Concurrency

Jeff Magee,Jeff Kramer

Java Concurrency in Practice Tim Peierls,Brian Goetz,Joshua Bloch,Joseph Bowbeer,Doug Lea,David Holmes,2006-05-09 Threads are a fundamental part of the Java platform. As multicore processors become the norm, using concurrency effectively becomes essential for building high-performance applications. Java SE 5 and 6 are a huge step forward for the development of concurrent applications, with improvements to the Java Virtual Machine to support high-performance, highly scalable concurrent classes and a rich set of new concurrency building blocks. In Java Concurrency in Practice, the creators of these new facilities explain not only how they work and how to use them, but also the motivation and design patterns behind them. However, developing, testing, and debugging multithreaded programs can still be very difficult; it is all too easy to create concurrent programs that appear to work, but fail when it matters most: in production, under heavy load. Java Concurrency in Practice arms readers with both the theoretical underpinnings and concrete techniques for building reliable, scalable, maintainable concurrent applications. Rather than simply offering an inventory of concurrency APIs and mechanisms, it provides design rules, patterns, and mental models that make it easier to build concurrent programs that are both correct and performant. This book covers: Basic concepts of concurrency and thread safety Techniques for building and composing thread-safe classes Using the concurrency building blocks in java.util.concurrent Performance optimization dos and don'ts Testing concurrent programs Advanced topics such as atomic variables, nonblocking algorithms, and the Java Memory Model

Java Concurrency in Practice Goetz,2006-09

Java Concurrency in Practice Brian Goetz,Tim Peierls,Joshua Bloch,Joseph Bowbeer,David Holmes,Doug Lea,2006 ©2006 Book News, Inc., Portland, OR (booknews.com).

Introduction to Concurrency in Programming Languages Matthew J. Sottile,Timothy G. Mattson,Craig E Rasmussen,2009-09-28 Exploring how concurrent programming can be assisted by language-level techniques, Introduction to Concurrency in Programming Languages presents high-level language techniques for dealing with concurrency in a general context. It provides an understanding of programming languages that offer concurrency features as part of the language definition. The book supplies a conceptual framework for different aspects of parallel algorithm design and implementation. It first addresses the limitations of traditional programming techniques and models when dealing with concurrency. The book then explores the current state of the art in concurrent programming and describes high-level language constructs for concurrency. It also discusses the historical evolution of hardware, corresponding high-level techniques that were developed, and the connection to modern systems, such as multicore and manycore processors. The remainder of the text focuses on common high-level programming techniques and their application to a range of algorithms. The authors offer case studies on genetic algorithms, fractal generation, cellular automata, game logic for solving Sudoku puzzles, pipelined algorithms, and more. Illustrating the effect of concurrency on programs written in familiar languages, this text focuses on novel language abstractions that truly bring concurrency into the language and aid analysis and compilation tools in generating efficient, correct programs. It also explains the complexity involved in taking advantage of concurrency with regard to program correctness and performance.

The Art of Concurrency Clay Breshears,2009-05-07 If you're looking to take full advantage of multi-core processors with concurrent programming, this practical book provides the knowledge and hands-on experience you need. The Art of Concurrency is one of the few resources to focus on implementing algorithms in the shared-memory model of multi-core processors, rather than just theoretical models or distributed-memory architectures. The book provides detailed explanations and usable samples to help you transform algorithms from serial to parallel code, along with advice and analysis for avoiding mistakes that programmers typically make when first attempting these computations. Written by an Intel engineer with over two decades of parallel and concurrent programming experience, this book will help you: Understand parallelism and concurrency Explore differences between programming for shared-memory and distributed-memory Learn guidelines for designing multithreaded applications, including testing and tuning Discover how to make best use of different threading libraries, including Windows threads, POSIX threads, OpenMP, and Intel Threading Building Blocks Explore how to implement concurrent algorithms that involve sorting, searching, graphs, and other practical computations The Art of Concurrency shows you how to keep algorithms scalable to take advantage of new processors with even more cores. For developing parallel code algorithms for concurrent programming, this book is a must.

