Research on Automatic Repair Method of Programming Module based on Semantic Association Relation

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Abstract: Due to the traditional repair methods, when doing the automatic repair of programming module, the heuristic semantic rules are not used to describe the constraints of automatic repair, so the coverage rate of automatic repair is low, and automatic repair of programming module cannot be realized. Aiming at this problem, the automatic repair method of programming module based on semantic correlation is studied. By establishing a set of calling relations between methods, the programming module can extract the constraints of automatic repair. The programming module is used to automatically repair the calculation of semantic correlation degree and retrieve the abnormal constraint information with the highest semantic correlation degree. Using the automatic repair template, the programming module can be automatically repaired based on the semantic association relationship. Simulation experiments were designed, and the results showed that the maximum coverage of the designed repair method could reach 0.873, and the maximum coverage of the control group was only 0.455. The designed repair method was more capable of automatic repair and could realize automatic repair of the programming module.

Keywords: Semantic correlation; Programming module; Automatic repair method; Research

1. Introduction

On the basis of comparing traditional information, Binary Large Object encoding data type is added to the programming module, which is mainly used to represent the scene description, information description and version data information [1]. Due to programmer's negligence and software maintenance and upgrade, the programming module appears abnormal, resulting in the occurrence of phenomenon of defects. This means that higher requirements are put forward for programming module's automatic repair method, which not only needs to describe the defects in the abnormal phenomena, but also needs to automatically repair the defects in the abnormal phenomena through constraint conditions and semantic rules. At present, the domestic study on automatic repair of programming module has been rarely seen, by using the method of stack overflow, foreign scholars investigated the types of constraints in programming module gears, automatically repair through online web site source code, but the method for programming module exception information retrieval precision is low, could not be repaired automatically. This paper proposes a new method of automatic repair of programming module based on semantic correlation. Semantic correlation actually refers to the degree of semantic correlation, and the measurement of similarity is expressed by specific values [2]. As a widely used retrieval method, the most basic and important part of semantic association is to calculate semantic association degree. Semantic correlation in the application of automatic programming module repair is mainly reflected in the semantic characteristics determined by correlation of fuzzy space, which can determine the fuzzy space information characteristics and determine the size of the degree, and then extract the corresponding constraint information for automatic repair of programming module, thus improving coverage of automatic repair of programming module [3].

2. Automatic Repair Method of Programming Module based on Semantic Association Relation

The basic principle of the automatic repair method proposed in this paper is to detect the constraint conditions that throw exceptions in the code based on semantic association relationship, and judge whether there is a correct description in the programming module. If there is no description, the programming module is proved to have defects, and the programming module is automatically repaired through semantic understanding. The overall process of automatic repair method for programming

module based on semantic association relationship is shown in Figure 1.

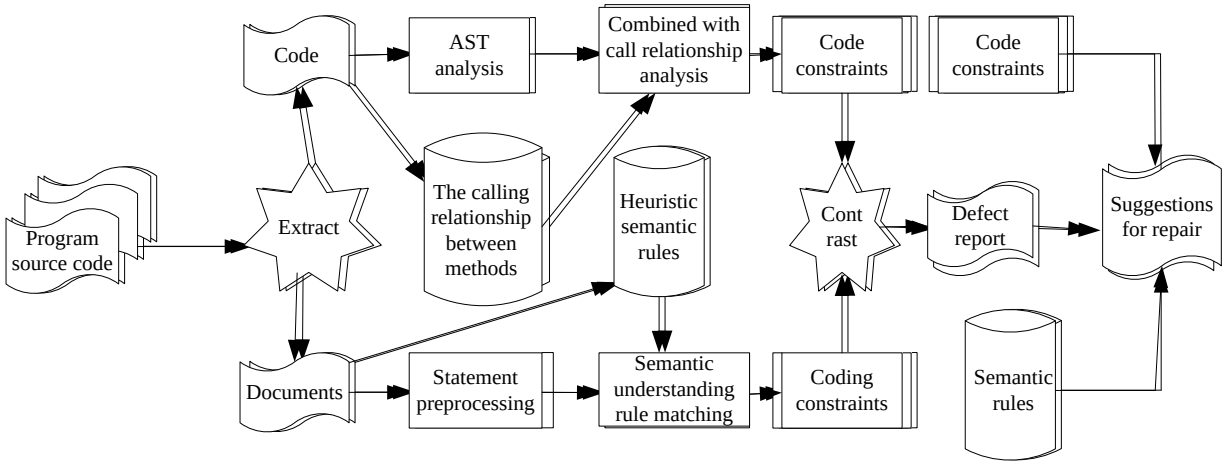

Figure 1. The overall flow of automatic repair method of programming module

Combining with the information in Figure 1, the program static analysis is used to extract the constraint conditions when throwing an exception from the programming module code. The specific code is: eavertlyTypel = = nulle; The programming module is processed to extract the constraint information related to the exception. On this basis, the extracted exception information is compared. If it is inconsistent, the programming module can be automatically repaired by using the constraints extracted from the code according to the relevant semantic rules.

