

# Model-Driven Software Engineering in Practice

Marco Brambilla Jordi Cabot Manuel Wimmer

SYNTHESIS LECTURES ON SOFTWARE ENGINEERING

# **Model Driven Software Engineering In Practice Jordi Cabot**

Klatt, Benjamin

# **Model Driven Software Engineering In Practice Jordi Cabot:**

Model-Driven Software Engineering in Practice, Second Edition Marco Brambilla, Jordi Cabot, Manuel Wimmer, 2022-05-31 This book discusses how model based approaches can improve the daily practice of software professionals This is known as Model Driven Software Engineering MDSE or simply Model Driven Engineering MDE MDSE practices have proved to increase efficiency and effectiveness in software development as demonstrated by various quantitative and qualitative studies MDSE adoption in the software industry is foreseen to grow exponentially in the near future e q due to the convergence of software development and business analysis The aim of this book is to provide you with an agile and flexible tool to introduce you to the MDSE world thus allowing you to quickly understand its basic principles and techniques and to choose the right set of MDSE instruments for your needs so that you can start to benefit from MDSE right away The book is organized into two main parts The first part discusses the foundations of MDSE in terms of basic concepts i e models and transformations driving principles application scenarios and current standards like the well known MDA initiative proposed by OMG Object Management Group as well as the practices on how to integrate MDSE in existing development processes The second part deals with the technical aspects of MDSE spanning from the basics on when and how to build a domain specific modeling language to the description of Model to Text and Model to Model transformations and the tools that support the management of MDSE projects The second edition of the book features a set of completely new topics including full example of the creation of a new modeling language IFML discussion of modeling issues and approaches in specific domains like business process modeling user interaction modeling and enterprise architecture complete revision of examples figures and text for improving readability understandability and coherence better formulation of definitions dependencies between concepts and ideas addition of a complete index of book content In addition to the contents of the book more resources are provided on the book s website http www mdse book com including the examples presented in the Model-Driven Software Engineering in Practice Marco Brambilla, Jordi Cabot, Manuel Wimmer, 2017-03-30 This book book discusses how model based approaches can improve the daily practice of software professionals This is known as Model Driven Software Engineering MDSE or simply Model Driven Engineering MDE MDSE practices have proved to increase efficiency and effectiveness in software development as demonstrated by various quantitative and qualitative studies MDSE adoption in the software industry is foreseen to grow exponentially in the near future e g due to the convergence of software development and business analysis The aim of this book is to provide you with an agile and flexible tool to introduce you to the MDSE world thus allowing you to quickly understand its basic principles and techniques and to choose the right set of MDSE instruments for your needs so that you can start to benefit from MDSE right away The book is organized into two main parts The first part discusses the foundations of MDSE in terms of basic concepts i e models and transformations driving principles application scenarios and current standards like the well known MDA initiative proposed by OMG Object

