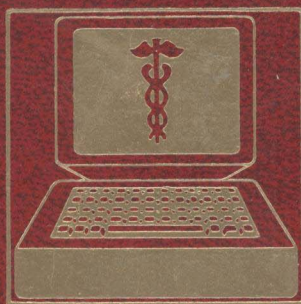


COMPUTERS IN THE PRACTICE OF MEDICINE

H. DOMINIC COVVEY
NEIL HARDING McALISTER

VOLUME I

Introduction to
Computing Concepts



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INTRODUCTION TO COMPUTING CONCEPTS**

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ADDISON-WESLEY PUBLISHING COMPANY

Reading, Massachusetts • Menlo Park, California
London • Amsterdam • Don Mills, Ontario • Sydney

This book is in the
Addison-Wesley Series
Computers in the Practice of Medicine

Library of Congress Cataloging in Publication Data

Covvey, H Dominic.

Computers in the practice of medicine.

(Addison-Wesley series in computers in the
practice of medicine)

Includes indexes.

CONTENTS: vol. I. Introduction to computing concepts.—vol. II. Issues in medical computing.

I. Medicine — Data processing. I. McAlister, Neil
Harding, joint author. II. Title. III. Series.

R858.C68 001.6'4'02461 79-14099

ISBN 0-201-01251-0 (pt. 1)

ISBN 0-201-01249-9 (pt. 2)

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ISBN 0-201-01251-0
ABCDEFGHIJ-AL-89876543210

*This book is dedicated to all those physicians
who have permitted us the privilege of
fiddling with the way they practice, and
especially to Dr. E. Douglas Wigle.*

Preface

The computer is no longer a novelty in medicine. Its present uses range from the simplest instrumentation to complete hospital information systems. Computers, large and small, populate our hospitals and institutes of medical learning, and their numbers are growing.

In spite of their increasing presence and occasional triumphs, however, computers have not yet become a tool in every doctor's bag or an indispensable management assistant in every hospital. Computer applications in medicine have been largely restricted to developmental research projects, a few common business functions, and some operations support roles. Although computers are used successfully as parts of some medical instruments, they are not in themselves generally perceived as tools suitable for the average physician, either in private practice or in hospital situations.

There are several reasons for this restriction. First, computer systems are still fairly expensive and therefore relatively inaccessible to most health-care workers and institutions. Equally significant, however, is the fact that many doctors, hospital administrators, and other health-care workers are still skeptical of the computer — with good reason. Computer science is a discipline far removed from the traditional interests of medical science. Usually, nothing in a doctor's medical education and little in an administrator's training have prepared them to approach the broad field of medical computing in a knowledgeable way.

Increasingly, physicians and other health-care workers are becoming aware of this lacuna in their training. In business, industry, and other fields of science the computer has already brought about incredible changes both in operating efficiency and in scientific

progress. Medicine lags behind the industrial sector in realizing the potential benefits of automation. The hospital that devotes to data processing a portion of its budget equivalent to that spent by most other industries of the same size is exceptional. In spite of a rather low level of commitment that has thus far restricted most medical computing to the research sphere, the successes that have already been realized have proved to many physicians and hospital management personnel that the ball is now in their court. The tool is available: It is now up to health care workers to recognize its potentials and to make use of it. Yet the person who may be responsible for designing, proposing, supervising, or approving a medical-computing facility often has little training or experience in this field to guide decision-making.

The books in this series attempt to provide the health-care worker with some of this missing information. These books are written for physicians, hospital administrators, nurses, laboratory technologists, medical students, and others whose main interest is in the health-care field. Their goal is to give such readers sufficient knowledge to make them comfortable with computer systems, current computer technology, and some of the most important issues in medical computing. The reader who masters this material should be able both to listen and to talk about the computer sensibly. Until there is more hard evidence on which to base opinions, medical-computing methods guaranteed to produce the hoped-for results will not be forthcoming. The best we can hope to offer the health-care worker who wants to know about the possibilities and the dangers of medical computing is a "working paper" that outlines the basics, reviews the state of the art, identifies the typical problem areas, and offers practical suggestions for coping with these problems.