Concurrency in Go Katherine Cox-Buday,2017-07-19 Concurrency can be notoriously difficult to get right, but fortunately, the Go open source programming language makes working with concurrency tractable and even easy. If you're a developer familiar with Go, this practical book demonstrates best practices and patterns to help you incorporate concurrency into your systems. Author Katherine Cox-Buday takes you step-by-step through the process. You'll understand how Go chooses to model concurrency, what issues arise from this model, and how you can compose primitives within this model to solve problems. Learn the skills and tooling you need to confidently write and implement concurrent systems of any size. Understand how Go addresses fundamental problems that make concurrency difficult to do correctly Learn the key differences between concurrency and parallelism Dig into the syntax of Go's memory synchronization primitives Form patterns with these primitives to write maintainable concurrent code Compose patterns into a series of practices that enable you to write large, distributed systems that scale Learn the sophistication behind goroutines and how Go's runtime stitches everything together

Concurrency Dahlia Malkhi,2019-09-16 This book is a celebration of Leslie Lamport's work on concurrency, interwoven in four-and-a-half decades of an evolving industry: from the introduction of the first personal computer to an era when parallel and distributed multiprocessors are abundant. His works lay formal foundations for concurrent computations executed by interconnected computers. Some of the algorithms have become standard engineering practice for fault tolerant distributed computing – distributed systems that continue to function correctly despite failures of individual components. He also developed a substantial body of work on the formal specification and verification of concurrent systems, and has contributed to the development of automated tools applying these methods. Part I consists of technical chapters of the book and a biography. The technical chapters of this book present a retrospective on Lamport's original ideas from experts in the field. Through this lens, it portrays their long-lasting impact. The chapters cover timeless notions Lamport introduced: the Bakery algorithm, atomic shared registers and sequential consistency; causality and logical time; Byzantine Agreement; state machine replication and Paxos; temporal logic of actions (TLA). The professional

biography tells of Lamport's career, providing the context in which his work arose and broke new grounds, and discusses LaTeX – perhaps Lamport's most influential contribution outside the field of concurrency. This chapter gives a voice to the people behind the achievements, notably Lamport himself, and additionally the colleagues around him, who inspired, collaborated, and helped him drive worldwide impact. Part II consists of a selection of Leslie Lamport's most influential papers. This book touches on a lifetime of contributions by Leslie Lamport to the field of concurrency and on the extensive influence he had on people working in the field. It will be of value to historians of science, and to researchers and students who work in the area of concurrency and who are interested to read about the work of one of the most influential researchers in this field.

Concurrency in .NET Riccardo Terrell,2018-06-05 Summary Concurrency in .NET teaches you how to build concurrent and scalable programs in .NET using the functional paradigm. This intermediate-level guide is aimed at developers, architects, and passionate computer programmers who are interested in writing code with improved speed and effectiveness by adopting a declarative and pain-free programming style. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About the Technology Unlock the incredible performance built into your multi-processor machines. Concurrent applications run faster because they spread work across processor cores, performing several tasks at the same time. Modern tools and techniques on the .NET platform, including parallel LINQ, functional programming, asynchronous programming, and the Task Parallel Library, offer powerful alternatives to traditional thread-based concurrency. About the Book Concurrency in .NET teaches you to write code that delivers the speed you need for performance-sensitive applications. Featuring examples in both C# and F#, this book guides you through concurrent and parallel designs that emphasize functional programming in theory and practice. You'll start with the foundations of concurrency and master essential techniques and design practices to optimize code running on modern multiprocessor systems. What's Inside The most important concurrency abstractions Employing the agent programming model Implementing real-time event-stream processing Executing unbounded asynchronous operations Best concurrent practices and patterns that apply to all platforms About the Reader For readers skilled with C# or F#. About the Book Riccardo Terrell is a seasoned software engineer and Microsoft MVP who is passionate about functional programming. He has over 20 years' experience delivering cost-effective technology solutions in a competitive business environment. Table of Contents PART 1 - Benefits of functional programming applicable to concurrent programs Functional concurrency foundations Functional programming techniques for concurrency Functional data structures and immutability PART 2 - How to approach the different parts of a concurrent program The basics of processing big data: data parallelism, part 1 PLINQ and MapReduce: data parallelism, part 2 Real-time event streams: functional reactive programming Task-based functional parallelism Task asynchronicity for the win Asynchronous functional programming in F# Functional combinators for fluent concurrent programming Applying reactive programming everywhere with agents Parallel workflow and agent programming with TPL Dataflow PART 3 - Modern patterns of concurrent programming applied Recipes and design patterns for successful concurrent programming Building a scalable mobile app with concurrent functional programming

Programming with POSIX Threads David R. Butenhof,1997 Software -- Operating Systems.

