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软件工程

实践者的研究方法

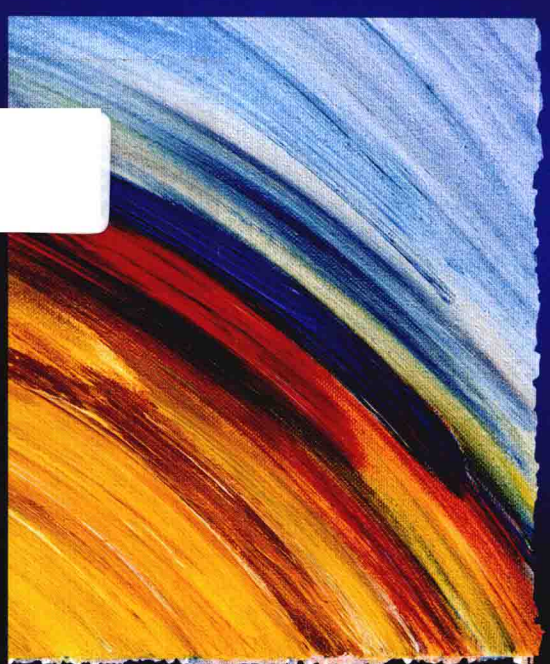
[美] 罗杰 S. 普莱斯曼 Roger S. Pressman 布鲁斯 R. 马克西姆 Bruce R. Maxim 著

（英文精编版·第8版）

Eighth Edition

Software Engineering

A PRACTITIONER'S APPROACH



Roger S. PRESSMAN

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机械工业出版社 China Machine Press

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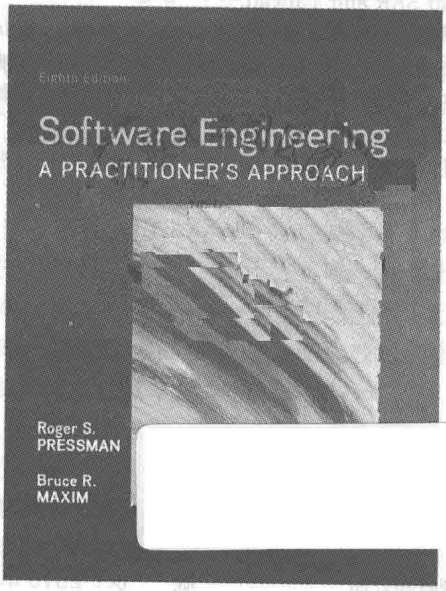

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出版者的话

文艺复兴以来，源远流长的科学精神和逐步形成的学术规范，使西方国家在自然科学的各个领域取得了垄断性的优势；也正是这样的优势，使美国在信息技术发展的六十多年间名家辈出、独领风骚。在商业化的进程中，美国的产业界与教育界越来越紧密地结合，计算机学科中的许多泰山北斗同时身处科研和教学的最前线，由此而产生的经典科学著作，不仅擘划了研究的范畴，还揭示了学术的源变，既遵循学术规范，又自有学者个性，其价值并不会因年月的流逝而减退。

近年，在全球信息化大潮的推动下，我国的计算机产业发展迅猛，对专业人才的需求日益迫切。这对计算机教育界和出版界都既是机遇，也是挑战；而专业教材的建设在教育战略上显得举足轻重。在我国信息技术发展时间较短的现状下，美国等发达国家在其计算机科学发展的几十年间积淀和发展的经典教材仍有许多值得借鉴之处。因此，引进一批国外优秀计算机教材将对我国计算机教育事业的发展起到积极的推动作用，也是与世界接轨、建设真正的世界一流大学的必由之路。

机械工业出版社华章公司较早意识到“出版要为教育服务”。自1998年开始，我们就将工作重点放在了遴选、移译国外优秀教材上。经过多年的不懈努力，我们与Pearson，McGraw-Hill，Elsevier，MIT，John Wiley & Sons，Cengage等世界著名出版公司建立了良好的合作关系，从他们现有的数百种教材中甄选出Andrew S. Tanenbaum，Bjarne Stroustrup，Brain W. Kernighan，Dennis Ritchie，Jim Gray，Afred V. Aho，John E. Hopcroft，Jeffrey D. Ullman，Abraham Silberschatz，William Stallings，Donald E. Knuth，John L. Hennessy，Larry L. Peterson等大师名家的一批经典作品，以“计算机科学丛书”为总称出版，供读者学习、研究及珍藏。大理石纹理的封面，也正体现了这套丛书的品位和格调。