Management Group as well as the practices on how to integrate MDSE in existing development processes The second part deals with the technical aspects of MDSE spanning from the basics on when and how to build a domain specific modeling language to the description of Model to Text and Model to Model transformations and the tools that support the management of MDSE projects The second edition of the book features a set of completely new topics including full example of the creation of a new modeling language IFML discussion of modeling issues and approaches in specific domains like business process modeling user interaction modeling and enterprise architecture complete revision of examples figures and text for improving readability understandability and coherence better formulation of definitions dependencies between concepts and ideas addition of a complete index of book content In addition to the contents of the book more resources are provided on the book s website http www mdse book com including the examples presented in the book **Model-Driven Software Engineering in Practice** Marco Brambilla, Jordi Cabot, Manuel Wimmer, 2022-11-10 This book discusses how model based approaches can improve the daily practice of software professionals This is known as Model Driven Software Engineering MDSE or simply Model Driven Engineering MDE MDSE practices have proved to increase efficiency and effectiveness in software development as demonstrated by various quantitative and qualitative studies MDSE adoption in the software industry is foreseen to grow exponentially in the near future e g due to the convergence of software development and business analysis The aim of this book is to provide you with an agile and flexible tool to introduce you to the MDSE world thus allowing you to quickly understand its basic principles and techniques and to choose the right set of MDSE instruments for your needs so that you can start to benefit from MDSE right away The book is organized into two main parts The first part discusses the foundations of MDSE in terms of basic concepts i e models and transformations driving principles application scenarios and current standards like the well known MDA initiative proposed by OMG Object Management Group as well as the practices on how to integrate MDSE in existing development processes The second part deals with the technical aspects of MDSE spanning from the basics on when and how to build a domain specific modeling language to the description of Model to Text and Model to Model transformations and the tools that support the management of MDSE projects The book is targeted to a diverse set of readers spanning professionals CTOs CIOs and team managers that need to have a bird s eye vision on the matter so as to take the appropriate decisions when it comes to choosing the best development techniques for their company or team software analysts developers or designers that expect to use MDSE for improving everyday work productivity either by applying the basic modeling techniques and notations or by defining new domain specific modeling languages and applying end to end MDSE practices in the software factory and academic teachers and students to address undergrad and postgrad courses on MDSE In addition to the contents of the book more resources are provided on the book s website including the examples presented in the book Table of Contents Introduction MDSE Principles MDSE Use Cases Model Driven Architecture MDA Integration of MDSE in your Development Process Modeling Languages at a Glance

Developing your Own Modeling Language Model to Model Transformations Model to Text Transformations Managing Models Java Software Development with Event B Néstor Cataño Collazos, 2022-05-31 The cost of fixing software design flaws after the completion of a software product is so high that it is vital to come up with ways to detect software design flaws in the early stages of software development for instance during the software requirements the analysis activity or during software design before coding starts It is not uncommon that software requirements are ambiguous or contradict each other Ambiguity is exacerbated by the fact that software requirements are typically written in a natural language which is not tied to any formal semantics A palliative to the ambiguity of software requirements is to restrict their syntax to boilerplates textual templates with placeholders However as informal requirements do not enjoy any particular semantics no essential properties about them or about the system they attempt to describe can be proven easily Formal methods are an alternative to address this problem They offer a range of mathematical techniques and mathematical tools to validate software requirements in the early stages of software development This book is a living proof of the use of formal methods to develop software The particular formalisms that we use are EVENT B and refinement calculus In short i software requirements as written as User Stories ii they are ported to formal specifications iii they are refined as desired iv they are implemented in the form of a prototype and finally v they are tested for inconsistencies If some unit test fails then informal as well as formal specifications of the software system are revisited and evolved This book presents a case study of software development of a chat system with EVENT B and a case study of formal proof of properties of a social network **Execution and Quantitative Reasoning** Corina S. Păsăreanu, 2022-05-31 This book reviews recent advances in symbolic execution and its probabilistic variant and discusses how they can be used to ensure the safety and security of software systems Symbolic execution is a systematic program analysis technique which explores multiple program behaviors all at once by collecting and solving symbolic constraints collected from the branching conditions in the program The obtained solutions can be used as test inputs that execute feasible program paths Symbolic execution has found many applications in various domains such as security smartphone applications operating systems databases and more recently deep neural networks uncovering subtle errors and unknown vulnerabilities. We review here the technique has also been extended to reason about algorithmic complexity and resource consumption Furthermore symbolic execution has been recently extended with probabilistic reasoning allowing one to reason about quantitative properties of software systems The approach computes the conditions to reach target program events of interest and uses model counting to quantify the fraction of the input domain satisfying these conditions thus computing the probability of event occurrence This probabilistic information can be used for example to compute the reliability of an aircraft controller under different wind conditions modeled probabilistically or to quantify the leakage of sensitive data in a software system using information theory metrics such as Shannon entropy This book is intended for students and software engineers who are interested in advanced techniques for

testing and verifying software systems 
Consolidation of Customized Product Copies into Software Product Lines
Klatt, Benjamin,2016-11-10 In software development project constraints lead to customer specific variants by copying and adapting the product During this process modifications are scattered all over the code Although this is flexible and efficient in the short term a Software Product Line SPL offers better results in the long term regarding cost reduction time to market and quality attributes This book presents a novel approach named SPLevo which consolidates customized product copies into an SPL 
Quality-driven Reuse of Model-based Software Architecture Elements Busch, Axel,2019-10-17

