

# Manual: 7. Background and Concepts

A mathematical model is a mathematical description of a system that usually takes the traditional equation format, e.g.  $y = mx + b$ .

Modeling is a process that has the mathematical model as its objective and end. Mostly it starts with data that has been obtained by taking measurements in the world. Industrially, we have instrumentation equipment in our plants that produce a steady stream of data, which may be used to create a model of the plant. Note that modeling itself converts data into a model -- a model that fits the situation as described by the data. That's it.

Practically, just having a model is nice but does not solve the problem. In order to solve a particular practical problem, we need to use the model for something. Thus, modeling is not the end of industrial problem solving but modeling must be followed by other steps; at least some form of corporate decision making and analysis. Modeling is also not the start of solving a problem. The beginning is formed by formulating the problem itself, defining what data is needed, collecting the data and preparing the data for modeling. Frequently it is these steps prior to modeling that require most of the human time and effort to solve the problem.

Mathematically speaking, modeling is the most complicated step along the road. It is here that we must be careful with the methodology and the data as much happens that has the character of a black box.

Generally speaking modeling involves two steps: (1) Manual choice of a functional form and learning algorithm and (2) automatic execution of the learning algorithm to determine the parameters of the chosen functional form. It is important to distinguish between these two because the first step must be done by an experienced modeler after some insight into the problem is gained and step two is a question of computing resources only (supposing, of course, that the necessary software is ready). In practice, however this two-step process is most frequently a loop. The results of the computation make it clear that the manual choices must be re-evaluated and so on. Through a few loops a learning process takes place in the mind of the human modeler as to what approach would work best. Modeling is thus a discovery process with an uncertain time plan; it is not a mechanical application of rules or methods.