2.1. Extract constraints for automatic repair of programming module

For a programming module, the exception constraints that are thrown exist not only in its own method, but also in the calling method [4]. Therefore, this paper determines the programming module's automatic repair constraint condition through three steps. The first step is to analyze the relationship between the calling method and its own method, and establish the collection of calling relations between methods. Among them, the concrete establishment method of the collection of call relations between methods is as follows: API source code of programming module is analyzed based on semantic association relationship, then abstract syntax tree is extracted through the call hierarchy module of eclipse in semantic association relationship, and call relationship analysis is carried out. The second step is to extract the constraint conditions of the automatic repair method. By traversing the abstract syntax tree, all throw statements in the programming module can be obtained, and relevant exception information can be collected to find the constraint conditions that trigger the exception retrospectively. The extraction algorithm of abnormal constraint conditions in the programming module is shown in Figure 2:

```
1 infoList←
2 if dep ＞ = 0 then
3 foreach stm∈stmList do
/* if stm throws an exception，records all information in a tuple
and add to the list* /
4 if isThrowable( stm) then
5 infoList←infoList∪{ f( m; P; t; c) | P:
6 parameter，t: exceptiontype，c: condition}
/* recursively invoke itself，in case of composite statement
* /
7 else if is Composite( stm) then
8 List subList←( Block) stm: getBody( ) ;
9 infoList←infoList∪expExtractor( subList; dep) ;
/* if the statement contains a method call of n，check the
invoked method recursively* /
10 else if isMethod( stm) ^( stm's args∈m's list) then
/* n is the callee of m in stm* /
11 mList←n: getBody( ) ;
12 infoList←infoList∪expExtractor( mList; dep － 1) ;
```

Figure 2. The schematic diagram of the extraction algorithm of abnormal constraint conditions in the programming module

Combined with the information in Figure 2, extract the abnormal constraint conditions in the programming module. The third step is to consider whether the calling relationship exists and build a complete programming module constraint information [5]. Considering that the description of the abnormal constraint information of the programming module has the natural language characteristics, the following text calculates the semantic correlation degree of the automatic repair of programming module through the semantic correlation relationship, and strives to achieve an accurate description of the abnormal constraint information of the programming module.

2.2. Calculate the semantic correlation degree of the automatic repair of programming module

Based on semantic correlation, this paper calculates the semantic correlation degree of the automatic repair of programming module by the method of statement splitting. Setting the semantic correlation degree of the automatic repair of programming module as c, then its calculation formula, as shown in Formula (1).

$$c = \frac{\sum_{i=1}^{n}(w \times \sum_{k}^{m} w_i \times Min(\mu(x), \mu(y)))}{\sum_{i=1}^{g}(w \times \sum_{k}^{m} w_i \times Max(\mu(x), \mu(y)))} - 10(u^2) \quad (1)$$

In Formula (1), n refers to the information feature vector; i refers to the number of information features, which is real; w refers to the smoothing coefficient of fuzzy semantic space of information features; m refers to the friction coefficient of information feature fuzzy semantic space; k refers to the information feature weight coefficient; g refers to the membership function of information characteristics; μ refers to the dimension of information characteristics; x refers to the Hamming distance abscissa of semantic correlation information features; y refers to the Hamming distance ordinate of semantic correlation information characteristics; u refers to the information feature similarity weight. Through Formula (1), the semantic correlation degree of automatic repair is obtained, and the abnormal constraint information with the highest semantic correlation degree is retrieved [6].

2.3. Realize automatic repair of programming module based on semantic association relationship

On the basis of describing the abnormal constraint information of the programming module through the automatic repair of semantic relevance degree through the programming module, this paper analyzes the automatic repair of sentences by the programming module according to the dependency grammar of sentences and the heuristic semantic rules defined by human. In this paper, the programming module is automatically repaired based on semantic association relationship, and 64 semantic parsing rules are applied, as shown in Table 1.

Table 1. 64 Heuristic semantic rules

Rule type	Semantic description	Number of semantic rules
A null value allowed	The incoming parameter can be null, which has special meaning	18
No null value	The input parameter cannot be empty	20
Type restrictions	Parameters must belong to certain types	10
Limit values	The parameter must be within a certain range	16
Total		64

Combined with Table 1, the 64 heuristic semantic rules, including description objects of various semantics, are adopted to improve the automatic repair coverage of the design method [7]. The specific process of automatic repair of programming module based on semantic correlation is as follows: firstly, the semantic conceptual feature set of programming module is automatically repaired according to the semantic correlation degree of the programming module, and clustering is carried out according to the size of the distribution of feature attributes to form a clustering center. Then, according to the resource distribution in the cluster center, the automatic repair code in the programming module is summarized. Finally, through the automatic repair template to achieve automatic repair of programming module.

