PROGRAMMING FOR EVERYONE IN JAVA

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PER BRINCH HANSEN

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**In memory of
Ole Bak and Ole Riis**

PREFACE

THE MAIN GOAL

This is a book about computer programming for beginners. I assume that you know very little or nothing about how computers work and how you program them. I will show you how to write understandable computer programs in *Java*, a programming language that is widely used on the Internet.

Now, why should you be interested in computer programming? After all, most of you will probably not become professional programmers. Well, the most important reason I can think of is simply that computer programming is *fun*. You will enjoy learning a new skill and becoming good at it.

And, in today's world, it is important for professionals in any field to appreciate what computers can (and cannot) do well. To reach this level of understanding, you must go beyond the routine skills of a computer user and learn the art of programming in some depth.

KEY FEATURES

While emphasizing *general principles* of programming, this book

- Uses examples from the *humanities* only, without any mathematics or engineering.
- Explains all programming concepts by means of *complete programs*.
- Concentrates on *exercises* solved by writing complete programs.
- Takes you from *text input/output* to *object-oriented programming* in one semester.

- Gives you a solid *background* for a second course on the graphics and networking facilities of Java.

THE PROGRAMMING LANGUAGE JAVA

This is *not* a book about the programming language Java. I only explain what you need to know about Java to understand the programming examples and solve the exercises.

Although you will be using Java in this course, the same methods can be used for systematic programming in other languages, such as C, Fortran, and Pascal.

It is too early to tell whether Java will become the standard language in introductory courses on computer programming. There are unmistakable symptoms of unnecessary complexity in Java, which are confusing for beginners (and for me as well).

The only features of Java I use are those that simplify the programmer's task. To help you stay clear of the pitfalls of Java, I recommend some restrictions on the use of the language. Brief examples demonstrate violations of these restrictions. Rather than attempting to explain the obscure effects of these examples, I show you how to rewrite them and avoid the pitfalls.

TEACHING AIDS

This first course concentrates on programs for *text processing*. Since standard Java is inconvenient for text input/output, I have written a simple programming interface, called the *Java text program*. This Java program

- Defines identical output methods for screen and disk files, similar to the write procedures of Pascal.
- Defines identical input methods for keyboard and disk files, similar to the read procedures of Pascal.
- Uses single-character lookahead for syntax-directed input.
- Requires a single compilation only.

The Java text program is defined by a text file, named `text.java`. The instructor can obtain this file by anonymous file transfer from the directory `pbh/textprogram` at `ftp.cis.syr.edu` and distribute it to you by E-mail. Appendix A explains how you compile this program in your own directory.

I have used the Java Developer's Kit (JDK) from Sun Microsystems and my own Java text program to program all examples and exercises. And I have tested these Java programs under both Macintosh System 7.5 (JDK 1.0.2) and Unix (JDK 1.1.2).

TEACHING EXPERIENCE

At Syracuse University, I have taught this course to undergraduates in Arts and Sciences, Management, Public Communications, Visual and Performing Arts, Engineering, and Computer Science (see the *Sample Class Schedule* in Appendix B).

I have learned that it is possible to teach students from *any* field of study to write computer programs. But novices must be taught by an experienced programmer. It is *not* a task for a teaching assistant. It is, however, essential to supplement classes with a programming lab run by a teaching assistant, who can help students with language details and problems of compilation and execution.

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Per Brinch Hansen, *Operating System Principles*. Prentice Hall, Englewood Cliffs, NJ, 1973. Copyright © 1973 by Prentice Hall.

Per Brinch Hansen, *The Architecture of Concurrent Programs*, Prentice Hall, Englewood Cliffs, NJ, 1977. Copyright © 1977 by Prentice Hall.

Per Brinch Hansen, *Studies in Computational Science: Parallel Programming Paradigms*, Prentice Hall, Englewood Cliffs, NJ, 1995. Copyright © 1995 by Prentice Hall.

Per Brinch Hansen, Monitors and Concurrent Pascal: A personal history. In T. J. Bergin, Jr. and R. G. Gibson, Jr. Eds. *History of Programming Languages II*, 121–172, ACM Press, New York, 1996. Copyright © 1996 by Association for Computing Machinery, Inc.

Per Brinch Hansen, *The Search for Simplicity: Essays in Parallel Programming*. IEEE Computer Society Press, Los Alamitos, CA, 1996. Copyright © 1996 by The Institute of Electrical and Electronics Engineers, Inc.

Thomas Brinch Hansen, *The Brain*, unpublished poem, 1975. Copyright © 1975 by Thomas Brinch Hansen.

Good Time Crossword Puzzles, Crossword 1, *Good Time Crossword Puzzles*, No. 126. Penny Press, Norwalk, CT, March 1997. Copyright © 1997 by Penny Press.

Gerald Maguire, *Create Your Own Shakespearean Insults*, unpublished list of words, 1988.
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