Discovering, Visualizing, and Controlling Software Structure

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1. Introduction

Although many good principles, methods, and notations for large system design have been developed in the last two decades, they have seen little application to software-system maintenance. The reasons seem to be the large cost and the diminishing value of writing specifications after the code already exists. This paper describes research that is attempting to bridge the gap between software design and software maintenance. The MAINTAINER'S ASSISTANT project at Siemens Research is researching ways to make the software maintainer more productive, in part by helping him contend with the enormous amounts of information in the project database. A sub-project, ARCH[1], is developing a new approach to controlling the structure of a large software system during maintenance. The approach assumes that a large body of code may already exist before the structure is formally specified. The ARCH methodology includes

- a practical notation for specifying software structure,

- a graph editor to help the architect visualize and construct the specification,

- a tool that extracts the actual structure of a system and compares it to the specification, and

- an automatic classification tool that helps an architect analyze existing code to discover an appropriate structure specification.

This paper describes the specification method used in ARCH, the *condensation* method that aids visualization, and the classification tool, which uses *conceptual clustering* to help the architect discover the structure of the system. The clustering is based on detailed cross-reference information, which we hypothesize provides useful "light semantic" profiles of the parts of a system. The paper includes preliminary results from some experiments in analyzing a real system, and describes the full-scale experiment we plan to carry out next.

2. How ARCH Will Be Used

The focal point of ARCH is an architecture specification that documents the intended structural design of a large program, and controls its evolution. We use the term "architecture" to refer to structural aspects of the program, and not its function.[2] The structure of a program is the set of connections between software units. The architecture is a set of *allowed* connections. ARCH controls the structure by checking the actual connections to see if they are allowed. This checking is incorporated in the system building process, so that errors are reported to the programmer as early as possible.

Typically, the structure of a system contains far too many connections for the architecture to list each of them individually. Instead, the architecture specifies a subsystem tree that places software units in groups, and those groups in larger groups, and so on. Then, the set of allowed connections can include connections between groups, as well as individual units.

Keeping the specification separate from the code distinguishes "what is allowed" from "what is". The architecture permits a large set of possible structures that are equally acceptable from the point of view of the overall design. The import/export clauses in the code of, say, an Ada program, describe only the current structure of the actual code.

This distinction is very useful for coordinating teams of programmers. An individual programmer is expected to take advantage of as much existing code as possible, by importing it into his modules and invoking its procedures, types, and so on. Therefore, he is authorized to modify his import/export clauses to fit the needs of his code.

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[1] The name is drawn from "architecture" and from bridging the gap between design and maintenance.

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[2] Reasonable persons might disagree with our choice of terms. Nonetheless, the need to control structure is apparent.

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Alistair Sutcliffe

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   Fifth International Workshop on Software Specification and Design International Workshop on Software Specification and Design,1989   *Proceedings* International Workshop on Software Specification and Design (5, 1989, Pittsburgh, Pa.),1989   **Proceedings of the Fifth International Workshop on Software Specification and Design** ,1999   **Proceedings of the Fifth International Workshop on Hardware/Software Co-Design (Codes/CASHE '97)** ,1997 Contains papers from the March 1997 workshop in sections on scheduling and allocation target architectures and debugging optimization communication issues synthesis of run time environments modeling and simulation acceleration and trading off hardware and software Topics include interface optimization during hardware software partitioning software architecture synthesis for retargetable real time embedded systems software acceleration using coprocessors and an evolutionary approach to system level synthesis No index Annotation copyrighted by Book News Inc Portland OR

   Business Modeling and Software Design Boris Shishkov,2012-04-23 This book contains the extended and revised versions of eight of the ten full papers out of 58 submissions presented at the First International Symposium on Business Modeling and Software Design BMSD 2011 held in Sofia Bulgaria The theme of BMSD 2011 was Business Models and Advanced Software Systems and the related scientific areas of interest were business models and requirements business models and services business models and software and information systems architecture   *Fifth International Workshop on Software Specification and Design* ,1989   **Proceedings** ,1989   Proceedings ,1989   *Z User Workshop, York 1991* J. E. Nicholls,2012-12-06 In ordinary mathematics an equation can be written down which is syntactically correct but for which no solution exists For example consider the equation x x 1 defined over the real numbers there is no value of x which satisfies it Similarly it is possible to specify objects using the formal specification language Z 3 4 which can not possibly exist Such specifications are called inconsistent and can arise in a number of ways Example 1 The following Z specification of a functionf from integers to integers f x 1 x O fx x 1 i f x 1 x O fx x 2 ii is inconsistent because axiom i gives f 0 1 while axiom ii gives f 0 2 This contradicts the fact that f was declared as a function that is f must have a unique result when applied to an argument Hence no suchfexists Furthermore iff 0 1 andfO 2 then 1 2 can be deduced From 1 2 anything can be deduced thus showing the danger of an inconsistent specification Note that all examples and proofs start with the word Example or Proof and end with the symbol 1   Z User Workshop, Oxford 1990 J.E. Nicholls,2013-11-11   The Fifth International Workshop on Rapid System Prototyping Nick Kanopoulos,1994 Proceedings of the June 1994 workshop presenting 25 papers on models for system simulation emulation in a hierarchical sense software to hardware mapping software prototyping and validation prototyping environments of hardware simulators and experiences from specific system prototyping projects Lacks an index Annotation copyright by Book News Inc Portland OR   **Object-oriented Technology For Database And Software Systems** V S Alagar,Rokia Missaoui,1995-09-28 Object orientation has become a must know subject for managers

