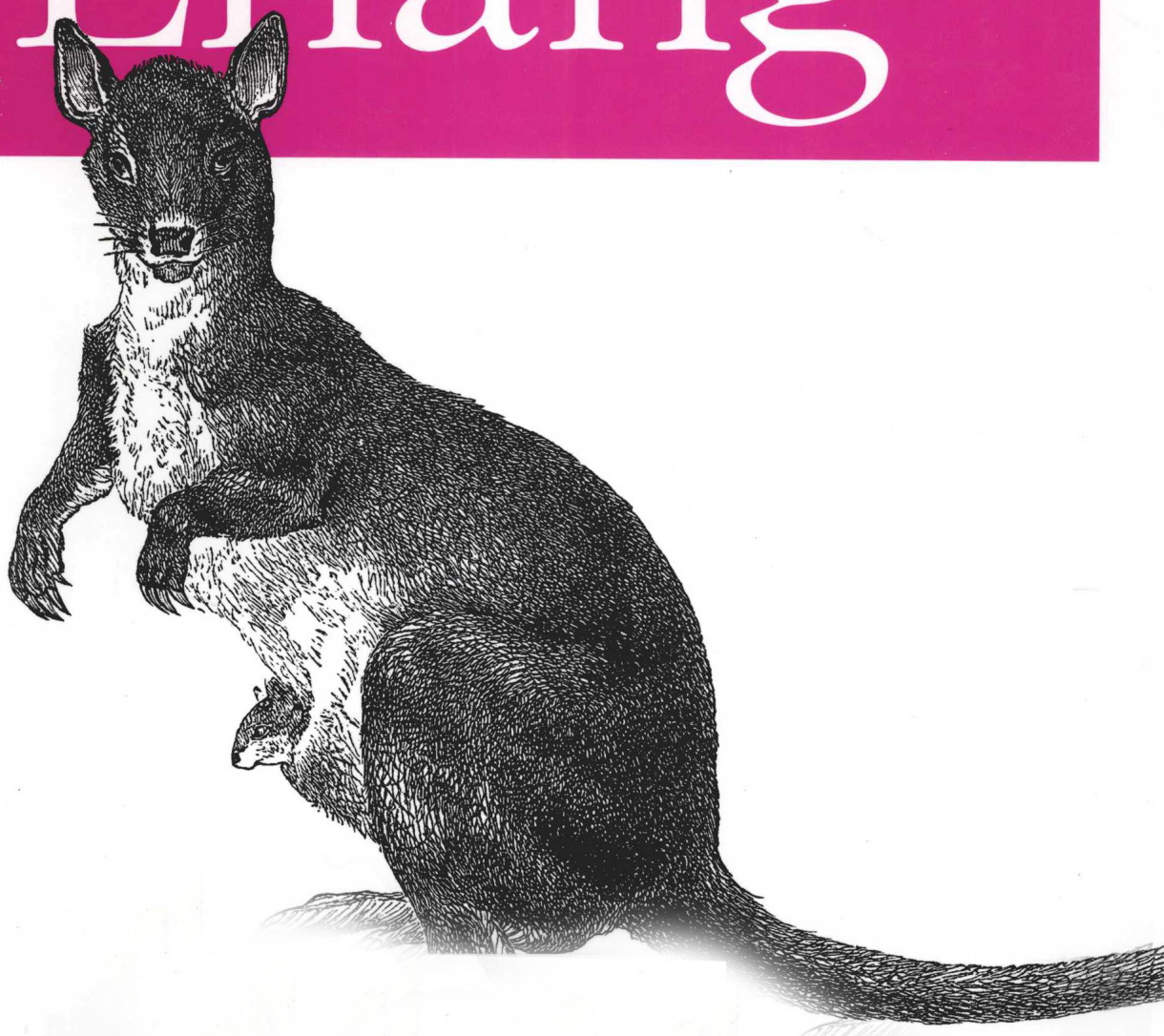
Erlang 编程（影印版）

Programming Erlang



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Francesco Cesarini & Simon Thompson 著

Erlang 编程(影印版)

Erlang Programming

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Foreword

Erlang is our solution to three problems regarding the development of highly concurrent, distributed "soft real-time systems":

- To be able to develop the software quickly and efficiently
- To have systems that are tolerant of software errors and hardware failures
- To be able to update the software on the fly, that is, without stopping execution

When we "invented" Erlang, we focused on telecommunication systems, but today these requirements are applicable to a large number of applications, and Erlang is used in applications as divergent as distributed databases, financial systems, and chat servers, among others. Recent interest in Erlang has been fueled by its suitability for use on multicore processors. While the world is struggling to find methods to facilitate porting applications to multicore processors, Erlang applications can be ported with virtually no changes.

