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Retrieving Similar Code Fragments based on Identifier Similarity for Defect Detection

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ABSTRACT
Similar source code fragments, known as code clones or duplicated code, may involve similar defects caused by the same mistake. However, code clone detection tools cannot detect certain code fragments (e.g. modified after copy-and-pasted). To support developers who would like to detect such defects, we propose a method to retrieve similar code fragments in source code based on the similarity of identifiers between a query and a target code fragment. We present two case studies of similar defects in open source systems.

Categories and Subject Descriptors
D.2.5 [Software Engineering]: Testing and Debugging—Debugging aids and diagnostics; D.2.4 [Software Engineering]: Software/Program Verification—Statistical methods

General Terms
Algorithms, Experimentation

1. INTRODUCTION
Similar code is generally considered as one of factors that make software maintenance more difficult[1, 2, 4]. If developers modify one of similar code fragments, they have to determine whether or not apply the same modifications to the others. Similar code is also called code clone or duplicated code. Developers often introduce similar code by because of various reasons (e.g. “copy-and-paste”)[2, 5]. Especially, large-scale software system, such as Linux, JDK (Java Development Kit), often involves large amount of similar code[4].

Similar code fragments sometimes involve similar defects caused by the same mistake[6, 7]. Therefore, if one of similar code fragments has a defect, it is necessary to inspect the others. Figure 1 is an example of such code fragments in Linux 2.6.6. Those code fragments involve similar defects caused by accessing incorrect pointer (i.e. &prom_phys_total). Because type cast operations (e.g. (char *)) are inserted into the lower fragment, code clone detection tools[1, 2, 4] do not treat those code fragments as a pair of code clones. Hence, even if developers find out that one of those code fragments has a defect and perform code clone detection, they can not detect the other code fragment that has similar defect. We propose a new approach that compares only identifiers to detect such code fragments.

In this paper, we focus on similar defects that are involved in code fragments sharing identifiers with the same name, and we propose a method to retrieve similar code fragments based on identifier similarity.

2. PROPOSED METHOD
As shown in Figure 2, our method accepts a code fragment as a query and retrieves similar code fragments in target source files. The process comprises the three steps as follows.

(1) Lexical Analysis Both the input code fragment and the target source files are translated into token sequences. Then, only identifiers are extracted from each token sequence. Finally, those identifiers are normalized based on several rules (e.g. dividing at underscore, number suffix elimination) and are listed as Identifier Lists.

(2) Comparison We compare the input identifier list with sublists in the target identifier lists. We compute the
The definition of the similarity in our method is shown in Equation 1. Let \( S_i \) be a set of elements in input identifier list \( L_i \), \( S_w \) be a set of elements in the sliding window. Then we define the similarity in our method as % Similarity \( (S_i, S_w) \):

\[
\text{Similarity}(S_i, S_w) = \frac{2 \times |S_i \cap S_w|}{|S_i| + |S_w|}
\]  

Figure 3: Sliding window

In the ranking step, since similar sublists are ranked using the similarity score described above, the code fragments which share more identifiers with the input code fragment are ranked higher in the result. Since the ranking involves a huge number of code fragments, developers may investigate similar code fragments according to their resource.

3. CASE STUDY

We performed two case studies of software systems, Linux 2.6.6 and Canna 3.6[3]. The arch directory of Linux 2.6.6 has two similar defects (see Figure 1). We used the two code fragments as queries and then retrieved similar code fragments to each of them in the arch directory. As a result, in both of those queries, the two code fragments in Figure 1 are detected as the top two code fragments in the similarity ranking. If one of those code fragments is given, we can detect the other one having similar defect.

The server directory of Canna 3.6 has 19 buffer overflow errors. Like the case of Linux, we used the 19 code fragments as queries and then retrieved similar code fragments in the server directory. As a result, in all of those queries, 18 or 19 queried code fragments are ranked in the top 30. If one of those code fragments is given, we can detect the almost the other code fragments having similar defect.

4. CONCLUSION

In this paper, we proposed a method to retrieve similar code fragments based on identifier similarity. In the case studies, by providing a code fragment having a defect, we could detect most of similar defects. We need further case studies on other software systems having similar defects.

Acknowledgments

This research was supported by JSPS, Grant-in-Aid for Scientific Research (A) (No.17200001) and Grant-in-Aid for JSPS Fellows (No.20-1964).

5. REFERENCES