INTRODUCTION TO COMPUTER SYSTEMS

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To

Dr. R. Bandyopadhyay……
to whom both
authors owe much……

FOREWORD

The New Three Year Degree Course of the Bombay University in the Faculties of Arts, Science and Commerce became operational from June 1977. The Course contains many innovative features, of which the introduction of the applied element is one. Computer System, Computer Science and Computer Programming are among the Applied Component subjects that have immediately became popular and have caught the imagination of alert, intelligent, undergraduate students. Computer Programming already forms part of the post-graduate courses in Statistics and Management. The increasing use of quantitative techniques in all aspects of the working of a modern society is the clear justification for the introduction of Computer techniques in academic courses.

Like many other branches of knowledge, computer technology and computer uses have their origin outside India. Their application to Indian experience involves all the problems and adjustments attendant upon the learning of a new language representative of a new culture. Teachers and text-books acting as communication links have, therefore, to undertake the delicate exercise of combining rigour of analysis, simplicity of expression, and ease of illustrative application. I am happy to say that Dr. S. M. Padwal and Dr. Smarajit Dey have succeeded in this task and deserve appreciation at the hands of all concerned, whether students, teachers, laymen or experts. The utility of this excellent book has further been enhanced by the addition of a glossary of technical terms, a list of computer installations in India, exercises of both scientific and commercial nature, and a bibliography of reasonable size.

I congratulate the authors on their success in producing a useful publication, that will at once meet the short term needs of students, wanting introduction to new knowledge, and the long term needs of enthusiasts aspiring a computer career. I wish the authors all good luck.

G. L. Abhyankar

Preface

"Another book on Computer Systems ?" was our initial reaction when we were approached to write this book. When we finally sat down to write the book, therefore, it was our endeavour to make it as different as possible from the other books available in the market. In this, we believe, we have been partly successful.

To begin with, we have tried to consistently maintain the Indian orientation of this book. In the examples and applications we have covered, there are no sophisticated systems impossilble to replicate in India; further, our chapter on Business Applications, and the appendix on Computer Installations in India, serves as a valuable guide to the reader who wishes to make computers as his career. It has also been our experience that books available today lay an unusually heavy emphasis on Engineering applications. This we have tried to avoid, and believe, that our book is a happy mix of scientific and commercial examples with the emphasis being on the underlying concepts that are used in all programming.

We have also been careful about the choice of our target population. The undergraduate syllabus of Bombay University has been used to guide the relative weightages of our chapters, and therefore this book is likely to be invaluable to the B. A., B. Com. and B. Sc. students of any university who have opted for Computer Science. We have also tried to cater to the needs of the Post-graduate Management students, the formal Computer Science syllabi of most such courses have been covered by this book. And lastly, we have had practising professionals — bankers, managers, engineers—in mind ; such people who may not have been formally trained in Computer Science, but who are aware enough and have vision enough to realise that today's professional is lost without some degree of knowledge about computers.

A few words now about the contents of this book. Chapter 1 deals with concepts and terminology frequently used in the field of Computer Science, while Chapter 2 introduces the reader to the peripheral devices which form a part of Computer Systems. Both these chapters are introductory in nature, and the reader with above average knowledge about computers will find in them perhaps only the freshness of a new approach. Chapter 3 is a detailed treatment of Computer Systems, and of the hardware and software that form a part of such systems. This chapter is important both to the serious student of Computer Science, for it establishes the general framework in which computers should be understood – and also to one who has a general interest in computers – for it is a comprehensive treatment of the functioning of computers.