This book, the first volume in the series, describes computing machinery and elementary concepts of programming to a computer-naïve health-care professional. Throughout, we make an effort to present the wide variety of modern computing hardware and software as a spectrum of alternatives from which appropriate selections can be made for different kinds of medical-computing applications.

First, we provide a brief introduction to computer systems. We then divide computing machinery, or hardware, into categories and

explain them. A discussion of basic concepts relating to computer programs, or software, follows. We next integrate the hardware and software components into a complete and functioning computer system. In the final chapter we summarize the state of the art of existing computer systems, look at their practical limitations in a medical environment, and point out probable areas of difficulty and advancement in the near future.

The person who knows little about computers will gain a working knowledge of the jargon that is an inescapable, if unfortunate, part of computer science. New key words with which noncomputer scientists are unlikely to be familiar are printed in boldface wherever they occur, and at the end of each chapter all key words that have been thus noted and explained in context are listed. At the end of the book there is a glossary where all such key words are defined.

Four appendices — on computer hardware, people active in medical computing, other books on the subject, and a classification of topical areas in medical computing — are also included.

Each major part and each chapter of this book is preceded by a block diagram schematically illustrating the hardware and software components of a complete computer system. The block diagrams serve two purposes.

First, by repeated exposure to this diagram, the reader is encouraged to think of computer *systems* as integrated wholes made up of many necessary parts. When configuring any computer system for a real application, one could use a diagram similar to this as a planning aid by “filling in the blanks.”

Second, the block diagram serves as a quick index. The topics discussed in each part or chapter are “shaded in” on the diagram that precedes it. The chapter numbers in which each topic is discussed are indicated on every diagram.

We hope that this book will also be helpful to computer scientists, even though they will already understand most of the technical concepts and vocabulary in this introductory volume. The expanding use of computer technology in health care makes the practice of medical computing quite relevant to computer scientists — especially to those young professionals who are seeking a challenging career.

The problems and constraints of the medical environment are somewhat different from those of the business community (toward which most computer science education is slanted). The computer scientist should therefore keep in mind the health-care worker's point of view when examining the hardware and software issues presented in this volume.

ACKNOWLEDGMENTS

During the Middle Ages it was customary for authors to commence a treatise with an apology to the reader, in which they confessed their own unworthiness and begged the reader's indulgence. Frequently the unstated aim of the apology was to defuse possible charges of heresy. Although this custom has gone out of style, we think it appropriate to revive the apology — not as a form of superfluous self-abasement, but as an acknowledgement of the contributions of many other people who have made this work possible.

Among the people who have most influenced our work, two above all should be acknowledged. The writings of G. Octo Barnett have influenced our attitudes profoundly. As long ago as 1965 he may well have conceived many thoughts expressed in these pages. Joseph Weizenbaum has deepened our concerns about the way people perceive computers. We highly recommend his eloquent and thought-provoking book, *Computer Power and Human Reason*.

We express our gratitude to our research assistant, Ms. Maeve O'Beirne, who located a great proportion of our source material. We also owe a debt of gratitude to Ms. Debbie Schreiber, who typed the entire manuscript (without word processing support . . . alas!) over and over again, uncomplainingly.

The editors of the *Canadian Medical Association Journal* were kind in permitting us to use material from our articles on "Computer-Assisted Medicine," which appeared in the *Journal* from 1977 through 1979. The editors of the *Journal* deserve much credit for this book, since they gave us an opportunity to express our views on medical computing to a wide medical audience on a regular basis. The feedback from our professional colleagues encouraged us to shoulder the burden of writing this book.

Professor Ken Sevcik and Professor Derek Corneil of the Computer Systems Research Group of the University of Toronto gave us their time and constructive advice. Dr. Corneil coauthored with us an article on which much of the material in Chapter 8 is based. [1]

Dr. E. Douglas Wigle, to whom this book is fittingly dedicated, has honored us with his continuing, enthusiastic support of this project and with his helpful insights and suggestions. Dr. Wigle also coauthored an earlier paper with us [2], and much of that material served as the foundation for Chapter 12.

