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Decision Making for the Software Architecture Structure Based on the Criteria Importance Theory

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Abstract

Software architectural decisions have a significant impact on the software development process as well as on the quality of developed software systems. In this paper, the technique that allows selecting the optimal software architecture among several alternatives is proposed. This selection technique is reduced to the criteria importance theory for decision-making problems with a hierarchical criterion structure. For applying it, we need to pick up a set of metrics that assess the characteristics of the software architecture. Next, we need to determine metrics scale and create the hierarchical criterion structure with all the relations between software metric groups. The results allow us making conclusions about usefulness of the proposed technique during architecture design phase for software systems.

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1. Introduction

The formation of architecture is the first and fundamental step in the software design process and provides the framework of a software system that can perform the full range of detailed requirements[1,2].

Most of the existing techniques for constructing a software architecture are not well formalized and are usually not based on any mathematical theory[1]. Therefore, the problem of software architecture selection and analysis based

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on quantitative evaluation is very important. In other words, it would be desirable to have a formalized technique that is based on mathematical theory, and which allows the user to analyze and make decisions when choosing a software architecture or its components.

Several techniques have been proposed to assist software architects in making architecture decisions[3]. There are several groups of such techniques, where some of them focused on architecture trade-off analysis, quality evaluation model analysis, performance optimization and some others well-known techniques[3].

Some other studies propose the usage of the criteria of efficiency and the architecture efficiency metrics for quantitative evaluation of a software architecture structure[4]. The disadvantage of this method is that the components of the architecture efficiency metrics are explicitly defined, and we cannot easily extend them to reflect the required software architecture features.

In this paper, we consider exactly the structural organization of the architecture. In the initial stages of software development there were no standardized approaches for the development of the structural organization of software systems. Those that existed were too much generalized and not very accurate. In consequence of that the development of such systems it is required much more time and financial resources. Usually, highly skilled professionals were required for such development. To reduce the development costs the more formalized techniques began to emerge. This work resulted in the appearance of software design patterns. The patterns later became more complex and some evolved to architectural patterns[2]. Nowadays there are plenty of different design patterns. With the help of these patterns you can build a variety of different architecture alternative, and the question then is how to make a choice among these alternatives. To answer this question there have been proposed different approaches that allows to make such decisions. Unfortunately, most of existing techniques does not well examine architectures' structural organization. Usually they based solely on expert evaluations[3].

We propose a technique that allows us to make architectural decisions when creating structure of a software architecture using set of architectural patterns. In other words, this technique allows us to choose the best structural organization of the software architecture that is build using the architectural patterns.

The proposed technique is based on the so-called criteria importance theory for decision-making problems[5]. It allows decisions to be made when choosing a software architecture system from among several alternatives and lacks the disadvantages that exist with other methods.

2. Selection of optimal architecture

The software architecture is the structure of the system, which comprise software components, the externally visible properties of those components, and the relationships among them[1]. The software architecture is a complex design artefact.

It's a complicated task to make a validation of software architecture at early design stage and it's much easier to rely on tried and tested approaches for solving certain classes of problems. One of the approaches is to use architectural patterns[1,2]. The architectural patterns improve partitioning and promote design reuse by providing solutions to frequently recurring problems. They allow reducing a risk by reusing successful designs with known engineering attributes.

Creating a software architecture based on architectural patterns we need to bear in mind that different architectural patterns are focused on different areas and solve different problems. That is why they might be categorized in several groups. There are several approaches of architectural patterns classification[1,2]. Usually the software isn't limited to a single architectural pattern. It is often a combination of architectural patterns that make up a complete system. For instance, there might be SOA based architecture where some services are designed using layered or *N*-tier architecture approach[1,2].

During the software architecture design stage, there could be obtained several different reference architectures, built using architectural patterns. In this case, there is a problem of comparison and choose the best architecture that is best satisfying the software requirements.

In this paper, we propose the technique that allows selection of the optimal software architecture among several alternatives. This selection technique could be reduced to the criteria importance theory for decision-making problems with a "flat" model of criteria[5] or a hierarchical criterion structure[6]. The use of "flat" model for selecting