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Towards a Software Metric for OSGi

Graduation Thesis

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Porto Alegre
November 2014

“If I have seen farther than others,
it is because I stood on the shoulders of giants.”
— Sir Isaac Newton

ACKNOWLEDGMENTS

Acknowledgments

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LIST OF ABBREVIATIONS AND ACRONYMS

SMP	Symmetric Multi-Processor
NUMA	Non-Uniform Memory Access
SIMD	Single Instruction Multiple Data
SPMD	Single Program Multiple Data
ABNT	Associação Brasileira de Normas Técnicas

ABSTRACT

Todays software applications are becoming more complex, bigger, dynamic and harder to maintain. One way to overcome modern systems complexities is to build modular applications so we can divide it into small blocks which collaborate to solve bigger problems, the so called *divide to conquer*. Another important aspect in the software industry that helps building large applications is the concept of software quality because its well known that higher quality softwares are easier to maintain and evolve at long term.

The Open Services Gateway Initiative(OSGi) is the *de facto* standard for building Java modular applications but there is no automated way to measure the quality of OSGi systems. In the context of Java applications there are many well known quality metrics and tools to measure application's quality but when we move to Java modular applications where standard quality metrics does not fit or even exist we run out of options.

In this work will be presented a tool called *Intrabundle* that analyses OSGi projects and measure their quality. Its also proposed 6 metrics based on good practices inside OSGi world which are applied to 10 real OSGi projects which vary in size, teams and domain.

Keywords: OSGi, java, quality, metrics, modularity.

RESUMO

As aplicações de software hoje em dia estão cada vez mais complexas, maiores, dinâmicas e mais difíceis de manter. Uma maneira de superar as complexidades dos sistemas modernos é através de aplicações modulares as quais são dividas em partes manores que colaboram entre si para resolver problemas maiores, o famoso *dividir para conquistar*. Outro aspecto importante na industria de software que ajuda à construir aplicações grandes é o conceito de qualidade de software já que é sabido que quanto maior a qualidade do software mais facil de mante-lo e evolui-lo a logo prazo será.

The Open Services Gateway Initiative(OSGi) é o *padrão de fato* para se criar aplicações modulares em java porém não existe forma automatizada de se medir a qualidade de sistemas OSGi. No ambito de aplicações java existem diversas metricas de qualidade e ferramentas para medir a qualidade de softwar mas quando entramos no contexto de aplicações modulares, onde as métricas conhecidas não se encaixam ou não existem, ficamos sem opções.

Neste trabalho será apresentada uma ferramenta chamada *Intrabundle* que analisa projetos OSGi a mede sua qualidade. Ainda seram propostas métricas de qualidade baseadas em boas práticas conhecidas do mundo OSGi que serão aplicadas em 10 projetos reais que variam em tamanho, equipes e domínio.

Palavras-chave: OSGi, java, quality, metrics, modularity.

1 INTRODUCTION

This chapter will drive the reader through the context and motivation of this work followed by the objectives and later the organization of this text is presented.

1.1 Context

One of the pillars of sustainable software development is its quality which can basically be defined as functional or non-functional where the first focuses on how the software meets its specification and how it works accordingly and the second is aimed on how well the software is structured, we can generalize the first as being *external quality* and second as *internal quality*. To measure external quality there is the need to execute the software, also known as *dynamic analysis*, either by an end user accessing the system or an automated process like for example functional testing. There is no known way to assure functional quality without executing the software.

Internal quality however can be verified by either statical analysis that is mainly the inspection of the source code itself or by executing the software like for example automated whitebox testing also known as structural testing(Beizer, 1995).

A well known and successful and way to structure software architecture is to modularize its components. In the Java ecosystem although there is a moving to modularize the JDK with the project Jigsaw(TODO reference) for now the only practical working solution for modular Java applications is OSGi, a component-based and service-oriented framework for building Java modular applications which is the *de facto* standard solution for this kind of software since early 2000's.

In the context of Java modular applications and OSGi there is no way to measure software internal quality which is the main objective of this work.

1.2 Objectives

This work is focused on internal OSGi projects quality mainly because of the following facts:

1. there is no known standard way to measure OSGi internal quality.
2. We already have tools and approaches to measure non OSGi projects internal and external quality.
3. For OSGi applications measuring external quality the classical approaches like automated testing are sufficient.

