Math 142 – Mathematical Modeling
University of California, Los Angeles

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This is math 142 – Mathematical Modeling taught by Professor Huang. We meet weekly on MWF from 9:00am – 9:50am for lecture. There is one textbook used for the class, which is *Mathematical Models* by *Haberman*. You can find other lecture notes at my blog site. Please let me know through my email if you spot any mathematical errors/typos.

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§1.1   Intro to Mathematical Modeling

First, let's examine the following question

Question 1.1. Why do we learn mathematical modeling?

There are lots of question that math may provide some explanation so that we could understand the question deeply.

Example 1.1   1. How is Covid-19 spread? How can we control the spread of Covid-19?

2. How to control the spreading of the forest fire and how to reduce the loss?

3. How does the population of human evolve over time?

So,

Question 1.2. What is a mathematical model and how can we create the model?

Definition 1.2 (Mathematical Model) —   A mathematical model is a description of a system using mathematical concepts and language. The process of developing a mathematical model is called mathematical modeling.

To create a mathematical model, we

1. formulate the problem: approximations and assumptions based on experiments and observations

2. solve the problem that is formulated above

3. interpret the mathematical results in the context of the problem

Let's now explain the three steps above in more details.

1. Formulation

    a) State the question: If the question is vague, then make it to be precise. If the question is too "big", then subdivide it into several simple and manageable parts.

    b) Identify factors: Decide important quantities and assign some notation to the corresponding quantity. Then, we need to determine the relationship between the quantities and represent each relationship with an equation.

2. Solve the problem above: This may entail calculations that involve algebraic equations, some ODE, PDE, etc; provide some theorems or doing some simulations, etc.

3. Interpretation/Evaluation: We need to translate the mathematical result in step 2 back to the real world situations and evaluate whether the model is good or not by asking the following questions:

    a) Has the model explained the real-world observations?

    b) Are the answers we found accurate enough?

    c) Were our assumptions good?

   d) What are the strengths and weaknesses of our model?

   e) Did we make any mistake in step 2?

If the answer to any of the above question is not favorable, we need to go back to step 1 and go through all the steps again until we get some satisfying results.