Concurrency in C# Cookbook Stephen Cleary,2014-05-15 If you're one of the many developers uncertain about concurrent and multithreaded development, this practical cookbook will change your mind. With more than 75 code-rich recipes, author Stephen Cleary demonstrates parallel processing and asynchronous programming techniques, using libraries and language features in .NET 4.5 and C# 5.0. Concurrency is becoming more common in responsive and scalable application development, but it's been extremely difficult to code. The detailed solutions in this cookbook show you how modern tools raise the level of abstraction, making concurrency much easier than before. Complete with ready-to-use code and discussions about how and why the solution works, you get recipes for using: async and await for asynchronous operations Parallel programming with the Task Parallel Library The TPL Dataflow library for creating dataflow pipelines Capabilities that Reactive Extensions build on top of LINQ Unit testing with concurrent code Interop scenarios for combining concurrent approaches Immutable, threadsafe, and producer/consumer collections LINQ Cancellation support in your concurrent code Asynchronous-friendly Object-Oriented Programming Thread synchronization for accessing data

C++ Concurrency in Action Anthony Williams,2019-02-07 This book should be on every C++ programmer's desk. It's clear, concise, and valuable. - Rob Green, Bowling Green State University This bestseller has been updated and revised to cover all the latest changes to C++ 14 and 17! C++ Concurrency in Action, Second Edition teaches you everything you need to write robust and elegant multithreaded applications in C++17. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About the Technology You choose C++ when your applications need to run fast. Well-designed concurrency makes them go even faster. C++ 17 delivers strong support for the multithreaded, multiprocessor programming required for fast graphic processing, machine learning, and other performance-sensitive tasks. This exceptional book unpacks the features, patterns, and best practices of production-grade C++ concurrency. About the Book C++ Concurrency in Action, Second Edition is the definitive guide to writing elegant multithreaded applications in C++. Updated for C++ 17, it carefully addresses every aspect of concurrent development, from starting new threads to designing fully functional multithreaded algorithms and data structures. Concurrency master Anthony Williams presents examples and practical tasks in every chapter, including insights that will delight even the most experienced developer. What's inside Full coverage of new C++ 17 features Starting and managing threads Synchronizing concurrent operations Designing concurrent code Debugging multithreaded applications About the Reader Written for intermediate C and C++ developers. No prior experience with concurrency required. About the Author Anthony Williams has been an active member of the BSI C++ Panel since 2001 and is the developer of the just::thread Pro extensions to the C++ 11 thread library. Table of Contents Hello, world of concurrency in C++! Managing threads Sharing data between threads Synchronizing concurrent operations The C++ memory model and operations on atomic types Designing lock-based concurrent data structures Designing lock-free concurrent data structures Designing concurrent code Advanced thread management Parallel algorithms Testing and debugging multithreaded applications

Concurrent Programming in Java Douglas Lea,2000 Software -- Programming Languages.

On Concurrent Programming Fred B. Schneider,2012-12-06 Here, one of the leading figures in the field provides a comprehensive survey of the subject, beginning with prepositional logic and concluding with concurrent programming. It is based on graduate courses taught at Cornell University and is designed for use as a graduate

text. Professor Schneier emphasises the use of formal methods and assertional reasoning using notation and paradigms drawn from programming to drive the exposition, while exercises at the end of each chapter extend and illustrate the main themes covered. As a result, all those interested in studying concurrent computing will find this an invaluable approach to the subject.

Concurrency in Dependable Computing Paul Ezhilchelvan,Alexander Romanovsky,2013-03-14 Concurrency in Dependable Computing focuses on concurrency related issues in the area of dependable computing. Failures of system components, be hardware units or software modules, can be viewed as undesirable events occurring concurrently with a set of normal system events. Achieving dependability therefore is closely related to, and also benefits from, concurrency theory and formalisms. This beneficial relationship appears to manifest into three strands of work. Application level structuring of concurrent activities. Concepts such as atomic actions, conversations, exception handling, view synchrony, etc., are useful in structuring concurrent activities so as to facilitate attempts at coping with the effects of component failures. Replication induced concurrency management. Replication is a widely used technique for achieving reliability. Replica management essentially involves ensuring that replicas perceive concurrent events identically. Application of concurrency formalisms for dependability assurance. Fault-tolerant algorithms are harder to verify than their fault-free counterparts due to the fact that the impact of component faults at each state need to be considered in addition to valid state transitions. CSP, Petri nets, CCS are useful tools to specify and verify fault-tolerant designs and protocols. Concurrency in Dependable Computing explores many significant issues in all three strands. To this end, it is composed as a collection of papers written by authors well-known in their respective areas of research. To ensure quality, the papers are reviewed by a panel of at least three experts in the relevant area.

