



On Inter-Method and Intra-Method Object-Oriented Class Cohesion

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ABSTRACT

Cohesion has been a topic of interest since structured design in the 1970's. Cohesion may also be viewed as a characterization of a system attribute. Today, there are numerous researchers continuing this work into object-oriented designs. Most of the current research has focused on the interaction of methods within a class, the inter-method cohesion. In this paper, we consider both the inter-method cohesion and the intra-method cohesion of a class. We have utilized the concept of program slice (Weiser, 1981) and have extended Functional Cohesion (Bieman & Ott, 1994) to devise a new intra-method cohesion metric, ITRA-C, for measuring cohesion of each method within the class. This intra-method cohesion is based on the notion of effects and chaining in an effect-slice. We further combine the (inter-method, intra-method)-tuple into one combined Class Cohesion, which provides a quick view of bands of cohesion for categorizing classes.

Keywords: object-oriented design; software metrics; software quality; systems evaluation

INTRODUCTION

Developing high quality software continues to be a difficult task. Many attributes may be studied to understand software. Since software engineering is still in a relatively

young stage, applying the “systems approach” as defined by R. L. Ackoff (Ackoff, 1971) where the complete software system is studied in a holistic manner is still a challenge. In this paper, we will focus on a specific software attribute, cohesion, and study

it further through measuring this attribute from an object oriented class perspective. Cohesion has been shown to be an important attribute for good quality software (Bansiya & Davis, 2002; Bieman & Ott, 1994; Briand, Morasca, Basili, 1995). In this paper, instead of the complete software, the object oriented class itself is viewed as the system. Cohesion is an attribute that characterizes connectedness and thus allows us to view a system as a set of connected elements (Checkland, 1981), rather than in separate parts. We pursue an in-depth analysis of this single attribute of the system through the various views of inter and intra method cohesion metrics. We will also show how the cohesion metrics may be used to help us design better object oriented classes. Thus, the value of the paper is not only in extending the concepts of cohesion and the various associated metrics, but also the application of these metrics in guiding us in improving our class, or system, design. This emphasis on engineering software has led to research into measurements for evaluating the quality of software. Low coupling and high cohesion have been identified as attributes of good software design (Bansiya & Davis, 2002; Briand et al, 1994) and a wide number of metrics have been developed to measure these quality attributes. The notion of cohesion has been in existence for several decades (Stevens, et al 1974; Yourdon & Constantine, 1979). These early papers introduced the concept of "functional relatedness" of modules. The relatedness among modules was called coupling and the relatedness within a module was called cohesion. Relatedness itself is an abstract concept which asks if items belonged together. Intuitively, those that "belonged" together ought to be designed into one entity. This made sense, especially, for the follow-on maintenance people who

had to understand and make modifications to the design and the code. That is, if the "related" entities are spread across the system, then it is more difficult to find them. As Checkland (1981) advocates, a system should be thought of as a connected set of elements rather than separate parts. Other than the now well known seven levels of cohesion (coincidental, logical, temporal, procedural, communicational, sequential, and functional), which defined ordered categories of cohesion, there was not a numeric metric for modular cohesion in those early days. Bieman and Ott (1994) and Bieman and Kang (1995; 1998) introduced numeric metrics based on program slices to gauge "relatedness," or cohesion.

Following the same concept of relatedness, there are several metrics designed to measure cohesion of an object-oriented class. Briand et al. (1994; 1998), Hitz and Montazeri (1995), Chidamber and Kemerer (1994), Bansiya and Davis (2002), Counsel et al. (2006), Henderson-Sellers (1996), Bonja and Kidanmariam (2006), Chae et al. (2004), and Zhou et al. (2002; 2004) have proposed different approaches to measuring cohesion in an object oriented class. For the most part, these metrics all revolve around the notion of relatedness of the methods in a class. The relatedness of the methods is primarily gauged by the amount of and the type of sharing of the attributes, or data. The methods in a class are considered more cohesive if the amount of or type of (or both) sharing of attributes is higher. Also, the amount of interaction among methods in the form of method evocation of other methods in the class is considered an important factor for cohesion among methods in a class. That is, the connectedness of the methods is considered important. But, still, whether each individual method itself is cohesive

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