From Chapter 4 begins the detailed treatment of the design of Software systems. This chapter deals with flowcharting and establishes its utility in all programming. Chapters 5 and 6 provide a reasonably thorough introduction to Fortran Programming. As we have stated elsewhere in this book, authors attempting to teach programming face a peculiar dilemma. Programming involves a set of concepts and techniques which are quite independent of the language in which the program is written; obviously it is these concepts which should be taught to the student, for then it is possible for him to pick up any language and program in it. At the same time, different languages have their special characteristics which must be explained to the student. What is required therefore is an approach which uses the language as only a medium to express the underlying concepts. We have found that in most cases, programming becomes language–teaching, very regrettably. We believe that we have been successful in synthesising programming with the teaching of FORTRAN. Even while teaching FORTRAN, we have been careful to point out the differences in the languages that exist among various computers.

Chapter 7 is a brief introduction to COBOL programming. In this chapter, we have assumed that the reader is already familiar with programming concepts, and have therefore presented some very condensed characteristics of the language. Regarding Chapters 5, 6 and 7, one point must be unequivocally made – we believe that it is impossible to master programming without actually writing programs, and running them on a computer. In the course of our teaching experience, we have encountered numerous students who are able to grasp concepts easily as they are being taught in class, but are unable to program because of lack of practice. The reader is advised ! Chapter 8 deals with predominantly Indian applications of computers, and also discusses the growth of computer technology. This chapter should once again prove very useful to both the advanced student and the interested layman. In addition to Exercises and Bibliography, our appendices consist of a Glossary of Terms and a comprehensive list of computer installations in India.

Before we end, it is our pleasure to thank all those who have in many ways helped us in the preparation of this book. We are grateful to Prof G. L. Abhyankar, Principal Sydenham College of Commerce and Economics, Bombay for having consented to write the Foreward of this book, and for having been a source of inspiration throughout.

We are indebted to Prof. Om Vikas of the Department of Electronics for permission to reproduce a part of his paper in our appendix. Our heartfelt thanks are to Sushil Saxena and Anjan Ghosh – students of ours (the latter now a colleague), for their help in the production of these notes. The last named author also gratefully acknowledges the suggestions and help given by fellow ' computer bug, ' Sudeb Basu. We are also grateful to our colleagues at the National Institute of Bank Management and the Birla Institute of Technology and Science, for having helped us to crystallise our ideas through numerous discussions. And of course, our most profuse thanks to the succession of secretaries who have battled doggedly to enable us to meet production deadlines; among them, special mention must be made of Mrs. Kashmira Golwala who, being a small computer by herself, always made fewer mistakes than we did, and was always faster than we were !

Bombay
July, 1980.

S. M. Padwal
Smarajit Dey

CONTENTS

CHAPTER 1

The Concepts and Definitions

Introduction : We hear and read about computers all the time. Newspapers carry some news about them. Banks, engineering firms, airlines, insurance companies, hospitals, government offices and the like have started making use of the computers, in India, and hence computers are very rapidly becoming the daily routine.

Before going into technical aspects of computers let us start with an acceptable definition of a computer.

Computer : It may be defined as one who or one which computes. This may be electronic machine for the high-speed performance of mathematical and logical operations, or for the processing of large masses of information. Thus computer is basically a very fast calculating *machine.*

The computer is able to do *only whatever it is precisely instructed to do* by its programmer within its capabilities. But it is not working on its own; it is merely carryiag out the instructions given to it.

All computers are machines that follow instructions given to them by their users. These instructions must be stated in a language that the computer 'understands', and these must be given in the proper sequence. If these are not given properly, the computer, dumb machine that it is, will follow them anyway and generate the wrong answer.

The process of writing and sequencing instructions is called computer programming. The set of instructions written by the programmer is known as the programme. In the latter chapters we will discuss the details of programming.

The computer is composed of five basic units. Instructions are given to the computer through some type of Input device. The computer remembers the instructions and data by storing them in its Memory Unit. It performs calculations and makes decision in its Arithmetic/Logic Unit, and it communicates information to its user through an Output device. Finally, in order to control all these operations a computer has a Control Unit, which decides what is to be done and when.

