Research on the Application of Adaptive Genetic Algorithm in Software Unit Security Test Simulation

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Abstract. At present, the security test and simulation of software unit mainly focuses on several links, such as software control structure amelioration, software process alternating quantity model control and model inspection tech, and there are still many shortcomings, such as high missed inspection rate, difficult to effectively guarantee the needs of practice, etc. Based on this, this paper first analyses the purpose and principle of software unit security test and simulation, then studies the utilization of ameliorated genetic algorithm in software unit security test simulation, and finally gives the simulation results analysis of software unit security test based on AGA.

Keywords: Genetic Algorithm, Software Unit, Security Test Simulation

1. Introduction

With the iterative progress and maturity of computer tech, it has been widely and deeply studied and popularized in many fields, especially the continuous amelioration of computer hardware computing power and the continuous amelioration of software, which makes all walks of life more and more inseparable from the assistance of computer tech. As an important part of the computer system, computer software will produce many unknown bugs in the process of writing related software. If the relevant tests are not carried out, it will have a serious threat and impact on the security and security of the system. In order to ensure the safe and reliable operation of computer software system, it is necessary to carry out security testing and Simulation in the process of software development, so as to find various hidden dangers in the software at a lower cost.

With the deepening of computer utilization scenarios and fields, as well as the continuous amelioration of computer software functions, the complexity of software is also constantly improving. In this context, the difficulty of computer software testing and simulation is also increasing. It is urgent to establish an effective balance between the cost of testing and software security, so as to find the vulnerabilities in the software with the minimum cost and effectively ameliorate the security and security of the software. At present, the security testing and Simulation of software unit mainly focus on the amelioration of software control structure, software process alternating quantity model control and model checking tech to realize the effective analysis and control of software security [1]. Although these testing methods can ensure the safety detection property and action of software to a
certain extent, there is still a high miss rate, which is difficult to effectively guarantee the needs of practice.

In view of the practical deficiencies and problems in software unit security testing and simulation, it is urgent to optimize the software unit security testing methods effectively. Genetic algorithm, as a direct operation of structural objects, does not have derivative and function continuity constraints. On the basis of genetic algorithm, further analysis of the similarity between population diversity and adjacent populations, ameliorate mutation operation, can further ameliorate the accuracy of software unit security testing. Therefore, the utilization of ameliorated genetic algorithm in software unit security test simulation has important practical value.

2. The purpose and principle of software unit security testing and simulation

2.1. The purpose of software unit security testing and simulation
According to different users, the objective of software unit security testing and simulation is different. At the software user level, the purpose of test and simulation is to expose the bugs hiding and defects to think over if the product is acceptable [2]. From the perspective of software developers, the purpose of test and simulation is to verify the quality, security and security of software, and find errors through the execution of software programs. It can be seen that the goal of software unit security testing and simulation is to systematically find out the potential errors and defects in the software at the minimum cost [3]. Through the software unit security testing and simulation, it is proved that the function and property and action of the software are consistent with the demanding, and according to the test data gathered from the test, it provides the basis for security analysis.

2.2. Object of software unit security test and simulation
Software unit security testing and simulation runs through the whole period of software definition and development. The object of software unit security testing and simulation includes several aspects as shown in Figure 1 below, and the validity of each link of software development is grasped through confirmation and verification. Secondly, the logical validity of the software in the given external environment is verified through the confirmation link, including the requirement specification confirmation, dynamic and static program confirmation, so as to achieve the logical coordination, completeness and validity in each stage of the software life cycle and between stages.

2.3. Principles of software unit security testing and simulation
The software unit security test and simulation should first take the software test as early as possible and continuously as possible as possible as the principle, and the test case should be composed of the test I/O results. Secondly, in the process of testing and simulation, programmers should avoid checking their own programs. In addition, when designing test cases, reasonable input circumstances and unreasonable input circumstances should be included, and cluster phenomenon in test should be
fully paid attention [4]. Strictly implement the test plan, exclude the stochastic of the test, and comprehensively check each test result, properly save the test plan, test case, error statistics and final analysis report, so as to provide convenience for maintenance.

3. Utilization of ameliorated genetic algorithm in software unit security test simulation

3.1. The concept and characteristics of genetic algorithm
Genetic algorithm has inherent implicit-parallel and better global amelioration ability by directly operating structural objects. It can automatically obtain and guide the amelioration search space, adaptively adjust the search direction, and does not need certain rules. Therefore, it has been widely and deeply studied and applied in many fields as shown in Figure 2. Firstly, genetic algorithm generates an initial population stochastically under a certain coding scheme. Secondly, by the utilization of the corresponding decoding method, the coded individuals are transformed into decision alternating quantity in the problem space, and their fitness values are obtained [5]. In addition, according to the individual fitness value, some individuals with higher fitness value are alternative from the population to form a mating pool, and the individuals in the mating pool are operated by two genetic operators, crossover and mutation, to form a new generation of population. The above steps are iterated until the convergence formula is satisfied.