Model-Integrating Software Components Mahdi Derakhshanmanesh, 2015-04-30 In his study Mahdi Derakhshanmanesh builds on the state of the art in modeling by proposing to integrate models into running software on the component level without translating them to code Such so called model integrating software exploits all advantages of models models implicitly support a good separation of concerns they are self documenting and thus improve understandability and maintainability and in contrast to model driven approaches there is no synchronization problem anymore between the models and the code generated from them Using model integrating components software will be easier to build and easier to evolve by just modifying the respective model in an editor Furthermore software may also adapt itself at runtime by transforming its own model part The The Complete Edition - Software Engineering for Real-Time **Systems** Jim Cooling, 2019-12-26 Adopt a diagrammatic approach to creating robust real time embedded systems Key Features Explore the impact of real time systems on software design Understand the role of diagramming in the software development processLearn why software performance is a key element in real time systemsBook Description From air traffic control systems to network multimedia systems real time systems are everywhere The correctness of the real time system depends on the physical instant and the logical results of the computations This book provides an elaborate introduction to software engineering for real time systems including a range of activities and methods required to produce a great real time system The book kicks off by describing real time systems their applications and their impact on software design You will learn the concepts of software and program design as well as the different types of programming software errors and software life cycles and how a multitasking structure benefits a system design Moving ahead you will learn why diagrams and diagramming plays a critical role in the software development process You will practice documenting code related work using Unified Modeling Language UML and analyze and test source code in both host and target systems to understand why performance is a key design driver in applications Next you will develop a design strategy to overcome critical and fault tolerant systems and learn the importance of documentation in system design By the end of this book you will have sound knowledge and skills for developing real time embedded systems What you will learnDifferentiate between correct reliable and safe software Discover modern design methodologies for designing a real time system Use interrupts to implement concurrency in the systemTest integrate and debug the codeDemonstrate test issues for OOP constructsOvercome software

faults with hardware based techniquesWho this book is for If you are interested in developing a real time embedded system this is the ideal book for you With a basic understanding of programming microprocessor systems and elementary digital logic you will achieve the maximum with this book Knowledge of assembly language would be an added advantage

Introduction to Software Architecture Kevin Lano, Sobhan Yassipour Tehrani, 2023-10-03 This unique accessible textbook gives a comprehensive introduction to software architecture using clean architecture concepts with agile methods and model driven development The work introduces the key concepts of software architectures and explains the importance of architectural design for the long term usefulness and sustainability of software systems In addition it describes more than 30 architectural styles and patterns that can be used for constructing mobile applications enterprise and web applications machine learning systems and safety critical systems Topics and features Combines clean architecture principles with agile model driven development Employs practical examples and real industrial cases to illustrate architectures for mobile apps web apps enterprise systems safety critical systems and machine learning systems Explores support tools for architectural design and system development using the approach Provides tutorial questions and slides to support teaching and learning Delivers material that has been class tested over 10 years with more than 1 000 students. The textbook can be used to support teaching of an undergraduate module in software architecture yet also includes more advanced topics suitable for a specialised software architecture module at master s level It also will be eminently suitable and relevant for software practitioners and researchers needing or wanting to explore the field in short courses or self study Dr Kevin Lano is Reader in Software Engineering Department of Informatics King's College London UK Dr Sobhan Yassipour Tehrani is a Lecturer Department of Computer Science University College London UK Metamodeling for Extended Reality Fabian Muff, 2025-02-12 This open access book which is based on the author's dissertation in 2024 explores the challenges of metamodeling in the context of extended reality and emphasizes the need for new concepts in metamodeling to effectively combine it with extended reality technologies The central question of this work is how metamodeling can be used in and for extended reality The book is structured in nine chapters Chapter 1 introduces the topic by providing background information and outlining the research objectives questions methodology and structure Chapter 2 delves into the existing literature and developments in the field It covers various aspects of modeling such as conceptual enterprise and metamodeling as well as extended reality XR virtual reality VR augmented reality AR and the metaverse Next chapter 3 presents the generic requirements for metamodeling for augmented and virtual reality by systematically deriving use cases for joining AR and metamodeling Chapter 4 then identifies specific requirements for integrating metamodeling with XR such as coordinate mappings visualization of model components detection and tracking context or interaction Subsequently chapter 5 introduces a new domain specific visual modeling language for creating augmented reality scenarios particularly within the context of metamodeling before chapter 6 outlines the conceptualization and design of a 3D enhanced metamodeling platform