If one were to draw a picture to show the computer's parts, it might look like Fig. 1.1. In reality, these components cannot be distinguished so easily. A small computer may have them all housed in one small cabinet, while a large computer may consist of many separate units. For purpose of reference we will find this figure has been reproduced in chapter 3 as Fig. 3.1.

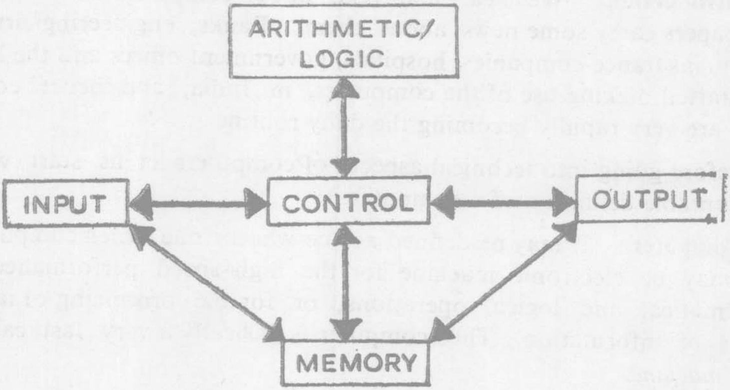

Fig. 1.1 Functional Parts of a Computer

As most people know, computers operate very quickly and accurately. They can do hundreds of thousands of calculations in a second and rarely make an error. We humans are much less fortunate; we can perform simple calculations in minutes or perhaps seconds, but not in minute fractions of a second and we often slip up in our arithmetic. The time differential between machines and humans is used to advantage by many computers. For example, picture a computer with ten users (Fig. 1.2). Each user operates at human speed. The

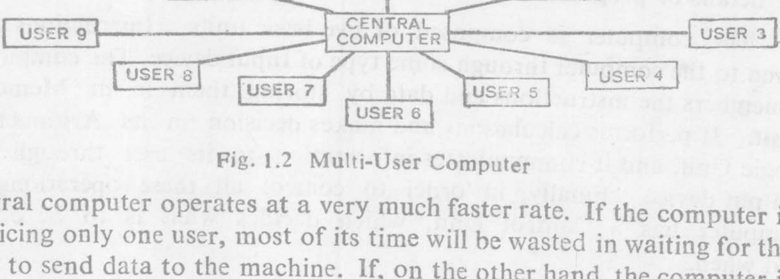

Fig. 1.2 Multi-User Computer

central computer operates at a very much faster rate. If the computer is servicing only one user, most of its time will be wasted in waiting for the user to send data to the machine. If, on the other hand, the computer is allowed a short amount of time to service the requirements of one user and then serves the next user in turn, all users will have access to the central computer. This type of operation, where a number of users share a single computer, is called time-sharing.

In essence, a time–sharing central computer gives each user a ' burst ' or ' slice ' of time. In this time interval, perhaps ·005 second, the computer does as much as possible for the user. At the conclusion of the time burst, the computer goes on to the next user and gives him a burst of time. The process is repeated until all users have had a burst of time. At this point the whole operation is performed again. Thus, if eight users are each given a ·005 second burst, the computer will repeat the operation every four hundredths of a second ! The user will never be aware that the computer 'left' him to work on some other user's programme. Time sharing thus allows many users to work " simultaneously'' with one central computer. The computer is used more efficiently with a lower cost to each user.

In contrast to time–sharing computers, many computers in use today can serve only one user at a time. This mode of processing is called " batch processing ". The vast majority of computers still operate in this mode.

Computer programmes can be written in a number of different computer languages. These languages can be grouped into three general categories : Machine languages, Assembly languages and High–level languages.

Machine language is the language of the computer. Machine language programmes can be run only on the type of computer for which they are written. The programme itself cannot be read except by the computer or an expert programmer since it is written as a sequence of characters. The details of computer programming languages will be dealt with in latter chapters.