researchers and software practitioners interested in the design evolution reuse and management of efficient software components The book contains technical papers reflecting both theoretical and practical contributions from researchers in the field of object oriented OO databases and software engineering systems The book identifies actual and potential areas of integration of OO and database technologies current and future research directions in software methodologies and reflections about the OO paradigm In providing current research and relevant information about this promising and rapidly growing field of object oriented databases and software engineering systems this book is invaluable to research scientists practitioners and graduate students working in the areas of databases and software engineering **VDM '91. Formal Software Development Methods. 4th International Symposium of VDM Europe, Noordwijkerhout, The Netherlands, October 21-25, 1991. Proceedings** Søren Prehn,W. J. Toetenel,1991 The proceedings of the fourth Vienna Development Method Symposium VDM 91 are published here in two volumes Previous VDM symposia were held in 1987 LNCS 252 1988 LNCS 328 and 1990 LNCS 428 The VDM symposia have been organized by the VDM Europe formed in 1985 as an advisory board sponsored by the Commission of the European Communities The VDM Europe working group consisted of reasearchers software engineers and programmers all interested in prommoting the industrial usage of formal methods for software development The fourth VDM symposium presented not only VDM but also a large number of other methods for formal software development Volume 1 contains the conference contributions It has four parts contributions of invited speakers papers project reports and tools demonstration abstracts The emphasis is on methods and calculi for development verification and verification tools support experiences from doing developments and the associated theoretical problems Volume2 contains four introductory tutorials on LARCH Refinement Calculus VDM and RAISE and four advanced tutorials on ABEL PROSPECTRA The B Method and The Stack They present a comprehensive account of the state of the art PUBLISHER S WEBSITE **Perspectives on Software Requirements** Julio Cesar Sampaio do Prado Leite,Jorge Horacio Doorn,2012-12-06 Perspectives On Software Requirements presents perspectives on several current approaches to software requirements Each chapter addresses a specific problem where the authors summarize their experiences and results to produce well fit and traceable requirements Chapters highlight familiar issues with recent results and experiences which are accompanied by chapters describing well tuned new methods for specific domains **Internetware** Hong Mei,Jian Lü,2016-12-01 This book presents a comprehensive introduction to Internetware covering aspects ranging from the fundamental principles and engineering methodologies to operational platforms quality measurements and assurance and future directions It also includes guidelines and numerous representative real world case studies that serve as an invaluable reference resource for software engineers involved in the development of Internetware applications Providing a detailed analysis of current trends in modern software engineering in the Internet it offers an essential blueprint and an important contribution to the research on software engineering and systems for future Internet computing **Proceedings, Fifth**

International Software Metrics Symposium, Metrics 1998 ,1998 Partial Contents Architectural Metrics Program Understanding Program Analysis Software Process Improvement Error Models Object Oriented Measures Program Management Measures Formal Models Testing Measures   *Software Engineering with Computational Intelligence* Jonathan Lee,2013-11-11 It is not an exaggeration to view Professor Lee s book Software Engineer ing with Computational Intelligence or SECI for short as a pioneering contribution to software engineering Breaking with the tradition of treat ing uncertainty imprecision fuzziness and vagueness as issues of peripheral importance SECI moves them much closer to the center of the stage It is ob vious though still not widely accepted that this is where these issues should be since the real world is much too complex and much too ill defined to lend itself to categorical analysis in the Cartesian spirit As its title suggests SECI employs the machineries of computational intel ligence CI and more or less equivalently soft computing SC to deal with the foundations and principal issues in software engineering Basically CI and SC are consortia of methodologies which collectively provide a body of con cepts and techniques for conception design construction and utilization of intelligent systems The principal constituents of CI and SC are fuzzy logic neurocomputing evolutionary computing probabilistic computing chaotic computing and machine learning The leitmotif of CI and SC is that in general better performance can be achieved by employing the constituent methodologies of CI and SC in combination rat her than in a stand alone mode In what follows I will take the liberty of focusing my attention on fuzzy logic and fuzzy set theory and on their roles in software engineering But first a couple of points of semantics which are in need of clarification   **User-Centred Requirements Engineering** Alistair Sutcliffe,2012-12-06 If you have picked up this book and are browsing the Preface you may well be asking yourselfWhat makes this book different from the large number I can find on amazon com Well the answer is a blend of the academic and the practical and views of the subject you won t get from anybody else how psychology and linguistics influence the field of requirements engineering RE The title might seem to be a bit of a conundrum after all surely requirements come from people so all requirements should be user centred Sadly that is not always so many system disasters have been caused simply because requirements engineering was not user centred or worse still was not practised at all So this book is about putting the people back into com puting although not simply from the HCI human computer interaction sense instead the focus is on how to understand what people want and then build appropriate computer systems   *Handbook of Software Engineering & Knowledge Engineering* Shi Kuo Chang,2002 This is the first handbook to cover comprehensively both software engineering and knowledge engineering two important fields that have become interwoven in recent years Over 60 international experts have contributed to the book Each chapter has been written in such a way that a practitioner of software engineering and knowledge engineering can easily understand and obtain useful information Each chapter covers one topic and can be read independently of other chapters providing both a general survey of the topic and an in depth exposition of the state of the art Practitioners will find this handbook useful when looking for solutions to practical

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In a digital era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its power to stir emotions, provoke thought, and instigate transformation is truly remarkable. This extraordinary book, aptly titled "**Fifth International Workshop On Software Specification And Design**," written by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we will delve into the book is central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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