The Modeling Process

What is Modeling

Definition **Modeling** is the application of methods to analyze complex, real-world problems in order to make predictions about what might happen with various actions.

Model Classifications

- **Probabilistic or stochastic behavior** - element of chance

  Ex: hurricane is probabilistic

- **Deterministic behavior** – determined by facts and calculations

  Ex: the position of a falling object in a vacuum

Definitions A system exhibits **probabilistic**, or **stochastic**, **behavior** if an element of chance exists. Otherwise, the system exhibits **deterministic behavior**. A **probabilistic**, or **stochastic**, **model** exhibits random effects, while a **deterministic model** does not.

Model Classifications

- **Static model -** not consider time, so that the model is comparable to a snapshot or a map

  Ex: weight of a lizard as being proportional to the cube of its length

- **Dynamic model** – Consider Time Change

  Ex: the number of lizards in an area undergoing development changes with time

Definitions A **static model** does not consider time, while a **dynamic model** changes with time.

Model Classifications

- **Continuous Model -** When time changes continuously and smoothly

  Ex: the real-world phenomenon like sound

- **Discrete** – time changes in incremental steps

  Ex: Recorded data of sound

Definitions In a **continuous model**, time changes continuously, while in a **discrete model**, time changes in incremental steps.

Steps of Modeling Process - Cyclic

1. Analyze the problem –

- study the situation sufficiently to identify the problem precisely
- understand its fundamental questions clearly
- determine the problems objective
- Decide problem's classification, such as deterministic or stochastic

2. Formulate a model –

a) Gather data - We collect relevant data to gain information about the system's behavior.

b) Make simplifying assumptions – ignore factors often exist that do not appreciably affect outcomes

c) Determine variables and units-

- **Independent variable -** trajectory of a ball -> time is independent
- **dependent variables -** trajectory of a ball -> the height and the horizontal distance from the initial position are dependent on time

d) Establish relationships among variables and sub-models **–**
Draw Diagrams to determine relationships

e) Determine equations and functions –

determine equations and functions by establishing relationships

example : Two variables are proportional to each other

3. Solve the model –

- This stage implements the model.

- Some of the techniques and tools that the solution might employ are algebra, calculus, graphs, computer programs, and computer packages.

4. Verify and interpret the model's solution-

- **Verification** - Determines if the solution works correctly (solving the problem right)
- **Validation -** Establishes whether the system satisfies the problem's requirements (solving the right problem)

Definitions The process of **verification** determines if the solution works correctly, while the process of **validation** establishes if the system satisfies the problem's requirements.

* If the model solution shows weaknesses, we should return to Step 1 or 2 to determine if it is feasible to refine the model

- **Simplification -** simplifying assumptions, include more variables
- **Refinement -** May need to extend the scope of the problem in Step 1

5. Report on the model –

A report contains the flowing components, which parallel to the steps of the modeling process

a) Analysis of the problem –

Describe the circumstances in which the problem arises. Then, we must clearly explain the problem and the objectives of the study.

b) Model design –

- State the simplifying assumptions
- Clearly labeled diagrams of the relationships among variables
- Submodels are usually very helpful in understanding the model

c) Model solution –

- Describe the techniques for solving the problem and the solution
- Give as much detail as necessary for the audience to understand the material
- Use appendices to provide more detail and information about the solutions of equations

d) Results and conclusions –

include

- results
- interprétations
- implications
- recommandations
- conclusions

of the model's solution

6. Maintain the model

- Future works
- Look for necessary or desirable
  - Corrections
  - Improvements
  - Enhancements