Introduction to

INFORMATION TECHNOLOGY

SECOND EDITION

V. Rajaraman
Honorary Professor
Supercomputer Education and Research Centre
Indian Institute of Science
Bangalore

PHI Learning Private Limited
Delhi-110092
2013
To
DHRAMA
My Constant Companion
# Contents

_Preface_  

1. **Data and Information**  
   1.1 Introduction 1  
   1.2 Types of Data 3  
   1.3 Simple Model of a Computer 8  
   1.4 Data Processing Using a Computer 10  
   1.5 Desktop Computer 13  
   1.6 The Organization of the Book 15  
   1.7 Epilogue 16  
   Summary 17  
   Exercises 18  

2. **Acquisition of Numbers and Textual Data**  
   2.1 Introduction 20  
   2.2 Input Units 22  
   2.3 Internal Representation of Numeric Data 25  
   2.4 Representation of Characters in Computers 35  
   2.5 Error-Detecting Codes 38  
   Summary 38  
   Exercises 40  

3. **Acquiring Image Data**  
   3.1 Introduction 41  
   3.2 Acquisition of Textual Data 42  
   3.3 Acquisition of Pictures 49  
   3.4 Storage Formats for Pictures 54  
   3.5 Image Compression Fundamentals 58  
   3.6 Image Acquisition with A Digital Camera 61  
   Summary 63  
   Exercises 64
4. **Acquiring Audio Data** 67–79
   4.1 Introduction 67
   4.2 Basics of Audio Signals 69
   4.3 Acquiring and Storing Audio Signals 73
   4.4 Compression of Audio Signals 75
   Summary 77
   Exercises 78

5. **Acquisition of Video** 80–89
   5.1 Introduction 80
   5.2 Capturing a Moving Scene with a Video Camera 81
   5.3 Compression of Video Data 83
   5.4 MPEG Compression Standard 85
   Summary 88
   Exercises 89

6. **Data Storage** 90–119
   6.1 Introduction 90
   6.2 Storage Cell 93
   6.3 Physical Devices Used as Storage Cells 95
   6.4 Random Access Memory 98
   6.5 Read Only Memory 101
   6.6 Secondary Storage 105
   6.7 Compact Disk Read Only Memory (CDROM) 110
   6.8 Archival Store 113
   6.9 Conclusions 114
   Summary 116
   Exercises 117

7. **Central Processing Unit** 120–140
   7.1 Introduction 120
   7.2 Structure of a Central Processing Unit 122
   7.3 Specifications of a CPU 126
   7.4 Interconnection of CPU with Memory and I/O Units 130
   7.5 Embedded Processors 133
   7.6 Conclusions 137
   Summary 138
   Exercises 139

8. **Computer Networks** 141–164
   8.1 Introduction 141
   8.2 Local Area Network (LAN) 142
   8.3 Applications of LAN 144
8.4 Wide Area Network (WAN) 151
8.5 Internet 153
8.6 Naming Computers Connected to Internet 158
8.7 Future of Internet Technology 160
Summary 160
Exercises 163

9.1 Introduction 165
9.2 Video Display Devices 166
9.3 Touch Screen Display 168
9.4 E-Ink Display 169
9.5 Printers 170
9.6 Audio Output 174
Summary 176
Exercises 178

10.1 Introduction 179
10.2 Operating System 180
10.3 Programming Languages 186
10.4 Classification of Programming Languages 189
10.5 Classification of Programming Languages Based on Applications 192
Summary 193
Exercises 194

11. Data Organization 196–213
11.1 Introduction 196
11.2 Organizing a Database 197
11.3 Structure of a Database 198
11.4 Database Management System 200
11.5 Example of Database Design 202
11.6 Non-Text Databases 205
11.7 Archiving Databases 209
Summary 210
Exercises 212

12.1 Introduction 214
12.2 Use of Spreadsheets 215
12.3 Numerical Computation Examples 222
Summary 225
Exercises 226
## Contents

### 13. Processing and Displaying Textual Data 227–244

13.1 Introduction 227  
13.2 Word Processor 228  
13.3 Desktop Publishing 234  
13.4 Page Description Language 235  
13.5 Markup Languages 236  
13.6 Conclusions 241  
*Summary* 242  
*Exercises* 243

### 14. Processing Multimedia Data 245–257

14.1 Introduction 245  
14.2 Graphics Processing 246  
14.3 Audio Signal Processing 250  
*Summary* 254  
*Exercises* 256

### 15. Some Internet Applications 258–289

15.1 Introduction 258  
15.2 Email 259  
15.3 World Wide Web 262  
15.4 Information Retrieval from the World Wide Web 267  
15.5 Other Facilities Provided by Browsers 271  
15.6 Audio on the Internet 274  
15.7 Accessing Pictures and Video via Internet 281  
*Summary* 285  
*Exercises* 287

