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Introduction

1.4 MODEL CONSTRUCTION

The unavoidable association of the concepts of model and approximation puts modeling in a twilight zone that does not belong to pure science due to the lack of unicity postulates but must, in any case, rely on results and methodologies offered by the abstract science of mathematics.

Moreover the limited capability of models to solve any specific problem leads to the opportunity of constructing application–oriented models; the rationales behind the different uses of models that have been described previously become thus rationales also behind the construction of special–purpose models for the same system.

1.4.1 Deducing models from other models: physical modeling

The procedures to obtain mathematical models are usually classified into physical modeling and identification. Physical modeling is based on the partition of a system into subsystems and on their description by means of known laws. The model is then obtained joining such relations into a whole. This approach requires a general knowledge of the structure or design of the considered system and of the “laws” describing their behaviors. Since physical laws are, in turn, models obtained from observations or from unfalsified speculations, physical modeling consists of constructing a whole model joining together simple and already established models. The advantages of physical modeling consist in the possibility of using, in the model construction procedure, *a priori* information on the system and in the physical meaning of the model variables. This procedure cannot be applied, however, to systems whose internal structure is not known, whose behaviors are not described by established relations or whose complexity would lead to unmanageable models where most parameters would only marginally influence the aspects to be reproduced of the system behavior.

1.4.2 Deducing models from data: identification

Identification consists in the selection of a specific model in a specified class on the only basis of observations performed on the system to be described and of a selection

criterion. The whole procedure makes no reference neither to the physical nature of the modeled system nor to the *a priori* knowledge of the modeller; only the data speak. The internal variables of identified models may lack any physical meaning and the same can be true of the model parameters. Such models are, on the other side, simple, accurate and can extract from complex frameworks only some relevant aspects.

It is not difficult to recognize that often physical laws have been obtained as a result of identification procedures; the data collected by Galileo in his experiments on falling bodies, for instance, led him to recognize that a simple model could explain every experiment and could consequently be considered a law.

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