric system structure with the Dependability Case structure elements, the basic principles of the Dependability case-based comprehensive metric system can be preliminarily obtained:

- The top-level overall goal of Dependability Case is directly transformed into the top-level overall goal of the indicator system.
- The Dependability Case argument layer converts the sub-target non-leaf nodes into the criteria layer of the indicator system.
- The leaf nodes in the Dependability Case argument layer are converted into the metric layer of the indicator system.
• Dependability Case evidence layer can provide data basis for the value of indicator layer of the metric system.

A schematic diagram of the transition from Dependability Case element to metric system element of comprehensive evaluation is presented:

![Figure 3. The transition from Dependability Case element to metric system element](image)

Based on the above analysis, the specific construction process of the comprehensive evaluation metric system for software Dependability based on Dependability Case is as follows:

Step 1: Build a Dependability Case
Step 2: Hide the background explanation, rationality explanation, hypothesis and strategy in the structure
Step 3: Determine the metric system according to the basic principle of constructing the software Dependability comprehensive metric system based on Dependability Case.

3. Conclusion

Based on the analysis of the correlation between the software credibility proof system and the evaluation metric system in terms of structure, element configuration and value, this paper puts forward a construction method of the software reliability credibility metric system based on credible evidence. The method hides strategies for explaining and disintegrate objectives, transform remaining objectives and sub-objectives into elements in metric system (including objective layer – criterion layer – metric layer), the transforming process improves rationality and sufficiency of the metric system, lays a foundation for the software credibility evaluation.

References

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