“计算机科学丛书”的出版工作得到了国内外学者的鼎力相助，国内的专家不仅提供了中肯的选题指导，还不辞劳苦地担任了翻译和审校的工作；而原书的作者也相当关注其作品在中国的传播，有的还专门为其书的中译本作序。迄今，“计算机科学丛书”已经出版了近两百个品种，这些书籍在读者中树立了良好的口碑，并被许多高校采用为正式教材和参考书籍。其影印版“经典原版书库”作为姊妹篇也被越来越多实施双语教学的学校所采用。

权威的作者、经典的教材、一流的译者、严格的审校、精细的编辑，这些因素使我们的图书有了质量的保证。随着计算机科学与技术专业学科建设的不断完善和教材改革的逐渐深化，教育界对国外计算机教材的需求和应用都将步入一个新的阶段，我们的目标是尽善尽美，而反馈的意见正是我们达到这一终极目标的重要帮助。华章公司欢迎老师和读者对我们的工作提出建议或给予指正，我们的联系方法如下：

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华章科技图书出版中心

ADAPTER'S FOREWORD

Purpose

The original of this book is an excellent work of Dr. Pressman and Dr. Maxim. The 8th edition emphasizes on the new software engineering process and techniques, and is definitive on basically all the subjects that are listed by the Software Engineering Body of Knowledge (SWEBOK, http://www.swebok.org/). The extensive examples, references and online exercises are also quite helpful to the students. There are numbers of universities and colleges in China that are taking this book as their textbooks and keep tracking through its different versions.

As the idea of bilingual teaching is promoted in the higher education institutes in China, more and more schools are getting interested in this book. However, over nine hundred pages of the original book make it too difficult for a Chinese student with an average English reading ability to comprehend the fundamentals of software engineering in a semester. In order to introduce this book to more Chinese college students, a compression of the original book is made to better fit the book into the syllabus of an undergraduate course with only the core contents, and to reduce the students' reading load.

What's Compressed

We noticed that MobileApps and security engineering are the two very important new concepts added into this version. However due to the limited class time we finally decide to keep only the security engineering and leave mobile applications to the graduate courses. Similar to what we have done to the 7th edition, basically we would concentrate on the fundamental concepts of common frameworks, and leave WebApps, MobileApps, metrics and measurements, and some advanced topics to the graduate level courses.

The chapters that we would take to the graduate level and hence would be excluded in the compressed version are: Chapter 16 (Pattern-based Design), Chapter 17 (WebApp Design), Chapter 18 (MobileApp Design), Chapter 20 (Review Techniques), Chapter 25 (Testing Web Applications), Chapter 26 (Testing MobileApps), Chapter 28 (Formal Modeling and Verification), Chapter 36 (Maintenance and Reengineering), and Part Five (Advanced Topics). Chapter 30 (Product Metrics) is considered advanced as well, except that the first Section 30.1 (A Framework for Product Metrics) is suitable for the undergraduates to learn. Thus we plan to move Section 30.1 to Chapter 21 (Software Quality Assurance) and add it to be Section 21.10.

Other compressions are made to keep everything consistent with the compressed 7th edition:

1. All the sections and sub-sections related to WebApp and MobileApps will be removed. They are: Section 11.5 (Requirements Modeling for Web and Mobile Apps), Section 14.5 (Component-level Design for Mobile Apps), Section 15.5 (WebApp and Mobile

Interface Design), Sections 22.5-22.6 (Test Strategies for WebApps, and Test Strategies for MobileApps), Section 29.4 (Configuration Management for Web and MobileApps), Section 32.2.6 (WebApp Project Metrics), and Section 34.5.4 (Scheduling for WebApp and Mobile Projects).