Seven Concurrency Models in Seven Weeks Paul Butcher,2014-06-30 Your software needs to leverage multiple cores, handle thousands of users and terabytes of data, and continue working in the face of both hardware and software failure. Concurrency and parallelism are the keys, and Seven Concurrency Models in Seven Weeks equips you for this new world. See how emerging technologies such as actors and functional programming address issues with traditional threads and locks development. Learn how to exploit the parallelism in your computer's GPU and leverage clusters of machines with MapReduce and Stream Processing. And do it all with the confidence that comes from using tools that help you write crystal clear, high-quality code. This book will show you how to exploit different parallel architectures to improve your code's performance, scalability, and resilience. You'll learn about seven concurrency models: threads and locks, functional programming, separating identity and state, actors, sequential processes, data parallelism, and the lambda architecture. Learn about the perils of traditional threads and locks programming and how to overcome them through careful design and by working with the standard library. See how actors enable software running on geographically distributed computers to collaborate, handle failure, and create systems that stay up 24/7/365. Understand why shared mutable state is the enemy of robust concurrent code, and see how functional programming together with technologies such as Software Transactional Memory (STM) and automatic parallelism help you tame it. You'll learn about the untapped potential within every GPU and how GPGPU software can unleash it. You'll see how to use MapReduce to harness massive clusters to solve previously intractable problems, and how, in concert with Stream Processing, big data can be tamed. With an understanding of the strengths and weaknesses of each of the different models and hardware architectures, you'll be empowered to tackle any problem with confidence. What You Need: The example code can be compiled and executed on *nix, OS X, or Windows. Instructions on how to download the supporting build systems are given in each chapter.

Mastering Concurrency Programming with Java 8 Javier Fernández González,2016-02-29 Master the principles and techniques of multithreaded programming with the Java 8 Concurrency API About This Book Implement concurrent applications using the Java 8 Concurrency API and its new components Improve the performance of your applications or process more data at the same time, taking advantage of all of your resources. Construct real-world examples related to machine learning, data mining, image processing, and client/server environments Who This Book Is For If you are a competent Java developer with a good understanding of concurrency but have no knowledge of how to effectively implement concurrent programs or use streams to make processes more efficient, then this book is for you. What You Will Learn Design concurrent applications by converting a sequential algorithm into a concurrent one Discover how to avoid all the possible problems you can get in concurrent algorithms Use the Executor framework to manage concurrent tasks without creating threads Extend and modify Executors to adapt their behavior to your needs Solve problems using the divide and conquer technique and the Fork/Join framework Process massive data sets with parallel streams and Map/Reduce implementation Control data-race conditions using concurrent data structures and synchronization mechanisms Test and monitor concurrent applications In Detail Concurrency programming allows several large tasks to be divided into smaller sub-tasks, which are further processed as individual tasks that run in parallel. All the sub-tasks are combined together once the required results are achieved; they are then merged to get the final output. The whole process is very complex. This process goes from the design of concurrent algorithms to the testing phase where concurrent applications need extra attention. Java includes a comprehensive API with a lot of ready-to-use components to implement powerful concurrency applications in an easy way, but with a high flexibility to adapt these components to your needs. The book starts with a full description of design principles of concurrent applications and how to parallelize a sequential algorithm. We'll show you how to use all the components of the Java Concurrency API from basics to the most advanced techniques to implement them in powerful concurrency applications in Java. You will be using real-world examples of complex algorithms related to machine learning, data mining, natural language processing, image processing in client / server environments. Next, you will learn how to use the most important components of the Java 8 Concurrency API: the Executor framework to execute multiple tasks in your applications, the phaser class to implement concurrent tasks divided into phases, and the Fork/Join framework to implement concurrent tasks that can be split into smaller problems (using the divide and conquer technique). Toward the end, we will cover the new inclusions in Java 8 API, the Map and Reduce model, and the Map and Collect model. The book will also teach you about the data structures and synchronization utilities to avoid data-race conditions and other critical problems. Finally, the book ends with a detailed description of the tools and techniques that you can use to test a Java concurrent application. Style and approach A complete guide implementing real-world examples with algorithms related to machine learning, data mining, and natural language processing in client/server environments. All the examples are explained in a step-by-step approach.

