

Introduction to Modelling and Optimization

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Model

What is a model? A model is a prototype of something that is real. Such a prototype can be concrete or abstract.

- A mathematical model is an abstract model. It is a description of some part of the real world expressed in the language of mathematics. There may be some variables in the description - values that are unknown. If the model is formulated so that you can calculate these values then you can solve the model.
- Optimization models: This is one class of mathematical models.

Why use models?

- A model serves as a learning tool. In the process of constructing a model you are forced to concentrate on all the elements required to realize the model. In this way, you learn about the relationships between the elements that make up the model.
- Depending on the purpose of the model you then need to set priorities since mathematical models can grow in complexity with the quantity of detail.
- Models can also be a valuable tool of expression during discussions between concerned parties. If the formulation and data of a model are agreed, it can be used to make predictions of the consequences of different actions, which can then be compared.
- The combination of models and computers enhances the speed of decision With computers making.

The role of mathematics

- Mathematics provides a language in which models can be formulated using the following elements.
 - a Mathematical concepts such as variables (unknowns) and parameters (symbols representing known data)
 - b Operators such as:
 - unary operators (+, -, not),
 - comparison operators (equal to, not equal to, etc.),
 - algebraic operators (addition, subtraction, multiplication, division, power, etc.),
 - logical operators (and, or, etc.),
 - differential operators and integral operators;
 - c Data: which links a model to a real-world situation.
- Mathematics provides a theoretical framework for the formulation and solution of those models for which the translation from problem to model is not immediate.
- Mathematical algorithms are needed to obtain solutions of mathematical models.

The modeling process

The process of developing a model usually involves several different activities. These iterative activities are outline below.

- Define the goal:- analyze the general problem conceptually and to determine which aspects of the real-world situation must be included.
- Consult literature and other people:- investigate if a similar model has already been developed.
- Formulate the model, and collect the data:- Most models, built to analyze real-world problems, require lots of data.
- Initial testing:- start with a small model containing only the basic relationships before adding increased complexity, and continue in this gradual fashion.
- Validation:- Validation is the process of checking whether initial model results agree with known situations. It is an important final step before the model results are used in support of a real-world decision.

Application areas

- Production:- are used for planning, scheduling and process control.
- Production and inventory management: The scheduling of production and inventory can be formulated as a linear optimization model.
- Finance: A widely-used application in the finance field is the selection of investment portfolios. A portfolio is a collection of securities held by an investor, such as a pension fund.
- Manpower planning:- Linear and integer optimization models can be used to schedule work shifts when the demand for workers varies over the hours of the day, or the days of the week.
- Agricultural economics:- Models of both a country's agricultural sector and of individual farms have been used extensively by governments of developing countries for such purposes as assessing new technologies for farmers, deciding on irrigation investments, and determining efficient planting schedules to produce export-goods.

References I

- [1] Bisschop. Johannes.
AIMMS optimization modeling.
Lulu. com., 2006
- [2] Chong Edwin KP and Zak Stanislaw H.
An introduction to optimization.
John Wiley & Sons., (75), 2013
- [3] Pedregal Pablo.
Introduction to optimization.
Springer., (46), 2004