### 16. Business Information Systems 290–307

16.1 Introduction 290  
16.2 Types of Information Needed by Organizations 291  
16.3 Why Should We Use Computers in Businesses? 294  
16.4 Management Structure and their Information Needs 294  
16.5 Design of an Operational Information System 297  
16.6 System Life Cycle 299  
16.7 Computer System for Transaction Processing 303  
*Summary* 305  
*Exercises* 306

### 17. Electronic Commerce 308–337

17.1 Introduction 308  
17.2 Business to Customer E-Commerce 309  
17.3 Business to Business E-Commerce 311
17.4 Customer to Customer E-Commerce 313
17.5 Advantages and Disadvantages of e-Commerce 314
17.6 E-Commerce System Architecture 315
17.7 Digital Signature 320
17.8 Payment Schemes in e-Commerce 322
17.9 Electronic Clearing Service in e-Commerce 324
17.10 Cash Transactions in e-Commerce 325
17.11 Payment In C2C e-Commerce 327
17.12 Electronic Data Interchange 329
17.13 Intellectual Property Rights and Electronic Commerce 331
17.14 Information Technology Act 331
17.15 Conclusions 333

Summary 333
Exercises 336

18. Societal Impacts of Information Technology 338–358

18.1 Introduction 338
18.2 Social Uses of World Wide Web 340
18.3 Privacy, Security and Integrity of Information 343
18.4 Disaster Recovery 346
18.5 Intellectual Property Rights 347
18.6 Careers in Information Technology 349

Summary 354
Exercises 357

Suggested Further Reading 359–361

Index 363–372
Information Technology (IT) is currently a major industry in our country. The software services industry employed three million professionals with revenue of around 100 billion dollars during the financial year 2011–2012. Every day a large number of advertisements appear in newspapers for the employment of Information Technology professionals and also for persons in other professions who have a good knowledge of IT. A decision has been taken by many universities to introduce IT as a compulsory subject for all undergraduate students. In today’s world, the knowledge of Information Technology is essential. Thus, it is necessary for all students to be conversant with IT and its applications. The main objective of the book is to introduce IT in a simple language to all undergraduate students, regardless of their specialization.

Information Technology is a rapidly changing technology. In a university degree programme, it is important to emphasize the stable fundamental ideas on which this technology is built. The attempt of this book is to take this approach and not to emphasize the routine operation of computers, which is the approach taken in many user-oriented books. This book explains why some parts of computers are designed the way they are and how they work. It also describes a number of important applications of computers which are widely used and the fundamental ideas used in designing these applications.

Information Technology is primarily concerned with the acquisition, storage, processing and organization of data. It is also concerned with widely disseminating the organized and processed data for use by people and organizations. In the early days of IT, data mainly meant numbers and text. This has changed now. Besides numbers and text, computers also process image, audio and video data. Thus we need to understand how to acquire all these types of data, as well as how to organize, store, process, and disseminate them.

The first edition of this book was written in 2003. It was widely used by students and was reprinted 10 times. There have been many advances in Information Technology since 2003. I decided to review the book and bring out a new edition incorporating these advances. I have revised every chapter and improved the presentation and added new sections wherever appropriate. The basic structure of this edition of the book has not changed as it was written emphasizing the fundamentals of Information Technology.

This book is broadly organized into three parts. The first part consisting of Chapters 1–9 primarily deals with the acquisition of numerical, textual, image, audio, and video data. In Chapters 1–5, we describe the hardware devices used to acquire these types of data and the methods of converting these data to binary form suitable for storage and processing by computers. In Chapters 6–9, we describe the units of a computer used to store, process, and
disseminate data. Our aim in these chapters is not to describe the hardware units in great detail but to present the basic ideas used to design them. The second part consisting of Chapters 10–14 is essentially related to software used to organize and process data. We describe in these five chapters the basics of programming languages, operating systems, databases, spreadsheets, word processors, and multimedia processing. The final part of this book consisting of Chapters 15–18 presents major day-to-day applications of IT, including applications in business and commerce. In Chapter 15, we give a reasonably detailed account of the major applications of the Internet, such as email, file transfer, remote computing, search engines for locating information in the World Wide Web, and the use of the Internet for telephony and video conferencing. We describe in Chapter 16 how businesses use computers for management. E-commerce is an application of IT which is profoundly affecting our daily life. Thus a chapter is devoted to describing it in detail. The last chapter is intended to bring awareness among students about the many important changes which are occurring in our society due to the advent of IT. Applications such as Facebook, Blogs, Twitter, and LinkedIn are now becoming commonplace and changing interpersonal communications. We also discuss the various career opportunities which have arisen in IT enabled services.

