PONTIFÍCIA UNIVERSIDADE CATÓLICA
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A Blueprint-Based Approach for Prioritizing and Ranking Critical Code Anomalies

TESE DE DOUTORADO

Thesis presented to the Programa de Pós-Graduação em Informática of the Departamento de Informática, PUC-Rio as partial fulfillment of the requirements for the degree of Doutor em Informática

Advisor: Prof. Alessandro Fabricio Garcia

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Abstract

Guimarães, Everton Tavares; Garcia, Alessandro Fabricio, Alessandro Fabrício (Advisor). **A Blueprint-Based Approach for Prioritizing and Ranking Critical Code Anomalies**, 2014. 142p. DSc Thesis - Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Software systems are often evolving due to many changing requirements. As the software evolves, it grows in size and complexity, and consequently, its architecture design tends to degrade. Architecture degradation symptoms are often a direct consequence of the progressive insertion of code anomalies in the software implementation. A code anomaly is a recurring implementation structure that possibly indicates deeper architectural design problems. Code anomaly is considered critical when it is related with a structural problem in the software architecture. Its criticality stems from its negative influence on a wide range of non-functional requirements. For instance, the presence of critical code anomalies hinders software maintainability, i.e. these critical anomalies require wide refactoring in order to remove an architectural problem. Symptoms of architecture degradation have often to be observed in the source code due to the lack of an explicit, formal representation of the software architecture in a project. Many approaches are proposed for detecting code anomalies in software systems, but none of them efficiently support the prioritization and ranking of critical code anomalies according to their architecture impact. Our work investigates how the prioritization and ranking of such critical code anomalies could be improved by using blueprints. Architecture blueprints are usually provided by software architects since the early stages of the system development. Blueprints are informal design models usually defined to capture and communicate key architectural design decisions. Even though blueprints are often incomplete and inconsistent with respect to the underlying implementation, we aim to study if their use can contribute to improve the processes of prioritizing and ranking critical code anomalies. Aiming to address these research goals, a set of empirical studies has been performed. We also proposed and evaluated a set of

heuristics to support developers when prioritizing and ranking code anomalies in 3 software systems. The results showed an average accuracy higher than 60% when prioritizing and ranking code anomalies associated with architectural problems in these systems.

Keywords

Code Anomalies; Architecture Design; Blueprints; Software Metrics; Empirical Studies; Architecture Sensitive Heuristics;

Resumo

Guimarães, Everton Tavares; Garcia, Alessandro Fabricio. **Uma Abordagem Baseada em Blueprints para Priorização e Classificação de Anomalias de Código Críticas**. Rio de Janeiro, 2014. 142p. Tese de Doutorado - Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Sistemas de software estão evoluindo frequentemente devido a diversas requisições de mudanças. A medida que o software evolui, seu tamanho e complexidade aumentam, e consequentemente, sua arquitetura tende a se degradar. Sintomas de degradação arquitetural são por muitas vezes uma consequência direta da inserção progressiva de anomalias de código. Uma anomalia de código é uma estrutura da implementação recorrente que possivelmente indica problemas mais severos no projeto arquitetural. Anomalia de código é considerada crítica quando ela está relacionada problemas estruturais na arquitetura do software. Sua criticidade origina-se da sua influência negativa em uma ampla gama de requisitos não-funcionais. Por exemplo, a presença e anomalias e código críticas dificulta a manutenibilidade e software., ex. uma grande refatoração pode ser necessária para remover um problema arquitetural. Diversas abordagens tem sido propostas para a detecção de anomalias em sistemas de software, mas nenhuma delas suporta eficientemente a priorização e classificação de anomalias de código críticas de acordo com seu impacto na arquitetura. O presente trabalho investiga como a priorização e classificação dessas anomalias críticas de código pode se melhorado com o uso de *blueprints* arquiteturais. *Blueprints* arquiteturais são providos pelo arquiteto de software desde estágios iniciais de desenvolvimento do sistema. *Blueprints* são modelos de projeto informais normalmente definidos para capturar e comunicar as principais decisões de projeto arquitetural. Embora *blueprints* normalmente sejam incompletos e inconsistentes com respeito a implementação do sistema, eles podem contribuir para o processo de priorização e classificação de anomalias de código críticas. Com o intuito de alcançar nossos objetivos de pesquisa, um conjunto de estudos empíricos foram realizados. O trabalho também propõe e avalia um conjunto de heurísticas para auxiliar

desenvolvedores na priorização e classificação de anomalias de código em 3 sistemas de software. Os resultados mostraram uma acurácia média de mais de 60% na priorização e classificação de anomalias de código associadas com problemas arquiteturais nesses sistemas.

Palavras-Chave

Anomalias de Código; Projeto Arquitetural; Blueprints; Métricas; Estudos Empíricos; Heurísticas Sensíveis a Arquitetura;

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