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Selected Papers

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Kang et al. (Eds.)
Opportunities for Foreign Students to Study in Japan
Vitaly Klyuev

Building an Understanding of Major Advertising Strategy on Location Based Digital Signage: A Study of Korean Marketing Practitioners' Practice
Seungchul Yoo*, Kihwan Lee*, Jeongmin Ryoo*, Hong Melling*, and Jooyeon Ryu*

PassPositions-II: Improved Graphical Password Scheme of PassPositions
Gi-Chul Yang

Efficient Parallel K-Means Clustering Algorithm Running on MapReduce
Seung-Hee Kim* and Jun-Ki Min*

An Efficient Parallel Hash Join in NUMA Architecture
Sungjun Choe* and Jun-Ki Min*

Highly reliable blood pressure system during 119 ambulance driving in Korea
Kong, Ha-Sung, Jeon, Jai-In

Authentication Method between Participating Nodes in the Private Blockchain
Jungchul Yeum*, Zhou Qing*, Youngseok Lee*, Inho Ra*

An Automatic Visualization Approach for Vulnerability of Blockchain Code
Bo Kyung Park1, Jihoon Park2, Dohyoung Kim3 and R. Young Chul Kim1*

Performance Comparison of Content Store Replacement Algorithm in VCCN
Seung-Seok Kang*, Eunsoo Shin*, and Hyunhee Yoo*

A Study on the Direction of Technology Introduction of Drone Patrol: Focused on Artificial Intelligence Technology
Choelhee YOON*, Jongcheol PARK**, Jangmook KANG***, Sangwon LEE****

Strategy of Bigdata Center for Medical Service based on Bigdata and Artificial Intelligence
Da Hye CHOI*, Sangwon LEE**, Choelhee YOON***, Jangmook KANG****

A Study on the Relationship among risk factors of big data project via Correlation Analysis work
Seung-Hee Kim*

Design of information generation model for EPC-based collaborative work
Dong-Gi Kim* and Seung-Hee Kim*

A Study on the Integration of Heterogeneous Data Based on Deep Learning and the Imputation of Missing Data
Wooyung Lee1, Jinhee Park2, Bumwoo Park2, GeonUk Kang3 and *Joon Lee1
An Automatic Visualization Approach for Vulnerability of Blockchain Code

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Abstract

The global blockchain market is expected to grow more than 10 times over the next five years. The blockchain paradigm will have popularly been adopting various fields such as finance, logistics, and medical care. However, no one has a technical verification of the reliability, scalability, and stability of the blockchain code. To solve this problem, it will need how to identify the bad quality within blockchain code. In this paper, we propose a method to visualize vulnerability of blockchain code through static analysis. Through the proposed method, we solve the vulnerability problem of blockchain oriented software development (BOSD). This method can also improve the quality of the process.

Keywords: Automatic Visualization, Vulnerability of Blockchain Code, Blockchain Software Quality, Code Quality Factors, Software Visualization, JavaParser

1. Introduction

The global software market has grown to $1148.1 billion. The global software market is expected to further expand due to the effects of the fourth industrial revolution such as smart factories, AI, block chains, autonomous vehicles, and smart robot software. The era of the fourth industrial revolution is the intelligent information society. In this era, data generated through advanced information and communication technologies are merged with new ideas. In other words, converged data and ideas are expected to create new values. The software in the era of the fourth industrial revolution can change according to the intelligent, self-reliant capabilities and circumstances. In the future, software related to the fourth industry will be necessarily integrated with "blockchain technology."

However, some scholars argue for critical opinions on the scalability and stability of the blockchain system. In order to apply the blockchain technology universally, it is necessary to verify the technology realistically. In order to realize high-quality blockchain software and satisfy quality, quality improvement technology of blockchain software is required.

This paper proposes the visualization mechanism for the blockchain code vulnerability visibility system through static analysis. The proposed framework is a static analysis of blockchain created with Java code. The proposed method visualizes the inside of the blockchain code. The advantages of this method are as follows: 1) identify the vulnerabilities inherent in the blockchain system, 2) apply the software engineering method to reduce time, effort, and cost. We explain the visualization system of blockchain based java code. The static analysis tool is an open source, JavaParser. We also apply SQLite to the database and then automatically generate dotscript by combining the information stored in the database. Finally we create the visualization
graph of code vulnerability with Graphviz. Through the proposed method, we solve the vulnerability problem of blockchain software development. This method will improve the quality of the process.

The composition of this paper is as follows. Chapter 2 introduces related works. Chapter 3 describes visualization method of the vulnerability of blockchain based code. Chapter 4 describes a case study. Finally, Chapter 5 mentions the conclusion.