2. In Chapter 3, Section 3.5 (Process Assessment and Improvement) and Section 4.4-4.5 (Personal and Team Process Models, Process Technology) are considered as the advanced topics and hence will not appear in the compressed version.
3. The content of Chapter 7 (Principles that Guide Practice) will eventually be introduced in the following chapters. We would remove this chapter to save the students some reading time.
4. In Chapter 8, Sections 8.2.5-8.2.6 (Nonfunctional Requirements, and Traceability), and Sections 8.6-8.8 (Negotiating Requirements, Requirements Monitoring, and Validating Requirements) are considered as the advanced topics and hence will not appear in the compressed version.
5. In Chapter 23, Sections (and sub-sections) 23.4.4 (Graph Matrices), 23.6.1 (Graph-Based Testing Methods), 23.6.4 (Orthogonal Array Testing), 23.8-23.10 (Testing Documentation and Help Facilities, Testing for Real-time Systems, and Patterns for Software Testing) are considered as the advanced topics and hence will not appear in the compressed version.
6. We believe that it would be enough to simply introduce some basic concepts on metrics and estimation to the undergraduates. Hence we plan to remove Sections 32.4-32.6 (Metrics for Process and Projects – Integrating Metrics within the Process, Metrics for Small Organizations, and Establishing a Software Metrics Program), and Sections 33.9-33.10 (Specialized Estimation Techniques and the Make/Buy Decision).

Acknowledgments

We feel grateful to Roger S. Pressman and Bruce R. Maxim, the authors of the original book, and McGraw Hill, the original publisher, for allowing us to compress the original 941-page book into about six hundred pages. It is their understanding and generosity that make it possible for more Chinese students to enjoy this distinguished book. Since the compression is made by simply removing some chapters or sections, we hope to keep as far as possible the elegancy of Dr. Pressman and Dr. Maxim's writing style.

Thanks to everyone at China Machine Press who have put in great effort to make this kind of cooperation possible.

The compression is made according to my own experience in teaching and practicing in software engineering. It is certainly wild open for discussions and suggestions on further improvements. Your comments are important to us, and would be very much appreciated.

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PREFACE

When computer software succeeds—when it meets the needs of the people who use it, when it performs flawlessly over a long period of time, when it is easy to modify and even easier to use—it can and does change things for the better. But when software fails—when its users are dissatisfied, when it is error prone, when it is difficult to change and even harder to use—bad things can and do happen. We all want to build software that makes things better, avoiding the bad things that lurk in the shadow of failed efforts. To succeed, we need discipline when software is designed and built. We need an engineering approach.

It has been almost three and a half decades since the first edition of this book was written. During that time, software engineering has evolved from an obscure idea practiced by a relatively small number of zealots to a legitimate engineering discipline. Today, it is recognized as a subject worthy of serious research, conscientious study, and tumultuous debate. Throughout the industry, software engineer has replaced programmer as the job title of preference. Software process models, software engineering methods, and software tools have been adopted successfully across a broad spectrum of industry segments.

Although managers and practitioners alike recognize the need for a more disciplined approach to software, they continue to debate the manner in which discipline is to be applied. Many individuals and companies still develop software haphazardly, even as they build systems to service today's most advanced technologies. Many professionals and students are unaware of modern methods. And as a result, the quality of the software that we produce suffers, and bad things happen. In addition, debate and controversy about the true nature of the software engineering approach continue. The status of software engineering is a study in contrasts. Attitudes have changed, progress has been made, but much remains to be done before the discipline reaches full maturity.

The eighth edition of *Software Engineering: A Practitioner's Approach* is intended to serve as a guide to a maturing engineering discipline. The eighth edition, like the seven editions that preceded it, is intended for both students and practitioners, retaining its appeal as a guide to the industry professional and a comprehensive introduction to the student at the upper-level undergraduate or first-year graduate level.

The eighth edition is considerably more than a simple update. The book has been revised and restructured to improve pedagogical flow and emphasize new and important software engineering processes and practices. In addition, we have further enhanced the popular "support system" for the book, providing a comprehensive set of student, instructor, and professional resources to complement the content of the book. These resources are presented as part of a website (www.mhhe.com/pressman) specifically designed for *Software Engineering: A Practitioner's Approach.*

The Eighth Edition. The 26 chapters of the eighth edition are organized into four parts. This organization better compartmentalizes topics and assists instructors who may not have the time to complete the entire book in one term.

