A Quick Test Method Based On Requirements Traceability Matrix
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Abstract. This paper presents a requirement traceability matrix model, which can help to achieve rapid regression test. By combines rapid filtering test case and automated execution case functions to validate effective test performance.

Introduction

Before the software product formal commission, it usually need to go through multiple versions of iterations, and after the product on-line also need to constantly maintain management. This process has a large proportion of the test, especially when the test case base is larger, the repetitive execution of unfiltered test case sets will consume more time and cost. Therefore, to improve the efficiency of regression testing[1] and maintenance is the problem for all software development enterprises.

This paper presents a requirement traceability matrix model, which can be used to quickly filter test cases. Finally, a test management platform based on the requirement traceability matrix model[2] is presented, the platform combines rapid filtering test case and automated execution case functions to validate effective test performance.

Requirements Traceability Matrix Model

Requirements Traceability Relationship

The software requirements specification is one of the most important software process products, and is the baseline for software system compliance. When the requirements specification is extracted and tailored to a specific system requirement, the system requirements can be associated with the software process products by the way of a retrospective relationship[3-4], and system requirements also have a horizontal correlation between each other. A plurality of system requirements and traceability chain together to form the requirement traceability matrix, refer with Fig. 1.

![Figure 1. Requirements traceability chain.](image)

Requirements Traceability Matrix Model

The formal description of the association is described below:

1. The set of test requirements is \( S = \{s_1, s_2, s_3 \cdots \} \), the test demand set is \( R = \{r_1, r_2, r_3, \cdots \} \), the test case set is \( C = \{c_1, c_2, c_3 \cdots \} \), the test record set \( L = \{l_1, l_2, l_3 \cdots \} \), the defect set \( B = \{b_1, b_2, b_3 \cdots \} \);
2. Assuming that there are several test requirements directly related to any system requirements element, and the priority is different, the set of test demand priority coefficients is defined as \( P = \{ p_1, p_2, p_3, \ldots \} \), and \( p \in [0, 1] \); assuming that the test cases directly associated with any test requirements also have several different priorities, the set of test case priority coefficients is defined as \( Q = \{ q_1, q_2, q_3, \ldots \} \), and \( q \in [0, 1] \).

3. Suppose association between the traceability system requirements, testing requirements, to meet the test function, the definition of \( SR = \{ s_1, s_2, s_3, \ldots \} \), and \( RC = \{ r_1, r_2, r_3, \ldots \} \). Then the relationship between the system requirements and the system requirements is horizontally related. Assuming that the degree of closeness of the association is determined by the lateral coupling coefficient, the set of the horizontal coupling coefficients of the matrix is \( H = \{ h_{11}, h_{22}, h_{33}, \ldots \} \), and \( h \in [0, 1] \). The relationship between the elements of the system requirements and the elements is:

\[
\begin{align*}
    s_i &= k_{ij} s_j = k_{j(i+n)} s_{j+n} = \cdots ;
\end{align*}
\]

Based on the above description, the static requirements traceability matrix model[2] shown in Fig. 2:

![Figure 2. Requirements traceability matrix model.](image)

**Through the Traceability Matrix to Achieve Rapid Test**

After the demand traceability matrix is established, if the requirements of software is changed or the defect repair is performed, It is possible to quickly select the test cases of the regression test by the forward association and the reverse association of the demand traceability matrix[6]. The defect repair is the test cases which from the defect back to the system after the reverse, and then from the system needs to be traced back to the implementation.

The method of achieving rapid test by the traceability matrix:

1. From the demand traceability matrix model we can see: \( c_i = q_i RC^{-1}(t_j) = c_i = q_i RC^{-1}[p_j SR^{-1}(s_n)] \), when the function is satisfied, the main influencing factor is \( q_i \) and \( p_j \), so \( q_i \) and \( p_j \) are priority coefficient. Suppose \( X = f(q_i p_j) \), \( X \) is directly related to the priority of the test case, and \( X \) can determine the screening of the test case.

2. At the time of the regression test, static filtering a number of the minimum priority use cases which are longitudinally associated, obtaining the optimal value \( x_0 \) of \( X \) by calculation.

\[
x_0 = \frac{1}{N} \sum_{i=1}^{N} x_i \pm \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \frac{1}{N} \sum_{i=1}^{N} x_i)^2}
\]

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3. By using the greedy algorithm, filtering out the use case set $C' = \{ c \mid \text{all test cases satisfying } x_n \geq x_b \}$, and $C'$ is the set to be tested, which longitudinal association is reduced by the demand traceability matrix.

4. Because the relationship between the system requirements element and the element is: $s_i = k_{ij} s_j = k_{i+jn} s_{j+n}$, so combined the formula: $c_i = q_i p_j S C^{-1}(s_n)$, we can infer the formula: $c_i = q_i p_j S C^{-1}(s_n) = c_i = q_i p_j S C^{-1}[k_{nm}(s_m)]$. So we can see that filtering the horizontally associated system requirements for the application case is also related to $k$.

5. Static filtering a number of the minimum priority use cases which associated system requirements, obtaining the optimal value $y_b$ of $Y$ by calculation:

$$y_b = \frac{1}{N} \sum_{i=1}^{n} y_i \pm \sqrt{\frac{1}{N} \sum_{i=1}^{n} (y_i - \frac{1}{N} \sum_{i=1}^{n} y_i)^2}$$

6. Through the greedy algorithm, filtered out the use case set $C'' = \{ c \mid \text{all test cases satisfying } y_n \geq y_b \}$, and $C''$ is the set to be tested, which horizontal association is reduced by the demand traceability matrix.

7. $C' + C''$ is all the set of test cases to be executed in accordance with the requirements of this round of regression testing.

Based on the above description, the schematic diagram of the quick screening case using the Demand traceability matrix is as follows:

![Figure 3. The schematic of quickly filter test cases.](image)

Conclusions

Based on the researchers [5], this paper talks about the use of requirements traceability matrix to achieve quick test model. This model realizes its quick testing by the vertical correlation between system requirements and the tested products in the process, as well as the horizontal correlation between system requirements.

References