2. Related Works

The previous tool-chain consists of a static analyzer (parser), database, and visualization tools. The static analyzer interprets the information in the source code. The code information is class, method, variable, structure, function, etc. The static analyzer generates the data. These data store the information needed for visualization in the database. To generate dotscript, stored information uses queries. Finally, the visualization tool generates the graph using the retrieved data. Figure 1 shows a structure of previous visualization mechanism.

![Tool-Chain Diagram](image)

**Figure 1. The Structure of Previous Visualization Mechanism**

The existing coupling and cohesion is defined for procedural oriented language. According to Daniel Rodriguez, existing procedural oriented language has no concept of encapsulation, inheritance, polymorphism, etc. Object-oriented concepts are as follows: Objects, classes, components, packages, encapsulation, inheritance, polymorphism, etc. Thus, the existing coupling and cohesion should be redefined based on the characteristics of the object-oriented language.

Figure 2 shows the relationship between coupling and cohesion. Coupling and cohesion are always mentioned in the reusability of software engineering. Good software should have low cohesion and high cohesion. The left figure in Figure 2 is High Coupling, Low Cohesion. In this case, the complexity between the modules becomes extremely high. The right figure shows Low Coupling and High Cohesion. In this case, the complexity between the modules is lowered.
3. Automatic Visualization between Coupling and Cohesion

The block chain system is implemented in various languages. The block chain system is implemented in Java. Go-based block-chain systems are often used in web applications. In this paper, we explain the method of code vulnerability visibility of blockchain system implemented in Java.

Figure 3 shows the automatic visualization framework of java-based blockchain code. This toolchain extracts information from Java code and generates a visualization graph. The proposed visualization framework is as follows: 1) the existing toolchain uses Source Navigator as a static analysis tool. The source Navigator parses the Java code and extracts the SNDB files. However, SNDB files are unreadable binary code. To make reuse easier, we improved JavaParser. The existing Source Navigator can analyze both C and Java. However, there are only six Java code files analyzed. The analyzed files are as follows: cl (Classes), in (Inheritances), iv (Instance variables), lv (Local variables), md (Method definitions). Source Navigator lacks data from static analyzed Java code. To solve this problem, we developed a new static analysis tool using
JavaParser. JavaParser parses into AST structure and extracts necessary analysis data. At this time, the analysis data is reconstructed for storage in the database. Figure 4 shows the structure of Java code analyzed by JavaParser.

![Diagram of AST Structure of Java Code]

**Figure 4. The AST Structure of Java Code**

2) The analyzed results are stored into the database tables. We use the SQLite that is relatively light compared to other databases, extract information stored in the database, and write a DOT script. At this time, a query for extracting necessary data is prepared for each type. This data is generated by the DOT script. 4) We run this data in visualization tools. The analyzed code outputs the visualization graph.

4. Case Study

We expect to build how to guarantee quality of blockchain based on our visualization mechanism. We analyze blockchain code through static analysis of Java code with our extended JavaParser. In the database, we extract the following information: 1) inheritance relationships in all statements, 2) Variable declaration, 3) method declaration, 4) call relation, etc.

Figure 5 compares the information extracted from the source navigator with the information extracted from the JavaParser. The left picture is the Source Navigator. The right figure is JavaParser. The squares on the left are extended to the squares on the right. ATTRIBUTES is divided into ACCESSOR, ABSTRACT, FINAL, STATIC, RETURN_TYPE, and INITIALIZE. In addition, the inheritance information of the SDNB_IN table is added as a column in the JPDB_CLASS table. As a result, we reduced the relation of the database tables. In the figure on the right, the New Quality Indicator Table is the value of the quality index measured using the extended extracted information. Through the extraction results, we derived the improvement results: 1) the number of columns in the database has increased. 2) Visualization information was extracted specifically. 3) New Quality Indicator Table was created.
5. Conclusion

We apply the software engineering method to the block chain software. This paper propose a method to improve the complexity of blockchain software code. There is still a lack of research related to static analysis tools in blockchain codes. Through our visualization mechanism of reverse engineering, we visualized the complexity of the block-chain source code. This method allows static analysis of Java-based blockchain software source code. In addition, we developed static analysis tools suitable for object-oriented code analysis by expanding existing tools. Through a variety of quality indicators, blockchain developers can automatically visualize vulnerabilities in Java-based block-chain code. The advantages of the proposed method are as follows:
1) visualize the code inside. 2) Easily reduce the complexity of the code, and 3) prevent the possibility of bugs in the code. Future studies will analyze other languages used in Smart Contracts (e.g. Lua, Solidity, GO, etc).

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Reference