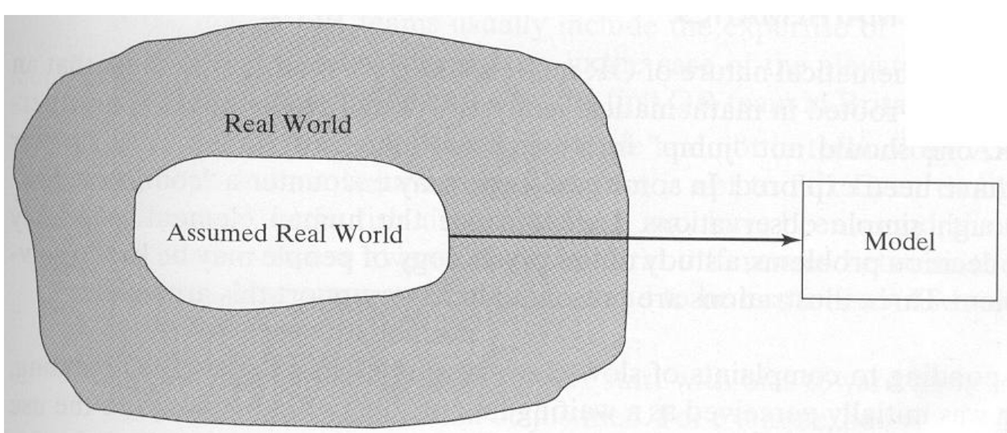
The OR Modeling Approach

- **What is special about the OR analysis approach?**
  - (i) *A primary focus on decision making*. The analysis must lead to clear suggestions to the decision maker.
  - (ii) *An appraisal resting on economic effectiveness criteria* (e.g. cost, profit, rate of return, etc.).
  - (iii) ***Reliance on a formal mathematical model***.
  - (iv) *Dependence on computers* (due to complexity of real world mathematical models.)

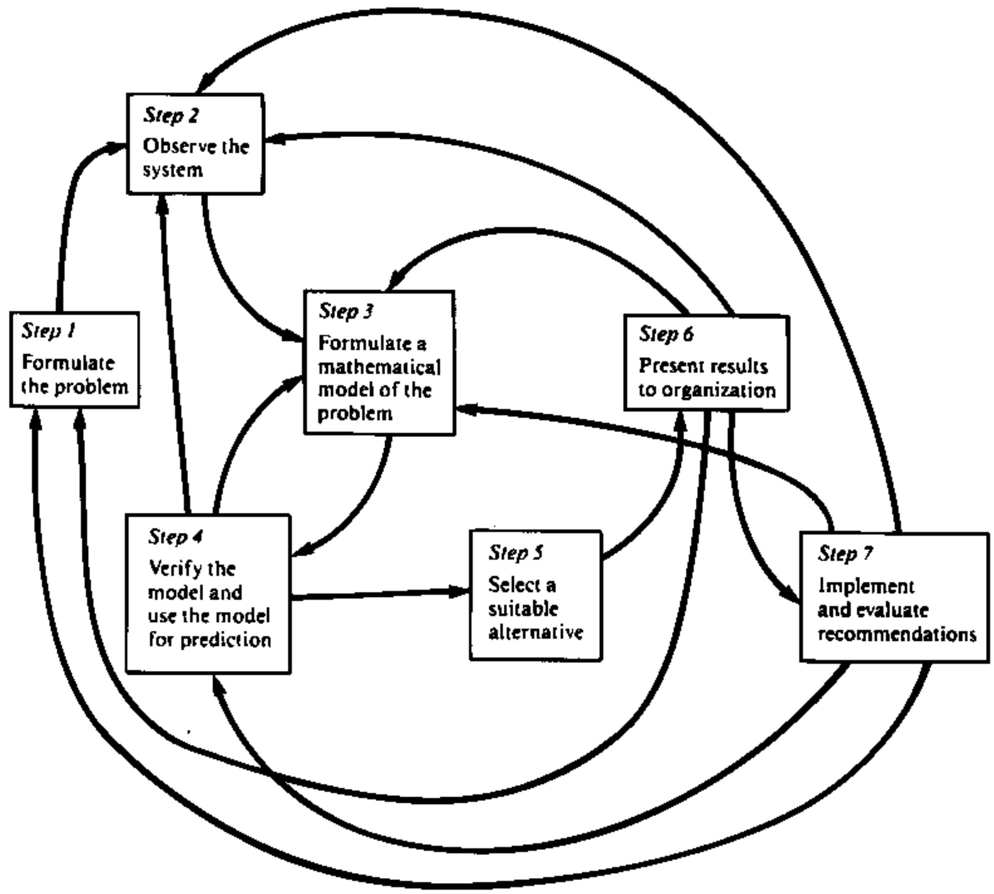
- **What is a model anyway?**
  - ➢ *A model is an abstract representation of the real world* physical, social, or other systems in terms of mathematical equations, logical relationships, computer programs, flow diagrams, drawings, or other forms.



- **Types of models**
  - *Iconic (scale) models, e.g., map, blue print.*
  - *Mathematical* models.
- **Math models**
  - A mathematical model defines measurable *observables,* **f = (**f_1, f_2, …), that relate the state of a system, Ω, to real numbers, $\mathbf{f} : \Omega \to \mathbf{R}$.
  - E.g., the laws of physics, $F = ma$, $E = mc^2$, $PV = eT$.
  - Equations such as these laws relating the observables of a model are known as the equations of states.
  - The model observables are classified into *parameters*, control or *decision variables*, and output or response variables (which will represent the *objective function* for us in this course).
  - E.g., in the linear programming model of the Fundys diet,
    - The parameters are the prices of beef and potatoes and their nutritional elements. (Peg has no control on these.)
    - The decision variables are how many pounds of beef and potatoes to buy, x_1 and x_2.
    - The response variable is the cost, *Z*.
    - The state "equations" are

$$
\begin{aligned}
&\text{(min)} \quad Z = 7x_1 + x_2 \\
&\text{(subject to)} \quad 3x_1 + x_2 \geq 12 \\
&\qquad\qquad\qquad x_1 + x_2 \geq 6 \\
&\qquad\qquad\qquad x_1 \geq 0, x_2 \geq 0
\end{aligned}
$$

- **Steps of the OR modeling approach**



Step 1. *Formulate the problem*. Define objective, scope, and data needed.
Step 2. *Observe the system*. Collect data to estimate the parameters.
Step 3. *Formulate a mathematical model of the problem*.
Step 4. *Validate (verify) the model and use the model for prediction*. Answer these questions: Are the model results reasonable? Are the model predictions close to current values? Is the model *robust*? Go back to Steps 2 and 3 if answers are No.
Step 5. *Select the suitable alternative(s).* The model may give the best (optimal) solution. However, this might be costly to implement. Many times one selects *good* solutions rather than optimal ones.
Step 6. *Present results to organization*. Decision makers may or may not like Step 5 alternatives based on their experience. Good managers are usually right. Go back to steps 1, 2 or 3 if they reject the alternatives.
Step 7. *Implement and evaluate recommendation*. Apply solution and monitor the system to check if objectives are met. Go back to earlier steps.

- ## Principles of modeling

1. All models are approximate; however some models are better than others.
2. Do not build a complicated model when a simple one would suffice.
3. Do not model a problem to merely fit the technique.
4. The deduction stage must be conducted rigorsly.
5. Models should be validated before implementation.
6. A model should not be taken too literally (it shouldn't replace reality and human intuition).
7. A model cannot be better than the information that goes into it – JI-JO (Junk in, Junk out).