# FLOWCHARTING

## A TOOL FOR UNDERSTANDING COMPUTER LOGIC

## A SELF-TEACHING GUIDE


NCY B. STERN

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## A Tool for Understanding Computer Logic



**NANCY B. STERN**
*Suffolk Community College*




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Editorial Supervisor: Winn Kalmon
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# FLOWCHARTING

# Preface

The primary objective of this book is to teach computer logic using the tool of the program flowchart. FLOWCHARTING is intended for a wide range of potential users who might wish to understand computer processing. There are no prerequisites for using this Self-Teaching Guide. It can be used by data processing majors, business majors, liberal arts majors, or even general readers who wish to gain conceptual knowledge of how the computer logically functions. As a supplement to an introductory data processing text, FLOWCHARTING will provide the reader with the most comprehensive and functional tools needed to understand computer processes.

After completing the book, the reader will be able to program in any programming language by simply learning the basic rules of the language. The crux of programming—the logic—is taught in this book; with an understanding of this logic, programming itself becomes a simplified task.

Unlike other flowcharting books, this book's step-by-step approach is especially designed to help the reader integrate the material through guided applications. By using the programmed instruction format, the reader progressively enhances practical understanding of the logic functions performed by a computer. The approach is basic, not encyclopedic, and is designed to provide a working knowledge of computer logic, not to overwhelm the reader with independent and unrelated topics.

I wish to express my thanks to Joan V. Hughes for her extremely useful advice on the subject matter and its organization; to Judy Vantrease Wilson, Editor at Wiley, for her invaluable assistance and advice in preparing the manuscript; and to Irene Franck Brownstone, Editor at Wiley, for her monumental efforts on behalf of this book.

And, lastly, a special word of thanks to my husband, Robert Stern, without whose profound support—both personal and professional—this book would not have been written. For this, and for so much more, I am very grateful.

Coram, New York
March, 1975

Nancy Stern

# How to Use This Book

Each chapter contains: (1) a set of objective which outline the material to be covered; (2) a series of numbered frames providing a step-by-step integration of material, each including one or more questions or flowchart problems designed to test your understanding of that material; and (3) a Self-Test which will assist you in determining whether you have sufficient understanding to proceed to the next chapter, and, if not, where the problem areas exist. Each answer furnished for the Self-Test questions contains references to a series of frames to which the question applies, so that if you answer a question incorrectly, the particular area of weakness can be readily found.

The programmed instruction format of this guide is particularly suited to flowcharting since it allows you to apply your understanding throughout by both answering questions and actually drawing flowcharts. Then you can check your understanding before you go on. Following the dashed line in each frame is the correct answer or a standard flowchart solution to compare with your own. You should note that just as it is possible to provide several different logical arguments, all correct, to prove a given point, it is possible to draw several different flowcharts, all correct, to perform a given task. For this reason, your flowchart drawings may not always conform exactly to the solutions provided. Where alternatives are obvious, a note has been inserted following the flowchart, describing these alternatives. In other cases, you will need to study the given flowchart solutions to determine if your answer is basically the same. In all cases, if you can answer the questions at the end of the frames and understand the flowchart solutions provided, you will have no difficulty assessing your solutions. It is most important, therefore, that you understand each flowchart solution before proceeding to the next frame.

The time you will need to complete each chapter will vary according to the complexity of the material and your own individual working habits. In all chapters, however, because each unit is carefully structured to integrate the material presented, it is important that you work through to the end of a chapter or section rather than stop at some arbitrary point.

# Contents

# CHAPTER ONE
# Why Computers?

The main objective of this Self-Teaching Guide is to provide an understanding of computer logic through flowcharting. The guide requires no previous exposure to data processing. It provides a step-by-step introduction to the logic used in computer processing, by utilizing the technique of the block diagram or flowchart. With an understanding of this logic the beginner will be able to program competently in any computer language by simply learning a few basic programming rules for that language.

Prior to a discussion of computer logic, however, it is important that you understand and be able to use certain fundamental terms in data processing. These terms are used throughout the book and, indeed, in all data processing centers. It is to these terms and concepts that we devote this chapter. When you complete this chapter, you will be able to:

- recognize and apply the following basic computer terms: input, output, source document, hardware, program, flowchart, data, central processing unit (CPU);
- organize data into hierarchies, from characters to files;
- show how data is organized on punched cards and on printed reports, including the length of each, the arrangement of data within fields, and use of edit symbols;
- describe how data is converted from the source document to the punched card;
- classify fields as numeric, alphabetic, or alphanumeric;
- write simple sequences of instructions for data transfer and arithmetic operations, using input areas, output areas, and storage areas;
- explain the relationship between a job description, a flowchart, and a program;
- identify various devices as input (I), output (O), or input/output (I/O);
- identify fields as variable or constant.