Types of Computers : Computers may generally be regarded as being special purpose or general-purpose. Special-purpose computers, as the name suggests, are able to perform only a limited number of functions. They are usually highly efficient and faster than general-purpose computers but more restricted in their application.

The general-purpose computer is capable of carrying out a wide variety of instructions.

A second way of classifying computers is as *analog* and *digital* computers. We usually say that an analog computer measures, whereas digital computer counts.

Analog computers are used primarily in engineering or scientific computing. They are designed to accept physical forces, such as voltage, forces, pressures, speeds of rotation, temperatures, or other phenomena, and record them as readings along a continuing scale. The thermostat and the automobile speedometer are elementary examples of analog computers. This is a very simplistic definition, using traditional concepts.

The digital computer accepts specific, discrete data. Most digital computers are used in business applications. Since they are the most widely used type of computers, most of our discussion will be devoted to them.

Data and Information : The word data, as used in this text, is considered a collective noun, like news. Data is a set of facts about some person, thing, or event. We speak of a data element, such as date of birth as being a general class or category of data. The specific value, the data element has at any given time, such as January 8, 1922, is a data item, which relates to a specific person.

Data ordinarily becomes meaningful only when it has been collected, processed in some way, and related to other data to form usable information. Collecting, relating and combining data have been done for years in various manual, mechanical, electrical, and electronic ways. The term ' data processing ' is normally applied to the use of electronic computers and related machines that can process data automatically at high rates of speed with remarkable accuracy.

Characters, Fields and Records : Data is made up of numerals, letters, and to a smaller degree, special character symbols. The characters or letters are put together in strings of different lengths, called *fields.* For example, a typical name field for a student or employee, showing last name first, then first name, then middle name or initial, with spaces between, requires, 20 to 24 spaces. In working with computers, we must figure the best field size for each type of data element and then adjust the data items by padding with zeros or blanks to make all data items that occupy that field a uniform size.

The related fields that concern one person, transaction, or thing are normally grouped together into a *record.* For example, a record about a student might contain such data elements as names, parent's name, address, current grade or class, programe or subject, credits or marks earned to date, courses taken during the current term, and many others.

Files : A file is a collection of records organized for some particular purpose. The purpose for which the file is to be used dictates to a large degree the amount of data each record in the file contains. For example, in a college, one file might give the name and a great deal of other information about every student who has ever attended the institution. A second file might contain information on only the students enrolled during the current term. A third file might give the name and more limited data about each student who lives in a particular dormitary or hostel.

Transaction Files : A transaction is some event or happening about which we wish to collect data. For example, a student might file application for admission to a college or university. The receipt of the application is one of a series of transactions about which we wish to make a record. From the student's application form, we can extract many relevant items of data and record them into punched cards or some other medium that machines are able to read and process. Later transactions would include receiving the student's transcript, notifying him of his acceptance into college, receiving his room reservation or tuition deposit, registering him for courses for a specific term and recording his grades at the end of a term.

Most transaction files do not need to repeat data elements that have been already recorded. Normally they include only some specific indentifier, such as student name and then record specific data about the transaction itself, such as data, type of transaction, rupee value, grade room assignment, or other specific items.

A listing of the transaction for any given day, week, or month is frequently called a register, log, or journal. In accounting, we have such transactions as cash receipts, charge sale, cash disbursements, and journal entries.

Master Files : Master files normally contain more extensive information than do transaction files. They show the condition or status of a student, employee, or account at any given time. Transaction files are used to make necessary updates or changes in master files. For example, the total term marks earned to date in a student master file would be updated at the end of each term as the transactions showing grades and credits for eaeh course are processed.

The Data Processing Cycle : As stated earlier, data processing involves taking certain data elements, organizing or relating them together in some way, and producing usable and meaningful information. Steps by which we do this are usually called input, processing and output.