considering extended reality detailing its structure components and the interconnection of its elements Chapter 7 then presents the initial implementation of the various components of this modeling platform and chapter 8 evaluates the newly introduced platform both theoretically and empirically Eventually chapter 9 concludes the book by an alignment with the initial research questions discussing limitations and provides a final summary and an outlook for further research This book mainly aims at researchers in conceptual modeling especially in projects related to XR VR or AR as the presented new domain specific modeling method for creating workflows for XR VR AR applications does not assume specific prior programming knowledge An Integration Framework for Knowledge-Supported Project Management in IT Consortia Andreas Grünwald. A Functional, Comprehensive and Extensible Multi-Platform Ouerving and Transformation Approach Tassilo Horn, 2015-07-11 This thesis is about a new model querying and transformation approach called FunnyQT which is realized as a set of APIs and embedded domain specific languages DSLs in the JVM based functional Lisp dialect Clojure Founded on a powerful model management API FunnyQT provides querying services such as comprehensions quantified expressions regular path expressions logic based relational model querying and pattern matching On the transformation side it supports the definition of unidirectional model to model transformations of in place transformations it supports defining bidirectional transformations and it supports a new kind of co evolution transformations that allow for evolving a model together with its metamodel simultaneously Several properties make FunnyQT unique Foremost it is just a Clojure library thus FunnyQT queries and transformations are Clojure programs However most higher level services are provided as task oriented embedded DSLs which use Clojure's powerful macro system to support the user with tailor made language constructs important for the task at hand Since gueries and transformations are just Clojure programs they may use any Clojure or Java library for their own purpose e g they may use some templating library for defining model to text transformations Conversely like every Clojure program FunnyQT queries and transformations compile to normal JVM byte code and can easily be called from other JVM languages Furthermore FunnyQT is platform independent and designed with extensibility in mind By default it supports the Eclipse Modeling Framework and JGraLab and support for other modeling frameworks can be added with minimal effort and without having to modify the respective framework's classes or FunnyQT itself Lastly because FunnyQT is embedded in a functional language it has a functional emphasis itself Every query and every transformation compiles to a function which can be passed around given to higher order functions or be parametrized with other functions Safety and Security of Cyber-Physical Systems Frank J. Furrer, 2022-07-20 Cyber physical systems CPSs consist of software controlled computing devices communicating with each other and interacting with the physical world through sensors and actuators Because most of the functionality of a CPS is implemented in software the software is of crucial importance for the safety and security of the CPS This book presents principle based engineering for the development and operation of dependable software The knowledge in this book addresses organizations that want to strengthen their