Programming Concurrency on the JVM Venkat Subramaniam,2011-08-26 More than ever, learning to program concurrency is critical to creating faster, responsive

applications. Speedy and affordable multicore hardware is driving the demand for high-performing applications, and you can leverage the Java platform to bring these applications to life. Concurrency on the Java platform has evolved, from the synchronization model of JDK to software transactional memory (STM) and actor-based concurrency. This book is the first to show you all these concurrency styles so you can compare and choose what works best for your applications. You'll learn the benefits of each of these models, when and how to use them, and what their limitations are. Through hands-on exercises, you'll learn how to avoid shared mutable state and how to write good, elegant, explicit synchronization-free programs so you can create easy and safe concurrent applications. The techniques you learn in this book will take you from dreading concurrency to mastering and enjoying it. Best of all, you can work with Java or a JVM language of your choice - Clojure, JRuby, Groovy, or Scala - to reap the growing power of multicore hardware. If you are a Java programmer, you'd need JDK 1.5 or later and the Akka 1.0 library. In addition, if you program in Scala, Clojure, Groovy or JRuby you'd need the latest version of your preferred language. Groovy programmers will also need GPars.

Learning Concurrency in Python Elliot Forbes,2017-08-16 Practically and deeply understand concurrency in Python to write efficient programs About This Book Build highly efficient, robust, and concurrent applications Work through practical examples that will help you address the challenges of writing concurrent code Improve the overall speed of execution in multiprocessor and multicore systems and keep them highly available Who This Book Is For This book is for Python developers who would like to get started with concurrent programming. Readers are expected to have a working knowledge of the Python language, as this book will build on these fundamentals concepts. What You Will Learn Explore the concept of threading and multiprocessing in Python Understand concurrency with threads Manage exceptions in child threads Handle the hardest part in a concurrent system — shared resources Build concurrent systems with Communicating Sequential Processes (CSP) Maintain all concurrent systems and master them Apply reactive programming to build concurrent systems Use GPU to solve specific problems In Detail Python is a very high level, general purpose language that is utilized heavily in fields such as data science and research, as well as being one of the top choices for general purpose programming for programmers around the world. It features a wide number of powerful, high and low-level libraries and frameworks that complement its delightful syntax and enable Python programmers to create. This book introduces some of the most popular libraries and frameworks and goes in-depth into how you can leverage these libraries for your own high-concurrent, highly-performant Python programs. We'll cover the fundamental concepts of concurrency needed to be able to write your own concurrent and parallel software systems in Python. The book will guide you down the path to mastering Python concurrency, giving you all the necessary hardware and theoretical knowledge. We'll cover concepts such as debugging and exception handling as well as some of the most popular libraries and frameworks that allow you to create event-driven and reactive systems. By the end of the book, you'll have learned the techniques to write incredibly efficient concurrent systems that follow best practices. Style and approach This easy-to-follow guide teaches you new practices and techniques to optimize your code, and then moves toward more advanced ways to effectively write efficient Python code. Small and simple practical examples will help you test the concepts yourself, and you will be able to easily adapt them for any application.

Mastering Concurrency in Python Quan Nguyen,2018-11-27 Immerse yourself in the world of Python concurrency and tackle the most complex concurrent programming problems Key FeaturesExplore the core syntaxes, language features and modern patterns of concurrency in PythonUnderstand how to use concurrency to keep data consistent and applications responsiveUtilize application scaffolding to design highly-scalable programs Book Description Python is one of the most popular programming languages, with numerous libraries and frameworks that facilitate high-performance computing. Concurrency and parallelism in Python are essential when it comes to multiprocessing and multithreading; they behave differently, but their common aim is to reduce the execution time. This book serves as a comprehensive introduction to various advanced concepts in concurrent engineering and programming. Mastering Concurrency in Python starts by introducing the concepts and principles in concurrency, right from Amdahl's Law to multithreading programming, followed by elucidating multiprocessing programming, web scraping, and asynchronous I/O, together with common problems that engineers and programmers face in concurrent programming. Next, the book covers a number of advanced concepts in Python concurrency and how they interact with the Python ecosystem, including the Global Interpreter Lock (GIL). Finally, you'll learn how to solve real-world concurrency problems through examples. By the end of the book, you will have gained extensive theoretical knowledge of concurrency and the ways in which concurrency is supported by the Python language What you will learnExplore the concepts of concurrency in programmingExplore the core syntax and features that enable concurrency in PythonUnderstand the correct way to implement concurrencyAbstract methods to keep the data consistent in your programAnalyze problems commonly faced in concurrent programmingUse application scaffolding to design highly-scalable programsWho this book is for This book is for developers who wish to build high-performance applications and learn about signle-core, multicore programming or distributed concurrency. Some experience with Python programming language is assumed.

Concurrency Jeff Magee,Jeff Kramer,2006-06-16 Designed to give students hands-on design and programming experience, this book provides a motivational learning package for a fascinating area of software design.

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Table of Contents Concurrency

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