We refer to data processing as being a cycle because of the fact that the output from one stage of processing is often used as input at a later time. It is therefore important for efficient operations to put some of our output on a type of medium or electronic device that can be read automatically by the computer as input at a later time (See Fig. 1.3).

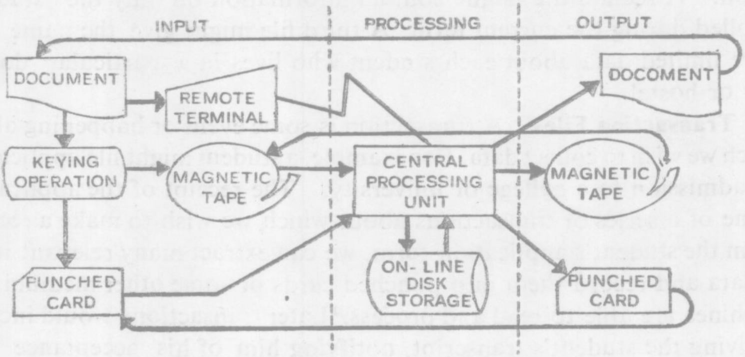

Fig. 1.3 The Data Processing Cycle

Input : Data can be entered into a computer system only when it has been captured and recorded in a form that machines can read. Modern electronic computers are able to sense or read data from punched cards, punched paper tape, magnetic tape, magnetic disks, optical marks, optical characters, typewriter keyboards, embossed plastic cards, and many other forms.

Origination : Input data originates when some transaction takes place. It is important to capture all the data you expect to need at the time and place the transaction occurs.

Recording : Ideally, all data about a transaction is recorded initially in some form that machines can read. Where this is not possible, the data should be recorded in a form so arranged that it is easy to transcribe at a later time into punched cards, magnetic tape, or some other media that are machine-readable.

Great care and accuracy must be used in recording the data, since any missing detail about the transaction may be difficult, if not impossible, to reconstruct at a later time.

Classifying : Often, in processing data into usable information, we must ensure that similar items are grouped together. The process of determining what group or class something belongs in is called classifying.

Usually we assign a code to some class of transaction or data item. The code not only requires less space but is more precise than a general narrative description. For example, if we offer 100 different subjects in our college, we might use numeric codes ranging from 00 through 99 to classify these subjects, rather than using names such as electrical engineering, biochemistry, or quantitative methods.

Transcribing : Once the essential facts about a transaction have been recorded and classified, they are ready to be transcribed into machine-readable form. The most common transcription process historically has been to keypunch data from a handwritten or typed paper document into fields of a punched card. The punched cards are collected into a batch and later read into the computer system.

Increasingly, data is being transcribed on magnetic tape, which may be processed faster than punched cards and requires less storage space.

Another form of transcribing that is growing rapidly is the use of a keyboard that is attached by means of telephone or other communication lines directly to a computer system. Transcribing directly into the computer keyboard saves time over keypunching, but does increase the danger of error or of destroying data already in the computer files.

Processing : Once the data we wish to use is available in machine-readable form, we are ready to begin processing. Some of these steps, such as sorting a group of punched cards using a high-speed sorter, may be done before the data is entered into the computer system, or off--line. Other steps are done by means of instructions, or programme carried out within the computer and are called on-line. Both data and instructions are placed internally in the main storage of the computer in the form of magnetic codes.

Sorting : The term sorting means placing a group of records, into the desired sequence. Typically, transaction records are sorted into the same sequence in which master files are kept. The sorting operation places together all the records that belong in the same class, and facilitates later steps of updating or summarizing.

Merging : We may combine two files that are already sorted in the same sequence into a single file by merging. The field on which the records in each file have been sorted is called the key. There is one primary and one secondary file. In straight merging, one record is read from each file, and the record having the lowest key is written out to the merged file. If both keys are the same, the primary record is written out first.

Many variations are possible, such as merging only records that have equal or matching keys, and bypassing unmatched records. More than two files may be merged by assigning secondary files a definite priority.