methodologies to build safe and secure software for mission critical cyber physical systems The book Presents a successful strategy for the management of vulnerabilities threats and failures in mission critical cyber physical systems Offers deep practical insight into principle based software development 62 principles are introduced and cataloged into five categories Business Provides direct guidance on architecting and operating dependable cyber physical systems for software managers An Extensible Component & Connector Architecture Description Infrastructure for **Multi-Platform Modeling** Andreas Wortmann, 2016-11-08 Software engineering for complex systems requires abstraction multi domain expertise separation of concerns and reuse Domain experts rarely are software engineers and should formulate solutions using their domain s vocabulary instead of general purpose programming languages GPLs Successful integration of domain specific languages DSLs into a software system requires a separation of concerns between domain issues and integration issues while retaining a loose enough coupling to support DSL reuse in different contexts Component based software engineering CBSE increases reuse and separation of concerns by encapsulating functionalities in components Components are GPL artifacts which raises accidental complexities Model driven engineering MDE abstracts from GPLs by lifting models to primary development artifacts Models can be abstract and better comprehensible by using domain vocabulary instead of a GPL They can be platform independent and translated into GPLs for different target platforms Component connector C C architecture description languages ADLs combine CBSE and MDE to compose of architectures from component models We present concepts for engineering software systems with exchangeable component behavior languages The concepts are realized in a software architecture modeling infrastructure that comprises modeling languages to develop applications based on C C software architectures with exchangeable component behavior DSLs It supports transformations from platform independent to platform specific software architectures and compositional code generation With this it enables domain experts to re use the most appropriate component behavior DSL and facilitates composition of Hard Problems in Software Testing Scott Tilley, Brianna domain solutions through encapsulation in components Floss, 2022-05-31 This book summarizes the current hard problems in software testing as voiced by leading practitioners in the field The problems were identified through a series of workshops interviews and surveys Some of the problems are timeless such as education and training while others such as system security have recently emerged as increasingly important The book also provides an overview of the current state of Testing as a Service TaaS based on an exploration of existing commercial offerings and a survey of academic research TaaS is a relatively new development that offers software testers the elastic computing capabilities and generous storage capacity of the cloud on an as needed basis Some of the potential benefits of TaaS include automated provisioning of test execution environments and support for rapid feedback in agile development via continuous regression testing The book includes a case study of a representative web application and three commercial TaaS tools to determine which hard problems in software testing are amenable to a TaaS solution The

findings suggest there remains a significant gap that must be addressed before TaaS can be fully embraced by the industry particularly in the areas of tester education and training and a need for tools supporting more types of testing The book includes a roadmap for enhancing TaaS to help bridge the gap between potential benefits and actual results Table of Contents Introduction Hard Problems in Software Testing Testing as a Service TaaS Case Study and Gap Analysis Summary Appendix A Hard Problems in Software Testing Survey Appendix B Google App Engine Code Examples Appendix C Sauce Labs Code Examples References Author Biographies Domain-Specific Languages Andrzej Wasowski, Thorsten Berger.2023-02-01 This textbook describes the theory and the pragmatics of using and engineering high level software languages also known as modeling or domain specific languages DSLs for creating quality software This includes methods design patterns quidelines and testing practices for defining the syntax and the semantics of languages While remaining close to technology the book covers multiple paradigms and solutions avoiding a particular technological silo It unifies the modeling the object oriented and the functional programming perspectives on DSLs The book has 13 chapters Chapters 1 and 2 introduce and motivate DSLs Chapter 3 kicks off the DSL engineering lifecycle describing how to systematically develop abstract syntax by analyzing a domain Chapter 4 addresses the concrete syntax including the systematic engineering of context free grammars Chapters 5 and 6 cover the static semantics with basic constraints as a starting point and type systems for advanced DSLs Chapters 7 Transformation 8 Interpretation and 9 Generation describe different paradigms for designing and implementing the dynamic semantics while covering testing and other kinds of quality assurance Chapter 10 is devoted to internal DSLs Chapters 11 to 13 show the application of DSLs and engage with simpler alternatives to DSLs in a highly distinguished domain software variability These chapters introduce the underlying notions of software product lines and feature modeling The book has been developed based on courses on model driven software engineering MDSE and DSLs held by the authors It aims at senior undergraduate and junior graduate students in computer science or software engineering Since it includes examples and lessons from industrial and open source projects as well as from industrial research practitioners will also find it a useful reference The numerous examples include code in Scala 3 ATL Alloy C F Groovy Java JavaScript Kotlin OCL Python QVT Ruby and Xtend The book contains as many as 277 exercises The associated code repository facilitates learning and using the examples in a course Theory and Practice of Model Transformations Davide Di Ruscio, Dániel Varró, 2014-07-05 This book constitutes the refereed proceedings of the 7th International Conference on Model Transformation ICMT 2014 held in York UK in July 2014 The 14 revised papers were carefully selected from 38 submissions The papers have been organized in topical sections on model transformation testing foundations of model synchronization applications of model synchronization and tracing and reverse engineering of transformations