Initially, Erlang was slow to spread; maybe it was too daring to introduce functional programming, lightweight concurrency, asynchronous message passing, and a unique method to handle failures, all in one go. It is easy to see why a language such as Java, which is only a small step away from C++, was easier for people to swallow. However, to achieve the goals I've just mentioned, we feel our approach has weathered the test of time. The use of Erlang is expanding rapidly.

This book is an excellent and practical introduction of Erlang, and is combined with a number of anecdotes explaining the ideas and background behind the development of Erlang.

Happy and, I trust, profitable reading.

—Mike Williams
Director of Traffic and Feature Software
Product Development Unit WCDMA, Ericsson AB
one of the inventors of Erlang

Preface

What made us start writing this book in the first place is the enthusiasm we share for Erlang. We wanted to help get the word out, giving back a little of what the community has given to us. Although we both got into Erlang for very different reasons, the end result was the same: lots of fun hours doing lots of fun stuff at a fraction of the effort it would have taken with other languages. And best of all, it is not a tool we use for hobby projects, but one we use on a daily basis in our real jobs!

Francesco: Why Erlang?

The year was 1994. While studying computer science at Uppsala University, one of the courses I took was on parallel programming. The lecturer held up the first edition of *Concurrent Programming in Erlang* (Prentice Hall) and said, "Read it." He then held up a handout and added, "These are the exercises, do them," after which Erlang barely got a mention; it was quickly overshadowed with the theory of threads, shared memory, semaphores, and deadlocks.

As the main exercise for this course, we had to implement a simulated world inhabited by carrots, rabbits, and wolves. Rabbits would roam this world eating carrots that grew in random patches. When they had eaten enough carrots, the rabbits would get fat and split in two. Wolves ran around eating up the rabbits; if they managed to catch and eat enough rabbits, they would also get fat and split. Rabbits and wolves within a certain distance of each other would broadcast information on food and predators. If a rabbit found a carrot patch, other rabbits would quickly join him. If a wolf found a rabbit, the pack would start chasing it.

The final result was amusingly fun to watch. The odd rabbit would run straight into a group of wolves, while others would run in other directions, sometimes stopping to grab a carrot en route. Every carrot patch, rabbit, and wolf was represented as an Erlang process communicating through message passing.

The exercise took me about 40 hours to solve. Although I enjoyed using Erlang and was positively surprised at the simplicity of its concurrency model and lack of OS threads for every process, I did not think that much of it right there and then. After all, it was one of the dozen or so languages I had to learn for my degree. Having used ML

in my functional programming courses and ADA in my real-time programming courses, for me Erlang was just another language in the crowd. That changed a few months later when I started studying object-oriented programming.

In the object-oriented (OO) programming course, we were given the same simulated world lab but had to solve it with Eiffel, an OO language our new lecturer insisted was ideal for simulations. Although I had already solved the same problem and was able to reuse a good part of the algorithms, it took me and a fellow student 120 man-hours to solve.

This was the eye-opener that led me to believe the declarative and concurrent features in Erlang had to be the direction in which software development was heading. At the time, I was not sure whether the language that would lead the way in this paradigm shift was going to be Erlang, but I was certain that whatever language it was, it would be heavily influenced by Erlang and its ancestors. I picked up the phone and called Joe Armstrong, one of the inventors of Erlang. A week later, I visited the Ericsson Computer Science Lab for an interview, and I have never looked back.

Simon: Why Erlang?

I have worked in functional programming since the early 1980s, and have known about Erlang ever since it was first defined about 20 years ago. What I find most attractive about Erlang is that it's a language that was designed from the start to solve real and difficult problems, and to do it in an elegant and powerful way. That's why we've seen Erlang used in more and more systems in recent years.

It's also a small language, which makes writing tools for it much more practical than for a language such as Java, C++, or even Haskell. This, and the quality of the libraries we've been able to build on in our work, has helped the functional programming group at Kent to be very productive in implementing the Wrangler refactoring tool for Erlang.

Who Should Read This Book?

We have written this book to introduce you to programming in Erlang. We don't expect that you have programmed in Erlang before, nor do we assume that you are familiar with functional programming in other languages.

We do expect you to have programmed in Java, C, Ruby, or another mainstream language, and we've made sure that we point out to you where Erlang differs from what you're used to.

How to Read This Book

We wrote this book in two parts, the first to be read sequentially and the second can be read concurrently (or sequentially in whatever order you like), as the chapters are independent of each other.