1. How long would it take you to add 998,756 + 985,769? It probably would take approximately five seconds. In the same time, a typical computer could easily perform between 50,000 and 100,000 such additions. In fact, some computers could perform over 1,000,000 additions in the same five seconds.

We have just observed one of the most compelling reasons for the great success of computers today—their speed. Computers can also perform their operations with far greater accuracy than people. But, you say, why is it that computers constantly goof? When computers are blamed, as they often are, for inaccurate results, the fault most often lies with the personnel using or programming the machinery.

The two major reasons for using computers are _____ and _____.

- - - - - - - - - - - - - - - - - - -

speed, accuracy

2. Computers are used in two main types of processing. Business applications of computer processing are described as data processing. Business applications usually require relatively simple calculations to be performed on large volumes of information. For example, the calculations of paychecks for 50,000 employees is a typical business application—large volume, simple arithmetic calculations.

The more intricate type of computer processing, where relatively complex mathematical operations are performed on a relatively low volume of information, is called scientific processing. For example, the calculation of a moon trajectory may involve the use of only a handful of variables, but the complexity of the calculation may keep the computer busy for hours!

What are the two main areas in which computers are used? _____

_____.

- - - - - - - - - - - - - - - - - - -

data processing (business applications) and scientific processing.

Our discussion of computer logic applies to both business and scientifically oriented computer processing. Let us begin with an introduction to the most fundamental forms of computer media—the punched card and the printed report.

## PUNCHED CARDS AND PRINTED REPORTS

3. This section will familiarize you with a common form of incoming computer information, the punched card, and with the most common form of outgoing computer information, the printed report. Knowing something about these computer media, you can begin to understand how data processing functions are performed.

First of all, two important terms: input and output. Incoming informa-

tion which enters a computer system is called input, sometimes abbreviated I/P. Outgoing information which leaves a computer system is called output, sometimes abbreviated O/P.

What is a common form of computer input? _____

What is the most common form of computer output? _____

_____

- - - - - - - - - - - - - - - - - - -

the punched card; the printed report

4. Information entering a computer center is called _____.

Information leaving a computer center is called _____.

- - - - - - - - - - - - - - - - - - -

input or I/P; output or O/P

## Punched Cards

5. The punched card is the most basic form of computer input. While many large companies also use forms such as magnetic tape and magnetic disk (to be discussed later), punched cards are still the most widely used form of input in small computer organizations.

Information is recorded on these punched cards by punching holes in the form of a code. Consider the time card illustrated in Figure 1.1. The punched holes represent information in coded form.

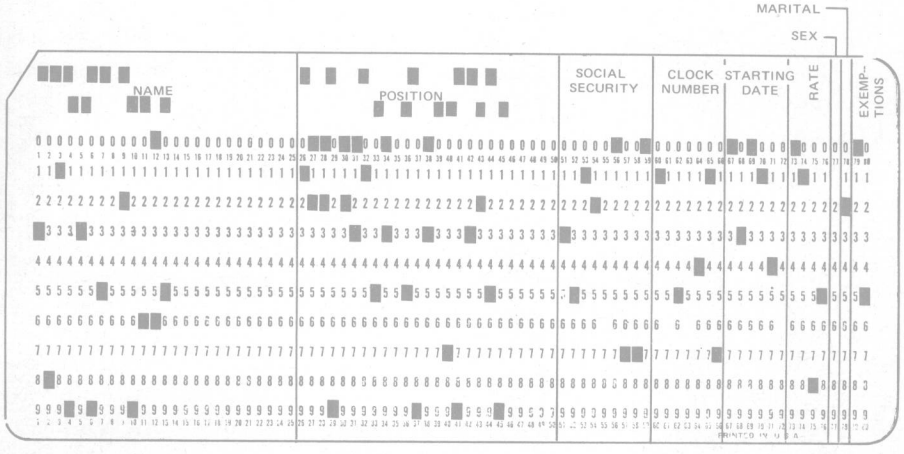



Figure 1.1. Time card.