<u>Software Engineering for Science</u> Jeffrey C. Carver, Neil P. Chue Hong, George K. Thiruvathukal, 2016-11-03 Software Engineering for Science provides an in depth collection of peer reviewed chapters that describe experiences with applying

software engineering practices to the development of scientific software It provides a better understanding of how software engineering is and should be practiced and which software engineering practices are effective for scientific software The book starts with a detailed overview of the Scientific Software Lifecycle and a general overview of the scientific software development process It highlights key issues commonly arising during scientific software development as well as solutions to these problems The second part of the book provides examples of the use of testing in scientific software development including key issues and challenges The chapters then describe solutions and case studies aimed at applying testing to scientific software development efforts The final part of the book provides examples of applying software engineering techniques to scientific software including not only computational modeling but also software for data management and analysis The authors describe their experiences and lessons learned from developing complex scientific software in different domains About the Editors Jeffrey Carver is an Associate Professor in the Department of Computer Science at the University of Alabama He is one of the primary organizers of the workshop series on Software Engineering for Science http www SE4Science org workshops Neil P Chue Hong is Director of the Software Sustainability Institute at the University of Edinburgh His research interests include barriers and incentives in research software ecosystems and the role of software as a research object George K Thiruvathukal is Professor of Computer Science at Loyola University Chicago and Visiting Faculty at Argonne National Laboratory His current research is focused on software metrics in open source mathematical and Testing iOS Apps with HadoopUnit Scott Tilley, Krissada Dechokul, 2022-05-31 Smartphone users have scientific software come to expect high quality apps This has increased the importance of software testing in mobile software development Unfortunately testing apps particularly the GUI can be very time consuming Exercising every user interface element and verifying transitions between different views of the app under test quickly becomes problematic For example execution of iOS GUI test suites using Apple s UI Automation framework can take an hour or more if the app s interface is complicated The longer it takes to run a test the less frequently the test can be run which in turn reduces software quality This book describes how to accelerate the testing process for iOS apps using HadoopUnit a distributed test execution environment that leverages the parallelism inherent in the Hadoop platform HadoopUnit was previously used to run unit and system tests in the cloud It has been modified to perform GUI testing of iOS apps on a small scale cluster a modest computing infrastructure available to almost every developer Experimental results have shown that distributed test execution with HadoopUnit can significantly outperform the test execution on a single machine even if the size of the cluster used for the execution is as small as two nodes This means that the approach described in this book could be adopted without a huge investment in IT resources HadoopUnit is a cost effective solution for reducing lengthy test execution times of system level GUI testing of iOS apps

Unveiling the Magic of Words: A Overview of "Model Driven Software Engineering In Practice Jordi Cabot"

In some sort of defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is really awe-inspiring. Enter the realm of "Model Driven Software Engineering In Practice Jordi Cabot," a mesmerizing literary masterpiece penned with a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve to the book is central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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