We have been fortunate in our relationship with our friend and editor Mr. William Gruener, who provided not only his professional services but also unflagging confidence and support. We acknowledge also the contributions of Ms. Mary Clare McEwing and many others at Addison-Wesley.

Finally, our families deserve special thanks. Our wives, Dr. Carol Thompson and Dr. Nazlin McAlister, who are both physicians, have been helpful with suggestions to make the material clearer to a medical audience.

January 1980
Toronto

N. H. M.
H. D. C.

NOTES

1. H. D. Covvey, N. H. McAlister, and D. Corneil, "Computer-assisted medicine: how soft is software?" *Can. Med. Assoc. J.* 121:1408, 1979.
2. H. D. Covvey, N. H. McAlister, and E. D. Wigle, "Computer-assisted medicine: the limitations of technology." *Can. Med. Assoc. J.* 118:1315, 1978.

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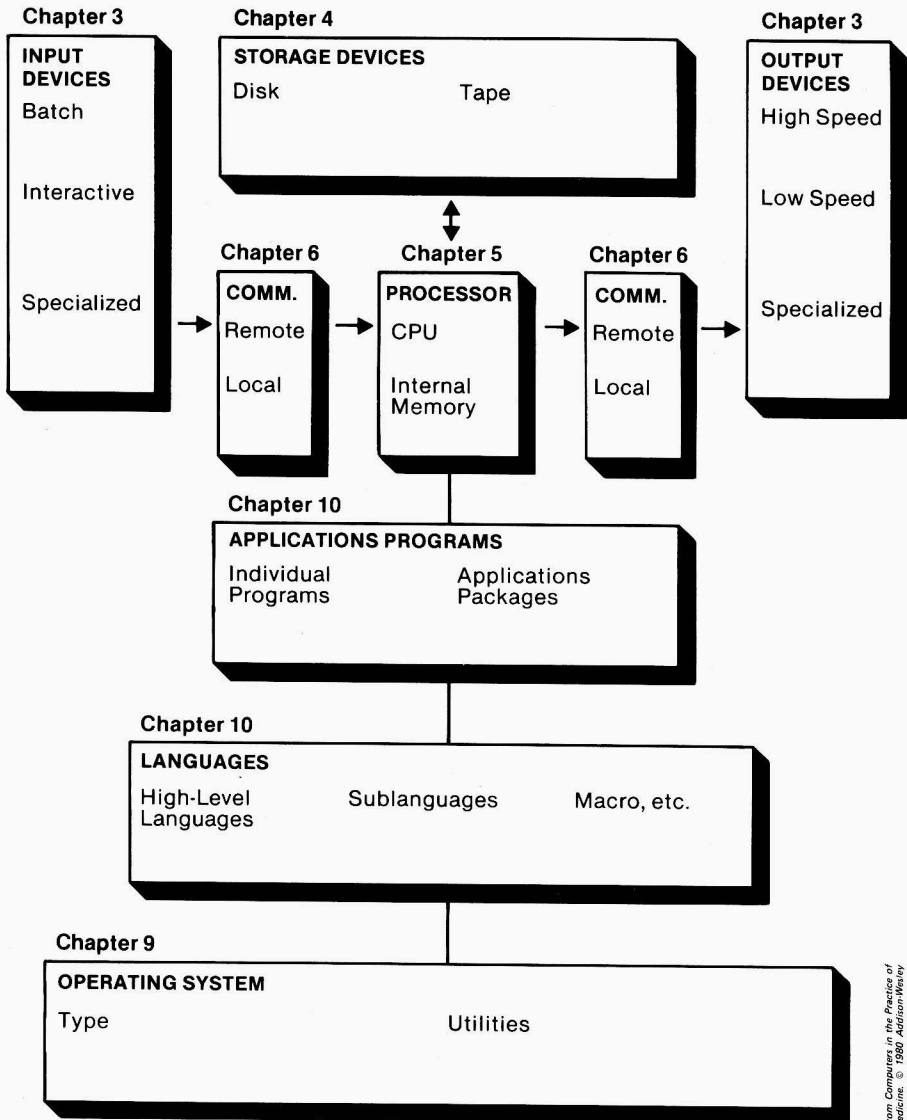
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PART

PRELIMINARIES



1

Introduction