

Overview of Mathematical Modeling

Modeling loosely describes the process of recasting a problem or concept from its natural environment into a form that can be analyzed by techniques we understand and trust. Modeling is a device that aids the modeler in predicting and explaining the behavior of a phenomenon, experiment, or event.

Differential Equations: A Modeling Approach, by Borelli and Coleman, Prentice Hall, 1987.

It is important to remember that mathematical models are like other types of models. The goal is not to produce an exact copy but rather to give a representation of some aspect of the real thing. For example, a portrait of a person, a store mannequin and a pig can all be models of a human being. The painting gives a description of what the person looks like; the mannequin wears cloths like the person does; and the pig is alive. Which of these three models is "best" depends on how we use the model---to remember old friends, to buy cloths or to study biology.

Differential Equations by Blanchard,
Devaney and Hall, Brooks-Cole, 1998

The underlying idea in most...models...is to indicate, in the form of an equation or inequality (i) an algebraic relationship between variables, (ii) the rate of change of some variable with respect to the other variables, and (iii) the sums or integrals of functions in order to obtain cumulative values and to see how they relate to other variables or functions.

Thinking With Models: mathematical Models in the Physical, Biological and Social Sciences, by Saaty and Alexander, Pergamon Press, 1981.

Some levels of description for mathematical model building

specific \longleftrightarrow general

model
estimation \longleftrightarrow first-principles
models

numerical \longleftrightarrow analytical

stochastic \longleftrightarrow deterministic

microscopic \longleftrightarrow macroscopic

discrete \longleftrightarrow continuous

qualitative \longleftrightarrow quantitative

The Nature of Mathematical Modeling,
by Gershenfeld, Cambridge, 1999

