the value of the population standard deviation σ. Although individual values of s can equal or exceed the value of σ, values of s generally tend to *underestimate* the value of σ. For example, consider an IQ test designed so that the population standard deviation is 15. If you repeat the process of randomly selecting 100 subjects, giving them IQ tests, and calculating the sample standard deviation s in each case, the sample standard deviations that you obtain will tend to be less than 15, which is the population standard deviation. There is no correction that allows us to fix the bias for all distributions of data. There is a correction that allows us to fix the bias for normally distributed populations, but it is rarely used because it is too complex and makes relatively minor corrections.

The sample variance s^2 is an **unbiased estimator** of the population variance σ^2, which means that values of s^2 tend to target the value of σ^2 instead of systematically tending to overestimate or underestimate σ^2. Consider an IQ test designed so that the population variance is 225. If you repeat the process of randomly selecting 100 subjects, giving them IQ tests, and calculating the sample variance s^2 in each case, the sample variances that you obtain will tend to center around 225, which is the population variance.

The concepts of biased estimators and unbiased estimators will be discussed more in Section 6-4.

using TECHNOLOGY

STATDISK, Minitab, Excel, the TI-83/84 Plus calculator, and StatCrunch can be used for the important calculations of this section. Use the same procedures given at the end of Section 3-2.

3-3 Basic Skills and Concepts

Statistical Literacy and Critical Thinking

1. Comparing Variation Which do you think has less variation: the IQ scores of students in your statistics class or the IQ scores of a simple random sample taken from the general population? Why?

2. Correct Statements? Which of the following statements are true?

a. If each of 25 sample values is equal to 20 min, the standard deviation of the sample is 0 min.

b. For any set of sample values, the standard deviation can *never* be a negative value.

c. If the standard deviation of a sample is 3 kg, then the variance is 9 kg.

d. If the variance of a sample is 16 sec^2, then the standard deviation is 4 sec.

e. If the standard deviation of a sample is 25 cm, then the variance is 5 cm^2.

3. Variation and Variance In statistics, how do the terms *variation* and *variance* differ?

4. Symbols Identify the symbols used for each of the following: (a) sample standard deviation; (b) population standard deviation; (c) sample variance; (d) population variance.