Table 2. Automatic repair templates

Rule type	Label	Automatic repair template
A null value allowed	@ param	if［param］be null
No null value	@ param	if［param］be null
Type restrictions	@ throws	if［throws］be null
Value restrictions	@ param	if［param］be null

Combined with table 2, the resulting final auto-fix recommendation is "@throws Null param Exception If data is Null.".

3. Simulation Experiment

3.1. Experimental preparation

In order to construct the simulation experiment, this paper is adopted on the Windows computer system. A total of 7584 source code samples were collected as the experimental object, and Ecldevgsdefsw luna-sr3 was used as the development IDE. The traditional repair method and the repair method designed in this paper were used for the simulation experiment respectively, and the traditional repair method was set as the experimental control group. Simulation verification environment includes: processor Inter (R) Core (TM) Duo CPU; Support wireless private network. The main content of the simulation experiment is to test the automatic repair coverage of the two repair methods, so as to evaluate the repair methods with better repair performance. In this simulation experiment, a total of 10 experiments were conducted. Based on the automatic repair coverage measured by the software Ecldevgsdefsw luna-sr3, the experimental results were recorded to judge the automatic repair capability of the two repair methods for the programming module.

3.2. Analysis of experimental results and conclusions

According to the above designed simulation experiment steps, 10 groups of experimental data were collected, and the automatic repair coverage under the two repair methods was compared. The results of the automatic repair coverage comparison were shown in Table 3.

Table 3. Comparison of automatic repair coverage

Number of experiments	Number of source lines	Control group automatic repair coverage(%)	Automatic repair coverage in the experimental group(%)
01	344	0.425	0.844
02	344	0.386	0.861
03	344	0.455	0.873
04	344	0.369	0.790
05	344	0.289	0.826
06	344	0.301	0.774
07	344	0.392	0.783
08	344	0.377	0.821
09	344	0.328	0.788
10	344	0.358	0.854

The following conclusions can be drawn from table 3: the repair method designed in this paper has a maximum coverage of automatic repair up to 0.873, and the control group only has a maximum coverage of 0.455. The designed repair method has a stronger ability of automatic repair and can realize automatic repair of programming modules. The simulation results show that all the functions of the designed repair method can meet the overall design requirements and can be widely used in the automatic repair of programming modules.

4. Conclusions

The simulation results show that the concrete advantages of semantic correlation in the application of automatic repair of programming modules have emerged. The coverage rate of automatic repair is the main standard to ensure the accuracy of automatic repair of programming module, and the design of automatic repair method for programming module based on semantic correlation can greatly improve the coverage rate of automatic repair. The semantic relational repair method can not only accomplish the task that the traditional repair method can't, but also take semantic relational repair as the core, providing academic significance for the research in the field of automatic repair of programming module. The only disadvantage of this paper is that it does not make an in-depth analysis of the application of semantic correlation in the visual repair of programming modules, which is believed to be one of the key research directions in the field of automatic repair of programming modules in the future.

References

[1] Zhang Xiaoxuan, Zhao Yuwei, Li Tianhui et al. Research on data competitive repair method of multithreaded concurrent program. Digital Technology and Application. 2019, 37(003), 058-059.

[2] Zhou Guoxin, Yang Huishan, Wang Kangkang et al. An automatic method for local vulnerability repair of airborne point cloud data. Digital Technology and Application. 2019, 37(006), 048-051.

[3] Li Zimao, Nie Mengyan, Chen Simin, et al. Bsaed: An entity disambiguation algorithm based on bidirectional semantic association. Journal of South-central University for Nationalities (Natural Science Edition). 2019, 38(004), 584-589.

[4] Zhang Liman, Zhang Xiangxian, Tao Xing, et al. Research on aggregation of academic APP service demand for review semantic relationship. Information Theory and Practice. 2020, 43(001), 155-162.

[5] Tian Zhonglin, Jie Xiaqing, Lu Yueming et al. A short text real-time analysis model based on domain semantic diagram. Data Analysis and Knowledge Discovery. 2020, 04(001), 239-247.

[6] Yuan Zheng. Launch Practical test: X-431 PAD V China general engine online programming introduction - a case study of Buick new excel. Auto Maintenance Technician. 2019, 01(007), 124-125.

[7] Zhang Haiyang, Lu Qi 'an, Zhang Dongdong et al. Efficient modular programming technology with typical features of integral shell segment. Navigation and Control. 2019, 18(005), 035-039 +007.