The book is written in a student-friendly style. Each chapter begins with a statement of learning goals and ends with a summary of the main points presented in the chapter. Exercises are given at the end of each chapter to assist students to reinforce their understanding of the contents of the chapter. The index of the book is fairly detailed.

I thank the following persons who helped me in writing the first edition of this book. Mr. N.R. Narayana Murthy, when he was the Chairman and the Chief Mentor of Infosys Technologies Ltd., provided partial financial assistance; Prof. S.K. Nandy, my colleague in the Supercomputer Education and Research Centre, gave several suggestions; Ms. Padmaja read the manuscript and assisted in many ways; Ms. Udaya Neelakantan read the entire manuscript and gave valuable suggestions; Ms. T. Mallika word processed the manuscript and typed several drafts of both the first and the second edition.

I gave the first edition of this book to Professor Hari Balakrishnan, Fujitsu Professor of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, USA, for his review and for suggesting improvements. In spite of his busy schedule, he meticulously read many chapters of the book and suggested several changes. I have incorporated most of them in this second edition. I thank him for his generous assistance.

This book could not have been written without the enthusiasm and wholehearted support of my wife Dharma. She read the entire manuscript, gave suggestions for improvement, proofread the press copy meticulously and assisted me in several ways. I thank her sincerely.

In spite of my best effort, there may still be some errors and some topics may not be clearly explained. I welcome criticism and suggestions from my readers. My email id is rajaram@serc.iisc.ernet.in.

V. RAJARAMAN
CHAPTER 1
Data and Information

LEARNING GOALS

After reading this chapter, you should be able to:

1. Explain the difference between data and information.
2. Classify different types of data which are processed by computers.
3. Explain the functions of the units of a desktop computer.
4. Describe how data is processed by a computer.

1.1 INTRODUCTION

Information Technology (IT) may be defined as the technology that is used to acquire, store, organize, process, and disseminate processed data which can be used in specified applications. Information is processed data that improves our knowledge, enabling us to take decisions and initiate actions.

Example 1.1 Let us take a very simple example. A home-maker who buys vegetables, provisions, milk, etc., everyday would write in a diary the money spent on each of these (see Table 1.1). At the end of each day she adds up the data on money spent for these items. The total obtained is the information which she uses to adjust expenses to spend within her budget. This is illustrated in the block diagram of Fig. 1.1.

FIG. 1.1 Data and information.
Table 1.1 Daily Expenses

<table>
<thead>
<tr>
<th>Date</th>
<th>Vegetables</th>
<th>Milk</th>
<th>Provisions</th>
<th>Miscellaneous</th>
<th>Daily total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.2001</td>
<td>25.50</td>
<td>20.00</td>
<td>95.00</td>
<td>150.00</td>
<td>290.50</td>
</tr>
<tr>
<td>2.1.2001</td>
<td>30.40</td>
<td>20.00</td>
<td>85.40</td>
<td>250.50</td>
<td>386.30</td>
</tr>
<tr>
<td>3.1.2001</td>
<td>15.50</td>
<td>25.00</td>
<td>128.00</td>
<td>80.00</td>
<td>248.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.1.2001</td>
<td>19.50</td>
<td>20.00</td>
<td>25.00</td>
<td>15.00</td>
<td>79.50</td>
</tr>
<tr>
<td>Total</td>
<td>750.50</td>
<td>650.00</td>
<td>2800.50</td>
<td>2852.50</td>
<td>7053.50</td>
</tr>
</tbody>
</table>

Observe that data is the raw material with which she started, and information is processed data that allows her to initiate action to balance her budget.

The data entered in the diary each day may be processed in other ways too to obtain different information. For example, if the total monthly expense on milk is divided by the monthly income, it gives information on the proportion of the budget spent on milk. This is shown in Fig. 1.2.

![FIG. 1.2 Information as input data.](image)

This information may be useful to manage the family income in a more efficient manner. Observe that the information obtained in Fig. 1.1 is used as data in Fig. 1.2. This illustrates that the distinction between data and information is not always clear. The point to be emphasized is that mere facts and figures about activities do not enable one to take decisions or to initiate actions. Only when they are processed and presented in an effective manner, they become useful.

**Example 1.2** As an example of how organizing data enhances our understanding, let us consider the marks obtained by students in an examination. The marks by themselves do not give any immediate idea about the performance of the class. By processing this data, a bar chart may be obtained, which gives the number of students with marks between 100 and 90, 90 and 80, 80 and 70, and so on. This chart (Fig. 1.3) gives the teacher of the class information on the performance of the class that would enable him or her to initiate appropriate action such as which students need special attention.