

Capturing and Replaying Architectural Knowledge through Derivational Analogy

Ibrahim Habli

Tim Kelly

Department of Computer Science

University of York

{Ibrahim.Habli, Tim.Kelly}@cs.york.ac.uk

Abstract

The architecture definition activity of complex systems is intellectually intensive – consuming much of the design time and budget. Rather than being regarded merely as a collection of views, software architecture can also be regarded as a collection of design decisions, such as tactics and design patterns, which are embodied in the architectural process. Therefore, the reuse of the architecture would be naïve if only carried out based on the architectural views, i.e. without regard to the design reasoning behind the architectural process. In this paper we review an approach to defining new software architectures through the use of derivational analogy, i.e. by replaying the process, sequence of decisions, behind the definition of a previously defined architecture. We conclude that, without the design reasoning, the reuse of the architecture would be a risky process, which can violate original design assumptions and dependencies.

1. Introduction

Most of human knowledge is acquired through analogy. Although it does not provide conclusive understanding, analogy may be considered one of the best feasible scientific means that establish confidence, but with a degree of probability [1]. For example, analogy is a fundamental problem solving device that is used by engineers to solve new problems based on knowledge and experience with solutions of similar past problems.

Software design, architecture definition in particular, can be regarded as a form of software construction knowledge. To this end, analogies can be drawn between previously designed and implemented software and new software. In software architecture, design knowledge is typically exemplified by the use of architectural tactics, design patterns, assumptions, alternatives and constraints [5, 7]. In addition to the need for different architectural views, it is necessary to articulate explicitly the design decisions, such as tactics and design patterns, which are typically embodied in the architectural process [10]. To this end, the reuse of the architecture would be incomplete if only carried out based on the architectural views, i.e.

without regard to the design reasoning behind the architectural process. In this paper, we address the reuse of architectural knowledge through the use of derivational analogy. Specifically, we employ the derivational analogy concept in the design of a new architecture by replaying the architectural process of a previously defined and validated architecture.

The rest of the paper is structured as follows. Section 2 and 3 compare and contrast two widely used approaches to establishing an analogy: transformational analogy and derivational analogy [2]. Section 4 presents a process for capturing and representing architecture knowledge. Next, Section 5 presents a design of a new architecture by replaying the architectural reasoning process, through the retrieval, analysis and adaptation of the architecture knowledge captured in Section 4. The paper concludes with a discussion of the suitability and practicability of applying derivational analogy to the capturing and replaying of the architectural reasoning.

2. Transformational Analogy

Transformational analogy is a straightforward concept. If a solution has successfully solved an earlier problem, it can be applied to solve a *similar* problem as long as the two problems share a number of *relevant elements*. In the context of architecture design, the application of transformational analogy means copying the architectural design solutions from a past design and reapplying them to a new design problem as long a sufficient number of relevant goals and conditions exist between the two design problems.

An obvious advantage of transformational analogy is the improvement in the efficiency, in terms of cost and time, of solving a design problem. By reusing a trustworthy past design solution, architects and designers need not reason beyond showing similarity and relevance between the new and old design problem. In such a case, the payoff of design reuse can be expected to be high. However, the cost-effectiveness of the design should not be regarded in isolation from other integral aspects such as design integrity and accuracy. Such aspects cannot be proven without regard to (1) the assumptions and justifications behind the design steps and the

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Intelligent Computing in Engineering and Architecture Ian F.C. Smith, 2006-11-23 This book constitutes the thoroughly refereed proceedings of the 13th Workshop of the European Group for Intelligent Computing in Engineering and Architecture EG ICE 2006 held in Ascona Switzerland in June 2006 The 59 revised full papers were carefully reviewed and selected from numerous submissions for inclusion in the book All issues of advanced informatics are covered including a range of techniques

