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软件演化过程建模

An Approach to Modelling Software Evolution Processes

Tong Li

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Springer

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An Approach to Modelling Software Evolution Processes

An Approach to Modelling Software Evolution Processes describes formal software processes that effectively support software evolution. The importance and popularity of software evolution increase as more and more successful software systems become legacy systems. For one thing, software evolution has become an important characteristic in the software life cycle; for another, software processes play an important role in increasing efficiency and quality of software evolution. Therefore, the software evolution process, the inter-discipline of software process and software evolution, becomes a key area in software engineering.

The book is intended for software engineers and researchers in computer science.

Prof. Tong Li earned his Ph.D. in Software Engineering at De Montfort University, U.K.; he has published five monographs and over one hundred papers.

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内 容 简 介

软件演化是近年来软件工程领域正逐步受到重视的研究方向，并将得到越来越多的关注。本书从软件演化管理的角度，较为系统地讨论了软件演化过程的相关问题，包括软件演化过程元模型、软件演化过程描述语言、软件演化过程框架、软件演化过程建模方法、软件演化过程改进等。本书还给出了一个软件演化过程的支撑工具，并提供了多个案例研究。

本书可以作为计算机专业研究生和高年级本科生的教材和教学参考书，也可供从事软件工程的科技人员使用和参考。

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To my daughter, Yixiao, my wife, Lixia and my parents with all my love.

Preface

The importance and popularity of software evolution increase as more and more successful software systems become legacy systems. For one thing, software evolution has become an important characteristic in the software life cycle; for another, software process plays an important role in increasing efficiency and quality of software evolution. Therefore, the software evolution process, the inter-discipline of software process and software evolution, becomes a key area in software engineering. A well-managed software evolution process can effectively support a successful software evolution; however, a poor software evolution process will lead to the failure of the corresponding software evolution.

What Is the Uniqueness of This Book?

This book aims to model and describe formal software processes that effectively support software evolution. For this purpose, progress has been made in the following aspects:

Firstly, five important properties of software evolution processes are analysed. It is indicated that iteration, concurrency, interleaving of continuous and discontinuous change, feedback-driven systems and multi-level frameworks play important roles in software evolution processes.

Secondly, a Petri Net is extended with object-oriented technology and Hoare Logic. Based on the extended Petri Net and according to the preceding properties, a formal evolution process meta-model EPMM is designed. EPMM can define software evolution process models with a four-level framework and can embody some important properties, such as iteration, concurrency, interleaving of continuous and discontinuous change and feedback-driven systems.

Thirdly, based on EPMM, an object-oriented evolution process description language EPDL is designed. It is more detailed and easier to implement in computers than EPMM.

Fourthly, based on EPMM, the framework of software evolution processes is discussed. According to the framework, a semi-formal approach to modelling and describing software evolution processes is proposed. The approach is used to design software evolution processes at the global level (designing global models), at the process level (designing software processes), at the activity level (designing activities) and at the task level (designing tasks), each corresponding to the levels in the framework. At the process level, the approach supports top-down white box modelling and top-down black box modelling, which are proved to preserve the interface consistency over refinement hierarchies. The approach also supports process reuse by means of three different reuse methods. At the task level, by repeatedly decomposing the function of a task into one of three basic control structures, the function can be decomposed into a code segment consisting of finer functions, which can be easily realised. If the executions of all the decomposed finer functions terminate, the decomposition is proved to be totally correct. Using EPDL, software evolution processes can be described in detail.

Fifthly, according to the dependence analysis between activities and between tasks, an approach is proposed to capture and extend concurrency in an inefficient process segment dug down from an evolution process model. After its efficiency is improved, the process segment is put back into the original model to improve the efficiency of the corresponding evolution process.

Sixthly, a CASE environment EPT that supports the proposed approach is designed and a prototype system of EPT is also implemented.

Finally, four case studies of various complexities and scales indicate that the proposed approach is feasible and effective.

In summary, a semi-formal approach is proposed to construct formal software evolution process models and the corresponding descriptions to effectively support software evolution.

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research project. I feel so lucky to have so many opportunities to discuss with him.

I am very happy that I have had the chance to research on software evolution processes in the Software Technology Research Laboratory at De Montfort University, U.K. The laboratory has such a unique academic atmosphere that I had numerous opportunities to interact with many excellent staff and Ph.D. students. My thanks must go to Professor Hussein Zedan, the Director of the laboratory, for this atmosphere, his valuable advice and the experienced guidance that he had provided along the way. In addition, I would like to thank Professor Hong Zhu, Oxford Brookes University, U.K., Dr. Martin Ward and Dr. Antonio Cau, De Montfort University, U.K. for their valuable suggestions concerning my research work.

I also wish to express many thanks to Dr. Juan F. Ramil, Open University, U.K. and Dr. Douglas R. Smith, Kestrel Institute and Stanford University, U.S.A. for providing me with their papers "Software Evolution and Software Evolution Processes" and "Top-Down Synthesis of Divide-and-Conquer Algorithms" respectively, by e-mail.

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Finally, I wish to express thanks to my daughter, Yixiao Li, my wife, Lixia Wang, and my parents for all their love, encouragement, patience and support over the years. This book is dedicated to them.

Tong Li
January, 2008

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