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On the Detection of Architecturally-Relevant Code Anomalies in Software Systems

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. Arndt von Staa
Co-advisor: Prof. Alessandro Fabricio Garcia

Rio de Janeiro
March, 2013



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To my parents and husband

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Abstract

Macía, Isela; Staa, Arndt; Garcia, Alessandro. **On the Detection of Architecturally-Relevant Code Anomalies in Software Systems**. Rio de Janeiro, 2013. 260p. DSc. Thesis – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Code anomalies can signal software architecture degradation. However, the identification of architecturally-relevant code anomalies (i.e. code anomalies that strongly imply architectural deficiencies) is particularly challenging due to: (i) lack of understanding about the relationship between code anomalies and architectural degradation, (ii) the focus on source code anomaly detection without considering how it relates to the software architecture, and (iii) lack of knowledge about how reliable these detection techniques are when revealing architecturally-relevant code anomalies. This thesis presents techniques for identifying architecturally-relevant code anomalies. Architecture-sensitive metrics and detection strategies were defined to overcome the limitations of conventional detection strategies. These metrics and strategies leverage traces that can be established between architectural views and system implementation. The thesis also documents code anomaly patterns (i.e. recurring anomaly relationships) that are strongly related to architectural problems. A tool, called SCOOP, was developed to collect the architecture-sensitive metrics, apply the new detection strategies, and identify the documented code anomaly patterns. Using this tool, we evaluated our technique in a series of empirical studies, comparing its accuracy with that of conventional detection techniques when identifying architecturally-relevant code anomalies.

Keywords

Software Architecture; Architectural Degradation; Code Anomaly; Architecturally-Relevant Code Anomaly.

Resumo

Macía, Isela; Staa, Arndt; Garcia, Alessandro. **Detecção de Anomalias de Código Arquiteturalmente Relevantes em Sistemas de Software**. Rio de Janeiro, 2013. 260p. Tese de Doutorado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Anomalias de código podem sinalizar a degradação da arquitetura de software. No entanto, a identificação de anomalias de código arquiteturalmente relevantes (ou seja, aquelas que implicam em deficiências arquiteturais) é particularmente difícil devido: (i) a falta de compreensão sobre a relação existente entre anomalias de código e degradação arquitetural, (ii) ao fato do processo de detecção de anomalias ter como foco somente o código fonte, sem considerar como ele se relaciona com sua arquitetura, e (iii) a falta de conhecimento sobre a confiabilidade das técnicas de detecção em revelar anomalias de código que são arquiteturalmente relevantes. Esta tese apresenta técnicas para identificar anomalias de código que são arquiteturalmente relevantes. Métricas sensíveis à arquitetura e estratégias de detecção foram definidas para superar as limitações das técnicas de detecção convencionais. Estas métricas e estratégias aproveitam rastros que podem ser estabelecidos entre as visões arquiteturais e a implementação dos sistemas. A tese também documenta padrões de anomalias de código (ou seja, relações recorrentes de anomalias) que estão relacionados com problemas arquiteturais. Uma ferramenta, chamada de SCOOP, foi desenvolvida para coletar as métricas sensíveis à arquitetura, aplicar as novas estratégias de detecção, e identificar os padrões de anomalias de código. Usando esta ferramenta, a técnica proposta foi avaliada em uma série de estudos empíricos, comparando sua acurácia com técnicas convencionais de detecção durante o processo de identificação de anomalias de código que são arquiteturalmente relevantes.

Palavras-chave

Arquitetura de Software; Degradação Arquitetural; Anomalia de Código; Anomalia de Código Arquiteturalmente Relevante.

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