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Issues and Applications of Case-Based Reasoning to Design Mary Lou Maher, Pearl Pu, 2014-02-25 Design is believed to be one of the most interesting and challenging problem solving activities ever facing artificial intelligence AI researchers Knowledge based systems using rule based and model based reasoning techniques have been applied to build design automation and or design decision support

systems Although such systems have met with some success difficulties have been encountered in terms of formalizing such generalized design experiences as rules logic and domain models Recently researchers have been exploring the idea of using case based reasoning CBR techniques to complement or replace other approaches to design support CBR can be considered as an alternative to paradigms such as rule based and model based reasoning Rule based expert systems capture knowledge in the form of if then rules which are usually identified by a domain expert Model based reasoning aims at formulating knowledge in the form of principles to cover the various aspects of a problem domain These principles which are more general than if then rules comprise a model which an expert system may use to solve problems Model based reasoning MBR is sometimes called reasoning from first principles Instead of generalizing knowledge into rules or models CBR is an experience based method Thus specific cases corresponding to prior problem solving experiences comprise the main knowledge sources in a CBR system This volume includes a collection of chapters that describe specific projects in which case based reasoning is the focus for the representation and reasoning in a particular design domain The chapters provide a broad spectrum of applications and issues in applying and extending the concept of CBR to design Each chapter provides its own introduction to CBR concepts and principles

Integrated Case-based Reasoning for Structural Design Stanford University. Center for Integrated Facility Engineering, Jenmu Wang, 1991 Civil and Structural Engineering Computing: 2001 B. H. V. Topping, 2001 Includes invited lectures presented at The Eighth International Conference on Civil and Structural Engineering Computing and The Sixth International Conference on the Application of Artificial Intelligence to Civil and Structural Engineering held in Eisenstadt Vienna Austria between 19-21 September 2001

Case-Based Reasoning Research and Development Klaus-Dieter Althoff, Ralph Bergmann, Luther Branting, 1999-07-14 The biennial International Conference on Case Based Reasoning ICCBR series which began in Sesimbra Portugal in 1995 was intended to provide an international forum for the best fundamental and applied research in case based reasoning CBR It was hoped that such a forum would encourage the growth and rigor of the field and overcome the previous tendency toward isolated national CBR communities The foresight of the original ICCBR organizers has been rewarded by the growth of a vigorous and cosmopolitan CBR community CBR is now widely recognized as a powerful and important computational technique for a wide range of practical applications By promoting an exchange of ideas among CBR researchers from across the globe the ICCBR series has facilitated the broader acceptance and use of CBR ICCBR 99 has continued this tradition by attracting high quality research and applications papers from around the world Researchers from 21 countries submitted 80 papers to ICCBR 99 From these submissions 17 papers were selected for long oral presentation 7 were accepted for short oral presentation and 19 papers were accepted as posters This volume sets forth these 43 papers which contain both mature work and innovative new ideas

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B. H. V. Topping, 2000 Includes invited lectures presented at The Fifth International Conference on Computational Structures Technology and The Second International Conference on Engineering Computational Technology held in Belgium September 2000 It includes contributions from KJ Bathe JL Chenot D Chapelle C Cinquini M Cross G De Roeck and many others

Finite Element Mesh Generation B. H. V. Topping, 2004 This book describes both structured and unstructured mesh generation techniques Structured mesh generation is covered briefly and the algebraic multi block technique is discussed in more detail The main part of the book covers unstructured mesh generation using the advancing front paving and Delaunay techniques The Delaunay method is described in two and three dimensions Both theoretical and implementation issues are discussed in detail An integrated framework that is used for the two dimensional unstructured methods is also described Common features of the framework include accurate control over mesh size boundary refinement procedures and postprocessing tasks such as smoothing Methods to convert triangular meshes to quadrilateral meshes are also presented Mesh quality of the different mesh generation procedures is addressed with some examples The book will be of interest to engineers computer scientists and mathematicians working on mesh generation and finite element methods The C source

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