The first 11 chapters of the book cover the core parts of Erlang:

- Chapter 1 gives a high-level introduction to the language, covering its key features for building high-availability, robust concurrent systems. In doing this, we also describe how Erlang came to be the way it is, and point out some of its high-profile success stories, which explain why you may want to adopt Erlang in one of your projects.
- The basics of sequential programming in Erlang are the subject of Chapters 2 and 3. In these chapters, we cover the central role of *recursion* in writing Erlang programs, as well as how *single assignment* in Erlang is quite different from the way variables are handled in other languages, such as C and Java.
- While covering sequential programming, we also introduce the *basic data types* of Erlang—numbers, atoms, strings, lists, and tuples—comparing them with similar types in other languages. Other types are covered later: records in Chapter 7, and function types and binaries in Chapter 9. Large-scale storage in ETS tables is the topic of Chapter 10.
- Erlang's distinctiveness comes to the fore in Chapters 4–6, which together cover the concurrent aspects of Erlang, embodied in *message passing* communication between concurrently executing *processes* running in separate memory spaces.
- It is possible to "hot-swap" code in a system, supporting *software upgrades* in running systems: this is the topic of Chapter 8.
- To conclude this part of the book, we cover *distributed programming* in Chapter 11. This allows different Erlang runtime systems (or *nodes*), which might be running on the same or different machines, to work together and interact as a distributed system.

In the remaining chapters, we cover a variety of different topics largely independent of each other. These include the following:

- The *Open Telecom Platform* (OTP) gives a set of libraries and design principles supporting the construction of robust, scalable systems in Erlang; this is the subject of Chapter 12.
- The Erlang distribution contains some standard computing applications: we cover the Mnesia *database* in Chapter 13 and the wxErlang *GUI programming* library in Chapter 14.

- Erlang distribution gives one mechanism for linking Erlang systems to each other. Chapter 15 shows how Erlang supports programming across the Internet using *sockets*, and Chapter 16 covers the various ways in which Erlang can *interwork* with systems written in C, Java, and Ruby, as well as many other languages.
- The standard Erlang distribution comes with a number of very useful tools, and we cover some of these next. Chapter 17 explains in depth how all aspects of Erlang systems can be traced without degrading their performance, and Chapter 18 covers tools for checking the correctness of programs, and for constructing documentation for Erlang systems. Unit testing, and how it is supported by EUnit, is the subject of Chapter 19.
- The last chapter, Chapter 20, looks at how to write programs that are elegant, readable, and efficient, and pulls together into one place much of the accumulated experience of the Erlang community.

The Appendix covers how to get started with Erlang, how to use the Erlang shell, popular tools for Erlang, and how to find out more about Erlang.

Each chapter is accompanied by a set of exercises, and you can download all the code in this book from its website:

http://www.erlangprogramming.org

The website also has references to further reading as well as links to the major sites supporting the Erlang community.

We wrote this book to be compatible with Erlang Release 13 (R13-B). Most of the features we describe will work with earlier releases; known incompatibilities with more recent earlier releases are detailed on our website.

Conventions Used in This Book

The following typographical conventions are used in this book:

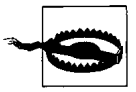
Italic
: Indicates new terms, URLs, filenames, file extensions, and occasionally, emphasis and keyword phrases.

`Constant width`
: Indicates computer coding in a broad sense. This includes commands, options, variables, attributes, keys, requests, functions, methods, types, classes, modules, properties, parameters, values, objects, events, event handlers, XML and XHTML tags, macros, and keywords.

`Constant width bold`
: Indicates commands or other text that the user should type literally.

Constant width italics
: Indicates text that should be replaced with user-supplied values or values determined by context.

This icon signifies a tip, suggestion, or general note.



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Using Code Examples

This book is intended to help you write programs and systems in Erlang. In general, you may use the code in this book in your programs and documentation.

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Other reviewers who deserve a special mention include Thomas Arts, Zvi Avraham, Franc Bozic, Richard Carlsson, Dale Harvey, Oscar Hellström, Steve Kirsch, Charles McKnight, Paul Oliver, Pierre Omidyar, Octavio Orozio, Rex Page, Michal Ptaszek, Corrado Santoro, Steve Vinoski, David Welton, Ulf Wiger, and Mike Williams.

Although we will not go into detail regarding what each of you did, it is important that you all know that your individual contributions had an influence in making this a better book. Thank you all!

Francesco needs to thank Alison for all her patience and support. I did not know what I was getting into when I agreed to write this book, and neither did you. Until the time to start working on the next book comes, I promise you laptop- and cell phone-free vacations. A thank you also goes to everyone at Erlang Training and Consulting for all the encouragement and to Simon for being such a great coauthor. We should all do it again sometime, as the result was worth it. But now, rest!

Simon wants to say a huge thank you to Jane, Alice, and Rory for their patience and support over the past few very busy months: without your encouragement, it just wouldn't have happened. Thanks, too, to Francesco for inviting me to join the project: it's been really enjoyable working together. I hope we get the chance to do it again, just not too soon....

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