This card represents a record or unit of information. The entire deck of such card records represents a file of information, which is the collective group of related records. Can you think of some punched card examples that you have encountered? _____

_____

- - - - - - - - - - - - - - - - - -

Many telephone company bills, electric company bills, and gas company bills are on punched cards; so are many college course registration cards. You may have thought of other examples, too.

6. Suppose that a telephone company sends out its bill on a punched card. The bill you receive is called a (file, record) _____. The totality of all bills sent out to all customers is called a (file, record) _____.

- - - - - - - - - - - - - - - - - -

record (If you answered "file," remember that a file is a collective group of records; generally, more than one card would be required for an entire file.)
file (If you answered "record," remember that a record is usually a single item.)

7. Why do you think such cards are called punched cards? _____

_____

- - - - - - - - - - - - - - - - - -

because they are coded with information in the form of punched holes

8. Each record consists of characters, which make up information referred to as data. In computer terminology, the terms data and information are generally interchangeable. A character is a single letter, digit, or special symbol such as $, +, -, or *.

Thus, data is a combination of characters, which may consist of _____ _____, _____, or _____, or any combination of these, that result in meaningful information or _____.

- - - - - - - - - - - - - - - - - -

letters, digits, special symbols, data

9. What input medium represents characters of information through the use of punched holes? _____

- - - - - - - - - - - - - - - - - -

_____

the punched card

10. Consider the blank card in Figure 1.2. Notice that at the very bottom of the card there are small digits numbered 1 through 80. Note also that below the first horizontal group of zeros, there are the same 80 numbers. Each of these numbers refers to a column or vertical section of the card.

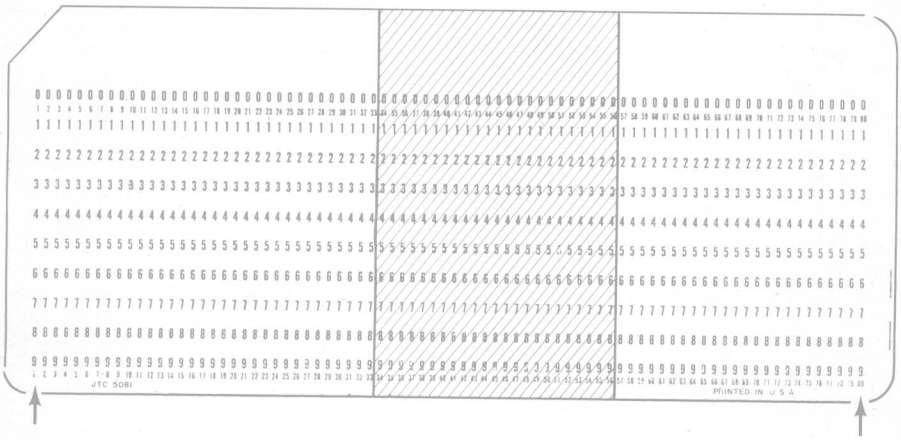



Figure 1.2. Sample punched card.

How many card columns are there ? _____

- - - - - - - - - - - - - - - - - - -

80

11. Part of Figure 1.2 is shaded lines. That portion includes columns ____ through ____ on the card.

- - - - - - - - - - - - - - - - - - -

34-56 (It is important that you understand the answer to this question, because you must be able to identify card columns. On the bottom of the illustrated card, there are 80 numbers; in the area shaded, these numbers correspond to 34 through 56. These numbers signify card columns 34 through 56.)

12. The code used for representing punched data on an 80-column card is called the Hollerith code, named for the man who developed it, Herman Hollerith.

Each column on a card is used to represent one character of information. Each column can contain one _____, one _____, or one

special symbol. A card, then, can store or hold how many characters? ____

- - - - - - - - - - - - - - - - - - -

letter, digit (in either order); 80

13. Notice in Figure 1.1 that columns _____ through _____ are referred to as NAME. NAME then would consist of how many characters? _____

- - - - - - - - - - - - - - - - - - -

1, 25; 25

14. NAME is called a field of information. A field is a consecutive group of characters used to represent a unit of information within a record. What are some other fields of information on the time card in Figure 1.1? _____

- - - - - - - - - - - - - - - - - - -

POSITION, SOCIAL SECURITY NUMBER, CLOCK NUMBER, STARTING DATE, RATE, SEX, MARITAL STATUS, EXEMPTIONS

15. The columns used to represent POSITION are _____ through _____. The field POSITION consists of how many columns? _____

