C 440

# Computer Models
## in the Social Sciences

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BIBLIOTHEQUE DU CERIST

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# Preface

Our aim is to arouse your interest in the potential of computer models in explaining or predicting social phenomena; to explain to you in plain terms how such models can be built; to instruct you, if you wish, in some practical methods of designing and testing these models; and to give you leads to further information should you wish to extend your knowledge or skills.

In writing this book, few problems have taxed us more than this: what assumptions can we make about our readers and how can we organize the book to suit their different backgrounds? The notes that follow state our assumptions and the structure that has resulted.

May we first dispel any idea you may have that in order to understand things to do with computers you must be something of a mathematician? We are not sure about the origins of this common misconception - could it be because mathematicians played such an important part in the development of early computers? Could it be because of the spectacular feats of mathematics which have been achieved with the aid of computers? Or could it be that most people's early learning about computers came from their mathematics teacher who, naturally, drew his examples from the area he was most familiar with? Whatever the reason, let us assure you that to understand this book you need only simple algebra, a little statistics and an alert mind. Quite a large part of the book can be understood without the first two of these.

The statistical concepts used are: probability, randomness, frequency, histogram, distributions of the normal, negative exponential and uniform types, sampling from a distribution. If histograms and distributions are new to you, you will find a précis explanation in Appendix A.

We have assumed you have an appreciation of computers but little or no practical experience. The key concepts here are: program, instruction, memory, loop, branch or jump, subroutine. For readers with less knowledge than we have assumed, a very brief description of these is supplied in Appendix B. We hope the text will be sufficiently novel still to maintain the interest of readers with more computing knowledge than we have assumed.

The book is organized as follows:

Chapters 1 to 4 - explanation
Chapters 5 to 8 - examples

The first four chapters are concerned with the purpose of computer models and some of the principles used in designing and constructing them. Chapter 1 may safely be skipped by readers with no interest in philosophical discussion or who consider this a digression from the important practicalities.

Chapter 5 is a survey which tries to describe the wider uses of models in the social sciences. The subsequent chapters are each concerned with a more detailed examination of an example model, drawn from the work of researchers in a variety of fields. A small part of the model analyses is in the form of technical notes aimed at those readers who have programmed a computer in the FORTRAN programming language. The general reader will, obviously, skip over these pages, but if such a reader later feels inspired to try building a computer model without assistance from a trained programmer, he could tackle

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this by learning FORTRAN from one of the many books or training courses available and then returning to a consideration of the skipped passages. Additional notes for readers with FORTRAN experience are provided in Appendix C.

We have not made any serious attempt to give references in the subject area treated by a particular example model - if you wish to follow up one of these, the original work cites its source references and a citation index in your library will help you find any later work done on the model. What we have done is to collect together the titles of a number of interesting computer models in a bibliography at the end of Chapter 5, and we hope some of these will be useful to you.

We hope you do not expect too much from us. We cannot teach you how to easily conceive good models, for instance - if we could, we would gladly make you into an instant Galileo or Newton. Moreover, although we hope to lead you gently, we have sought to add a dose of realism to the simplicity of our examples, to avoid over-simplification which may be misleading. We have come across some descriptions of computer models which are so simple that we are at a loss to understand why a computer was used at all, unless it was to impress the innocent reader. Generally, using a computer becomes worthwhile only when analyzing a system of some complexity which cannot easily be analyzed in more conventional ways. Practical techniques of analyzing complex systems is, perhaps, the unifying theme of the various parts of this book.

The particular techniques we introduce are used in a variety of places in the book and the reader may feel disappointed that there is no summary at the end which consolidates them. We find ourselves unable to summarize a collection of disparate techniques - perhaps the most useful thing we can do is list right here the techniques we describe and where they are used: processes involving sequential choices practically throughout, and sequential choices over time particularly in Chapters 3 and 4 and the hospital model of Chapter 7; stochasticity, sampling and the summation of distributions are used in Chapters 2, 3, 4 and 7 as well as the models of Smith and Vertinsky, and our suggested continuation of Reisman's experiments, in Chapter 5; the idea of discrete events is in Chapters 3, 4 and 7 and the similar notion of a threshold variable is in Smith's model in Chapter 5; the computer representation of a graphic network by a linked list, and the use of a push-down stack, are introduced in the memory model of Chapter 6; interactive models in Chapters 6 and 8; feedback through a time lag in Vertinsky's model in Chapter 5 and the macroeconomic model in Chapter 8; Greist's model in Chapter 5 is based on Bayesian statistics; solving a model based on a system of simultaneous equations is described in Chapter 8; and a number of other tricks pop up here or there.

We must apologize to readers who find the particular methods or models described do not immediately relate to their specific discipline: we can only hope that the knowledge of a technique may suggest a model - if not now, perhaps later. Certainly we find it difficult to imagine any system which could not - at least in principle - be modelled using the basic techniques we present here.

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# 1 Models in the Social Sciences

## Introduction

A short while ago, one of the authors of this book set out to read a dozen or so books written on scientific method as applied to the social sciences. In his naivety, he thought he would obtain from this exercise a collection of rules or dicta which he could point to and say, 'It is the consensus of opinion of social scientists that these are the methods to apply in social inquiry.'

He had not got very far before he realized that he had plunged into a hot-bed of debate of which he was previously unaware. The issues ranged from philosophical ones (what is truth?) through self-examination (are the social sciences Sciences?, i.e. is the method of the natural sciences applicable to the social sciences?) to practical ones (e.g. how can we obtain an observed fact without the experimenter influencing his subject?).

In all this literature, he found the word *model* cropped up but rarely and the words *computer model* even less frequently. The first amazed him, for it had been his opinion that the concept of a model was fundamental to reaching a view on matters such as truth and explanation. The second was less surprising, since computers are a new invention and their potential in other applications has been more readily apparent than their possible uses in the explanation of social phenomena.

It was from this experience that the idea came to write a book, for social scientists, on the construction and use of computer models. Before that theme is developed, though, we feel it desirable to express some personal opinions on the place of models in general in the social scientist's quest for knowledge. We feel we can best do this by offering our own interpretation of some of the issues under debate.

## Is social science a Science?

Let us argue from the less evident end in order to develop our point. We suppose the argument *ad hominem* is just about the most *a*scientific method one can imagine. The argument *ad hominem* is one where the proponent, without showing any experimental evidence, puts forward his case in the expectation that it will appeal to the prejudices or existing opinions of the listener. Arguments *ad hominem* are found everywhere, perhaps no more abundantly than in management literature distilling the wisdom of practising managers, usually propped up by examples or anecdotes. Of course, *an* example can be found in support of nearly *any* point. We are not arguing that such works are value-less for this reason - far from it, as we shall see later.

If we argue to you that there is no God, we will not have to talk for long if you are an atheist. If you are a believer, though, we will have a rough ride, probably without success even if we were to bring a scientific method into our case. If you listened at all, you would subject our method to a level of critical examination which it almost certainly would not stand. We

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