![Utilization fields of genetic algorithm](image)

3.2. The basic principle of genetic algorithm
As a global probability search algorithm based on natural selection and genetic mutation, genetic algorithm is an iterative method. It starts from the alternative initial solution, and gradually ameliorates the current solution through continuous recurring until the ameliorated solution is finally reached [6]. The iterative calculation process of genetic algorithm organically draws lessons from the evolution mechanism of organisms, and applies the way of natural selection and reproduction to realize the effective diffusion and amelioration of a group of solutions, so as to continuously generate offspring groups with better property and action indicators. Genetic algorithm has strong global amelioration, adaptive and intelligent search characteristics, which can effectively solve nonlinear amelioration problems.

3.3. Software security metrics selection
Ameliorated the traditional AGA, mutation operator which plays an important role in real coded genetic algorithm, in real coded genetic algorithm, mutation operator is no longer as simple as binary coding to recover the loss of diversity in the population [7]. It has become a main search operator. The parameter $P_m$ is defined as the probability of mutation operation, and the recommended value range is $0.01 \sim 0.1$. The utilization of non-uniform variation: set individual $X = x_1 x_2 \cdots x_k \cdots x_k$ as the variation point and its value range is: $[U_{\min}^k, U_{\max}^k]$, after mutation of individual x at this point, a new
individual can be obtained: \( X = x_1 x_2 \cdots x_k \cdots x_i \), among them, the new gene values of mutation point were as follows:

\[
x'_k = \begin{cases} 
 x_k + \left( T_{\text{max}}^k - x_k \right) \cdot \left( 1 - r^{(1-G/T)b} \right) & \text{Random}(0,1) = 1 \\
 x_k - \left( x_k - T_{\text{min}}^k \right) \cdot \left( 1 - r^{(1-G/T)b} \right) & \text{Random}(0,1) = 0 
\end{cases}
\]

(1)

In which, \( \text{Random}(0,1) \) takes any one of 0 and 1 with equal probability; \( r \) is a stochastic number with uniform distribution in the range of \([0,1]\); \( G \) is the current algebra; \( T \) is the termination algebra; \( b \) is the parameter to adjust the mutation step size, which changes dynamically with the evolution algebra \( G \).

3.4. Construction of software security testing model

AGA is used to select software unit security metrics, and the security test model is further confirmed. Secondly, when the network environment is open, a tree model is used to represent the distribution characteristics of software, and three tuples are used to represent the numerical characteristics of software attributes [8]. In addition, we need to further build the measurement granularity that represents software security. After testing software security, we use the security testing model to save the set and universe. Then, the set of security metrics of software security testing model is divided into several subsets to realize the construction of software unit security testing simulation model.

4. Analysis of simulation results of software unit security test based on AGA

4.1. Strategy of software unit security testing and simulation

The software unit security test and simulation based on AGA is the test work of checking the validity of the program module of software design, in order to find various errors that may exist in each module. Unit testing needs to design test cases from the internal structure of the program. Multiple modules can be tested in parallel and independently [9]. In the software unit security testing and simulation, it is necessary to understand the I/O circumstance of the software unit and the logical structure of the module according to the detailed design specification and source program list, so that it can identify and respond to any input. In addition, it is necessary to check whether the existing system security and confidentiality measures of the software unit are effective and whether there are loopholes.

4.2. Analysis of simulation results of software unit security test based on AGA

In order to verify the simulation effect of software unit security test based on AGA, as many test samples as possible are alternative for training, and the security measurement attributes of software unit are determined [10]. The ameliorated AGA is used to obtain the transformation results of population diversity and neighborhood recurring population diversity, as shown in Figure 3 below.

![Figure 3. Population diversity and the results of population diversity transformation of neighbor modern recurring](image-url)
The results show that the population diversity is negatively correlated with the number of recurring, but positively correlated with the similarity between adjacent recurring, which indicates that the security measurement attribute is more appropriate. AGA ameliorates the mutation ability of the algorithm, so that the accuracy of the security test of software unit can be significantly ameliorated.

5. Conclusion
In summary, genetic algorithm has inherent implicit-parallel and better global amelioration ability, and could guide the amelioration of the search space, adaptive adjustment of the search direction, without the need for certain rules. This paper analyzes the object of software unit security testing and simulation by studying the purpose and principle of software unit security testing and simulation. Through the analysis of the utilization of ameliorated genetic algorithm in software unit security test simulation, the concept and characteristics of genetic algorithm are studied. Finally, the simulation results of software unit security test based on AGA are analyzed.

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