- - - - - - - - - - - - - - - - - - -

26, 50; 25

16. The holes on the card are punched according to the _____ code representation.

- - - - - - - - - - - - - - - - - - -

Hollerith

17. The time card is a (field/character/record/file) _____ of information.

- - - - - - - - - - - - - - - - - - -

record

18. How many characters are there in the field called RATE in Figure 1.1?

_____

- - - - - - - - - - - - - - - - - - -

four (since there are four columns)

19. Most cards contain how many columns? _____

- - - - - - - - - - - - - - - - - - -

80

For our purposes, it is not necessary to learn the actual Hollerith code representation of data on a punched card. Figure 1.3, however, gives a complete description of that code for the curious. For a more thorough discussion of the Hollerith code, see any introductory data processing book.

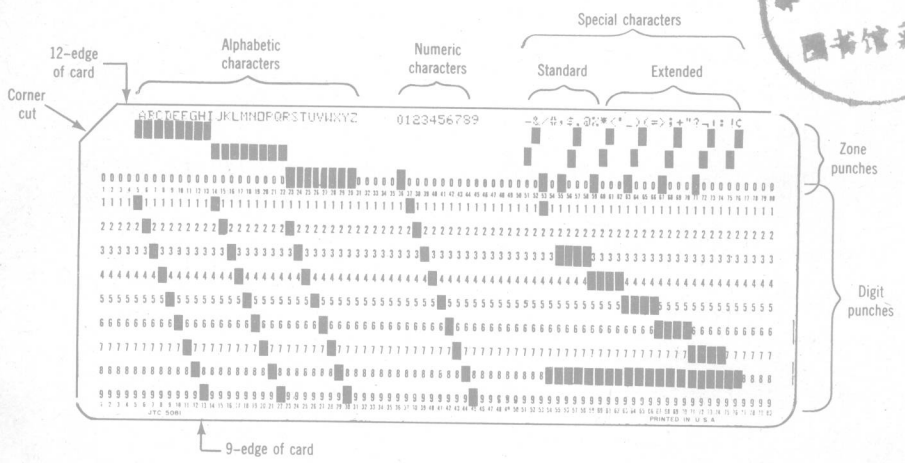
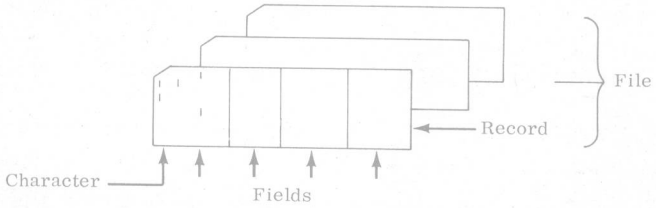



Figure 1.3. Review of punched card codes.

Note that alphabetic characters and most special characters require more than one punch in a column. Note also that the information punched in the card can also be printed on the top of the card. This printing enables data processing personnel to read the card data, and has no effect on the computer processing.

20. Now let's discuss the hierarchy of data using an illustration.




Each field consists of data items made up of _____. A group

of fields representing a unit of information is called a _____. The entire set of information which contains all records for a particular application is called a _____. Another name for information is _____.

- - - - - - - - - - - - - - - - - - -

characters; record; file; data

## Characteristics of Fields

21. Data fields can be classified in three ways.

| Classification of fields | Allowable characters |
|---|---|
| numeric | digits, decimal point, + or - sign |
| alphabetic | letters and blanks only |
| alphanumeric or alphameric | any characters: letters, digits, and special symbols |

What type of field is each of the following?

(a) +132.6 _____

(b) A123 _____

(c) AB$$ ($ means blank) _____

(d) 63 _____

- - - - - - - - - - - - - - - - - - -

(a) numeric; (b) alphanumeric or alphameric; (c) alphabetic; (d) numeric (Note that the fields in (a), (c), and (d) could be classified as alphanumeric, since they all contain allowable characters. The field A123, however, could only be an alphanumeric field; that is, it could not be either a numeric or an alphabetic field.)

22. A field that will contain only digits, a decimal point, and a plus or minus sign is called a numeric field. Such fields are generally used for arithmetic operations. A field that will contain only letters or blanks is called an alphabetic field. A NAME field, for example, is usually considered an alphabetic field. A field that can contain any combination of letters, digits, or special symbols is called an alphanumeric field.

What kind of field is an ADDRESS field, that will contain such data as '121 MAIN ST'? _____

- - - - - - - - - - - - - - - - - - -

alphanumeric, because it contains a combination of letters, digits, and special symbols