For measuring OSGi qualities we first will create the metrics based on good practices in the development of OSGi systems so in a second moment we can apply those metrics to real OSGi

projects using a tool called *intrabundle* which was created during this work and also will be presented here. In the end we will analyze the resulting output of intrabundle and analyzed projects qualities and conclude if the metrics we created have value for measuring Java modular applications or not.

1.3 Organization

This text is organized in the following way. First chapter defines the context, motivation and objectives of this work. The second chapter will introduce the main concepts in the area of software quality like quality measurement, quality metrics, program analysis and quality analysis tools. The third chapter will present Java and OSGi, how standard Java and OSGi are different in respect to quality metrics and why we need different metrics for OSGi(TODO - depending it will be merged into chapter two). The fourth chapter presents Intrabundle, a OSGi code introspection tool to measure internal quality, we will see how Intrabundle works, what kind of information it extracts and what metrics it is applying. The fifth chapter will analyses the results intrabundle produces and validate them to decide if this work has a valid contribution or not. The last chapter will present the conclusions and future work on this subject.

2 STATE OF ART

This chapter presents an overview of the concepts and technologies that were studied and used on the development of this work. Section 2.1(TODO reference subsection) introduces general *Software Quality*, 2.2 present the concepts of code *Quality Analysis*, 2.3 introduces the concept of *Software Metric*, 2.4 shows the concept of *Program Analysis* and section 2.5 lists well known *Code Quality Analysis Tools*.

2.1 Introduction

This section will talk about general quality analysis

2.2 Software Quality

This section will talk about software quality - functional quality(performed via automated testing) - structural quality(**this is where our work shines**)

2.2.1 Quality Measurement

2.2.1.1 Code Based Analysis

2.2.1.2 Efficiency

2.2.1.3 Maintainability

2.2.1.4 Other kinds of software Quality Measurement

2.3 Software Metric

2.3.1 Common Software Measurements

2.4 Program Analysis

Program analysis is the process of automatically analyzing the behavior of computer programs. Two main approaches in program analysis are **static program analysis** and **dynamic program analysis**. Main applications of program analysis are program correctness and program optimization.

2.4.1 Dynamic Program Analysis

2.4.2 Static Program Analysis

2.5 Quality Analysis Tools

This section will list most used code quality analysis tools.

3 JAVA AND OSGI

This chapter will talk about Java and OSGi
Java in the context of modular applications(OSGi)

4 INTRABUNDLE - AN OSGI BUNDLE INTROSPECTION TOOL

4.1 Implementation Overview

4.2 Collecting Bundle Data

4.3 Metrics Calculation

5 BUNDLE INTROSPECTION RESULTS

This chapter will make a deep analysis of results and prove that my contribution is valid(or not)

6 CONCLUSION

REFERENCES

ASSENMACHER, H.; BREITBACH, T.; BUHLER, P.; HÜBSCH, V.; SCHWARZ, R. Panda—supporting distributed programming in C++. In: EUROPEAN CONFERENCE ON OBJECT-ORIENTED PROGRAMMING, 7., 1993, Kaiserslautern, Germany. **Proceedings...** Berlin: Springer-Verlag, 1993. p.361–383. (Lecture Notes in Computer Science, v.707).

BAKER, L.; SMITH, B. J. **Parallel programming**. New York: McGraw-Hill, 1996. 381p.

CAROMEL, D.; KLAUSER, W.; VAYSSIERE, J. Towards seamless computing and metacomputing in Java. **Concurrency: Practice and Experience**, West Sussex, v.10, n.11–13, p.1043–1061, Sept./Nov. 1998.

FURMENTO, N.; ROUDIER, Y.; SIEGEL, G. **Parallélisme et distribution en C++**: une revue des langages existants. Valbonne, FR: I3S, Université de Nice Sophia-Antipolis, 1995. (RR 95-02).

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS. **Information Technology—Portable Operating System Interface (POSIX), Threads Extension [C Language]**, IEEE 1003.1c-1995. New York, 1995.

SILBERSCHATZ, A.; PETERSON, J. L.; GALVIN, P. B. **Operating system concepts**. 3.ed. Reading, USA: Addison-Wesley, 1991. 696p.

UTUG. **Página do grupo de usuários TEX da UFRGS**. Disponível em: <http://www.inf.ufrgs.br/utug>. Acesso em: maio 2001.

WILSON, P. C. **Um método ótimo para o preparo de café em laboratório baseado na reciclagem de filtros**. 2001. 123p. Dissertação (Mestrado em Ciência da Computação) — Instituto de Informática, Universidade Federal do Rio Grande do Sul, Porto Alegre.