Part 1, *The Process*, presents a variety of different views of software process, considering all important process models and addressing the debate between prescriptive and agile process philosophies. Part 2, *Modeling*, presents analysis and design methods with an emphasis on object-oriented techniques and UML modeling. Part 3, *Quality Management*, presents the concepts, procedures, and methods that enable a software team to assess software quality, conduct SQA procedures, and apply an effective testing strategy and tactics. Part 4, *Managing Software Projects*, presents topics that are relevant to those who plan, manage, and control a software development project. Continuing in the tradition of past editions, a series of sidebars is used throughout the book to present the trials and tribulations of a (fictional) software team and to provide supple-mentary materials about methods and tools that are relevant to chapter topics.

Acknowledgments. Special thanks go to Tim Lethbridge of the University of Ottawa who assisted us in the development of UML and OCL examples, and developed the case study that accompanies this book, and Dale Skrien of Colby College, who developed the UML tutorial in Appendix 1. Their assistance and comments were invaluable. In addition, we'd like to thank Austin Krauss, Senior Software Engineer at Treyarch, for providing insight into software development in the video game industry. We also wish to thank the reviewers of the eighth edition: Manuel E. Bermudez, University of Florida; Scott DeLoach, Kansas State University; Alex Liu, Michigan State University; and Dean Mathias, Utah State University. Their in-depth comments and thoughtful criticism have helped us make this a much better book.

Special Thanks. BRM: I am grateful to have had the opportunity to work with Roger on the eighth edition of this book. During the time I have been working on this book my son Benjamin shipped his first MobileApp and my daughter Katherine launched her interior design career. I am quite pleased to see the adults they have become. I am very grateful to my wife, Norma, for the enthusiastic support she has given me as I filled my free time with working on this book.

RSP: As the editions of this book have evolved, my sons, Mathew and Michael, have grown from boys to men. Their maturity, character, and success in the real world have been an inspiration to me. Nothing has filled me with more pride. They now have children of their own, Maya and Lily, who start still another generation. Both girls are already wizards on mobile computing devices. Finally, to my wife Barbara, my love and thanks for tolerating the many, many hours in the office and encouraging still another edition of "the book."

Roger S. Pressman
Bruce R. Maxim

About the Authors

Roger S. Pressman is an internationally recognized consultant and author in software engineering. For more than four decades, he has worked as a software engineer, a manager, a professor, an author, a consultant, and an entrepreneur.

Dr. Pressman is president of R. S. Pressman & Associates, Inc., a consulting firm that specializes in helping companies establish effective software engineering practices. Over the years he has developed a set of techniques and tools that improve software engineering practice. He is also the founder of Teslaccessories, LLC, a start-up manufacturing company that specializes in custom products for the Tesla Model S electric vehicle.

Dr. Pressman is the author of nine books, including two novels, and many technical and management papers. He has been on the editorial boards of *IEEE Software* and *The Cutter IT Journal* and was editor of the "Manager" column in *IEEE Software*.

Dr. Pressman is a well-known speaker, keynoting a number of major industry conferences. He has presented tutorials at the International Conference on Software Engineering and at many other industry meetings. He has been a member of the ACM, IEEE, and Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, and Pi Tau Sigma.

Bruce R. Maxim has worked as a software engineer, project manager, professor, author, and consultant for more than thirty years. His research interests include software engineering, human computer interaction, game design, social media, artificial intelligence, and computer science education.

Dr. Maxim is associate professor of computer and information science at the University of Michigan—Dearborn. He established the GAME Lab in the College of Engineering and Computer Science. He has published a number of papers on computer algorithm animation, game development, and engineering education. He is coauthor of a best-selling introductory computer science text. Dr. Maxim has supervised several hundred industry-based software development projects as part of his work at UM-Dearborn.

Dr. Maxim's professional experience includes managing research information systems at a medical school, directing instructional computing for a medical campus, and working as a statistical programmer. Dr. Maxim served as the chief technology officer for a game development company.

Dr. Maxim was the recipient of several distinguished teaching awards and a distinguished community service award. He is a member of Sigma Xi, Upsilon Pi Epsilon, Pi Mu Epsilon, Association of Computing Machinery, IEEE Computer Society, American Society for Engineering Education, Society of Women Engineers, and International Game Developers Association.

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