

5.2 Classification of Models

Models are classified according to the type of input variable, *discrete* or *continuous*, as well as the number of model equations: a *single equation* or a *system of equations*.

In discrete models, the underlying process is checked at specified **discrete** times. For example, we could look at the average temperature in Los Angeles on a daily basis. Thus, the measured quantity, $T(n)$, would indicate temperature on day n , where n is a counting number. In this case, our model would be discrete, and the graph would consist of separate points.

On the other hand, we can look at the condition of a patient in the critical care unit of a hospital. The life support machine **continually** records the patient's vital signs, such as heart rate or blood pressure. In this case, $BP(t)$ would stand for blood pressure at time t , where t is a real nonnegative number. The graph of $BP(t)$ would be a continuous function, i.e., a smooth curve without gaps.

How do we decide what type of model to choose? Unfortunately, there is no general rule. Usually, we have to look at the context of the problem and also at the way quantities change. For example, if we look at a checking account, interest is added at distinct points in time (at the end of the month, quarter, etc.). This suggests a discrete model. However, if we look at the change of temperature in a cup of coffee, then we would use Newton's law of cooling, which is stated in terms of rate of change, leading to a continuous model.

Many models exist in both a discrete and a continuous formulation. Also, a continuous model may have to be discretized to be solved using a numerical method, indicating that the two types of models are closely related. We will look first at discrete models, and then at continuous ones. For the latter models, we need to learn about the connection between the rate of change and the slope of tangent lines to a graph.

Chapter Review

Key Terms

top-down approach

discrete model

single equation

bottom-up approach

continuous model

system of equations

modeling process

Short Answers

1. What is the difference between the top-down and the bottom-up approaches?
2. Describe the steps of the modeling process in your own words.
3. Why do we have to (potentially) go through several iterations of the modeling process before we arrive at a good model?
4. How do we decide that a satisfactory model has been found?

True - False Questions

- T F 1. Some models exist both as a discrete and a continuous model.
- T F 2. All models can be described by a single equation.
- T F 3. In the bottom-up approach, the data is not used.

Fill in the Blanks

1. If the output variable is measured _____, then the model is classified as a continuous model.
2. Using the method of least squares fit creates a model using the _____ approach.