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BOOK REVIEW

A First Course in Mathematical Modelling, by F. R. GIORDANO and M. D. WEIR. Brookes-Cole, Belmont, Calif. (1985). XVII + 328 pp.

In their preface, the authors define problem solving as a multistep activity comprising

- (i) problem identification,
- (ii) model construction,
- (iii) identification and data collection,
- (iv) model validation,
- (v) model solutions

and

- (vi) model implementation and maintenance.

They state their perception that many mathematics students lack real problem-solving capability. They attribute it to various deficiences in undergraduate programmes, e.g.

- (1) the problems used being simple and often trivial,
- (2) the model being given as opposed to requiring construction

and

- (3) most of the effort being devoted to model solution.

They argue that more time and effort should be spent on steps (i)–(iv) and that this should start as early as possible in the student's programme. The book is written to help achieve this goal. More specifically, it aims to introduce steps (i)–(v) to students with limited mathematical background. The authors achieve their goal in a convincing manner with the prerequisite being a course in basic calculus.

The book is divided into four parts:

Part 1: Creative model construction and the modelling process
Part 2: Model fitting and models requiring optimization
Part 3: Empirical model construction
Part 4: Modelling dynamic behaviour.

The details are as follows.

Part 1 consists of three chapters and the emphasis is on model construction. Chapter 1 discusses use of graphs of functions as models; Chapter 2 deals with the modelling process and Chapter 3 discusses modelling using proportionality.

Part 2 consists of two chapters and the emphasis is on model selection. Chapter 4 deals with model fitting and Chapter 5 examines models requiring optimization.

Part 3 consists of three chapters and the emphasis is on replication of model behaviour via experimentation and simulation. Chapter 6 deals with experimentation modelling, Chapter 7 with dimensional analysis and Chapter 8 with simulation modelling.

Part 4 consists of two chapters and is written in the spirit of Part 1 except that the emphasis is on modelling dynamic behaviour. Chapter 9 deals with modelling using derivatives and Chapter 10 considers interactive dynamic systems.

In each chapter, the concepts and/or techniques are introduced in an interesting manner and illustrated through examples of real-world problems. Often, the same problem is used in more than one chapter to highlight the multistep nature of problem solving and the role of mathematical models. The examples used come from diverse disciplines and are presented in a manner to make them appealing and interesting to the student.

The main features of the book are:

- (1) the different steps of problem solving are highlighted;
- (2) the approach conveys to the student the true nature of problem solving;

and

- (3) the student is introduced to solving real-world problems.

In addition, the authors have produced a useful Instructor's Manual. The book suffers from a few minor and one major criticisms. Typical examples of the minor criticisms are the following:

- (i) On p. 54, the authors use a differential equation for modelling the motion of a falling raindrop but the concept of a differential equation is introduced on p. 303.

(ii) Sometimes the words "sub-model" and "assumption" are used interchangeably (e.g. p. 76).

(iii) Failure to mention the accuracy of the data available—e.g. on p. 58 the measurements are accurate to 10^{-3}, whereas on p. 60 they are accurate to 10^{0} for the length of fish.

(iv) On p. 265 they mention that a point must be chosen randomly within the rectangular region but fail to mention the desired property of randomness—i.e. it should be selected from a uniform distribution over the rectangle and not any other.

The major criticism is of the material in Chapter 8. The concepts and techniques used in the chapter are beyond the understanding of a student with only a first-level calculus course background. The material covered cannot be appreciated unless the student has had a basic course in either probability theory or statistics. For example, the use of simulation to evaluate definite integrals will require understanding of probabilistic convergence! The discussion of probabilistic and stochastic systems is done in a rather rushed and ineffective manner. The same can be said of Chapters 9 and 10 where too many concepts and techniques are introduced at a very fast pace.

The authors would have made a greater impact if they had replaced Chapters 8–10 by a single chapter which: (i) discussed the inadequacies of static deterministic formulations for solving a variety of real-world problems; (ii) motivated the need for the study of dynamic and/or probabilistic model formulations; and (iii) illustrated these through simple examples of real-world problems.

In spite of the above criticisms, the book is an excellent text for use in a first-level course on modelling based on Chapters 1–7. If the students understand the principles and the thinking processes involved, they should have no difficulty in solving more complex real-world problems with additional mathematical background. The authors are to be congratulated for the manner in which they have developed the principles and the thinking processes required and for achieving their stated goal. The book is a valuable addition to the large number of books available on mathematical modelling and problem solving.

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