Exercises

1.4.1 Identify at least one type of assumption behind the model used in each of the following situations.

a. A consumer magazine reports that a laundry detergent costs \$0.31 per load.
b. An exercise bike displays the number of calories burned.
c. A jogging pedometer measures the distance jogged.
d. A dashboard display in a car shows that it can travel 220 miles on the remaining fuel in the tank.
e. A small business owner predicts that his company will spend \$500,000 on phone bills next year.
f. A cooking magazine lists one ingredient for a recipe as 1-2 cups of shredded cheddar cheese. It then claims that each serving has 320 calories.

1.4.2 Identify at least two possible variables and two parameters involved in each of the following models. Clearly identify which is a variable and which is a parameter.

a. A biologist wants to model the population of foxes and rabbits in a forest over a period of time.
b. A consumer wants to model the monthly balance in his credit card.
c. A public health researcher wants to model the amount of alcohol in the bloodstream of a college student during an evening of partying.
d. An ecologist wants to model the amount of pollution in a lake over a period of time.
e. A market researcher wants to model the number of viewers of a TV show over the span of the season.

1.4.3 To predict the time at which the bacteria population in section 1.3 reached 600, we solved the equation $600 = (1 + 0.05)^n 500$ and concluded that at the beginning of day 4 we will have over 600.

a. Show how this equation was solved for n.
b. A student argues that we should be more precise in our conclusion. She argues that we should say, "on day 3.736850652 there will be exactly 600 bacteria" because this is the value given by her calculator. How would you explain to her that such a level of precision is not appropriate?

1.4.4 A cashier at a supermarket can checkout, on average, 3 customers a minute (this is called the *service rate*). Customers arrive, on average, 2 a minute (this is called the *arrival rate*). The manager figures that since the service rate is greater than the arrival rate, customers will never have to wait in line. What assumptions are the manager making? Does these assumptions seem reasonable? What does this say about the validity of the conclusion?

1.4.5 A college student plans to ask 100 different girls for a date. He calculates the number who will say "yes" with the following reasoning:

> Since every girl can say "yes" or "no," exactly half will say yes. Since half of 100 is 50, exactly 50 girls will say "yes."

What, if anything, is faulty with this model? Explain.

1.4.6 A model for the population of the United States (in millions) between at year t is

$$P(t) = 5.3e^{-0.000067t^2+0.273832t-275.032}.$$

Using data, it can be shown that this is a reasonable model for the years 1800-1960. A student reasons that the population in the year 2050 will be $P(2050) \approx 222.5$ million. What assumption is the student making when doing this calculation? Do you think this assumption is reasonable? What does this say about the validity of the prediction?

For Further Reading

- For a further discussion of the modeling process and related issues, see Frank. R. Giordano, M. D. Weir, and W. P. Fox, *A First Course in Mathematical Modeling*, Third ed., Thomson Brooks/Cole, 2003, pg. 52–63.
- For more information on modeling methodology, tips on writing reports, and numerous example problems, see Dilwyn Edwards and Mike Hamson, *Guide to Mathematical Modelling*, CRC Press, 1990.
- For a discussion of the benefits of mathematical modeling, see Lucas, William F., The Impact and Benefits of Mathematical Modeling, in *Applied Mathematical Modeling* (D.R Shier and K.T. Wallenius eds.), Chapman and Hall/CRC, 1999, pg. 1–25, and the included references.
- For a lengthy discussion of how assumptions impact environmental models, see Orrin H. Pilkey and Linda Pilkey–Jarvis, *Useless Arithmetic: Why Environmental Scientists Can't Predict the Future*, Columbia University Press, 2007.
- For a brief discussion of some of the assumptions behind global–warming models, see K. K. Tung, *Topics in Mathematical Modeling*, Princeton University Press, 2007, pg. 146–157.