Chapter 7
Data for Decisions

Chapter Outline

Chapter Summary

Statistics is the science of data. Designs for producing data that will convincingly answer specific questions are indispensable in statistics. Generally, data are generated by sampling or by conducting experiments.

A *sample* is a part of a large population. Hopefully, information obtained from the sample will allow us to draw conclusions about the *population* as a whole. In order for this to be possible, the sample must be representative of the population. Typically, samples are chosen at random, perhaps by assigning a number to each member of the population and then by using a table of random digits to select the individuals to be included in the sample. Random sampling avoids the *bias* that can result when an investigator chooses convenient subjects or allows subjects to choose themselves (as in a phone-in poll). Sometimes, more complex samples may be needed; for example, we may require that the age distribution of the sample subjects be the same as that of the population as a whole. Even in these situations, random sampling is used within the specified subcategories of the sample.

Experiments aim to show that certain treatments produce certain effects. Responses to treatment can be *confounded* with other variables in the environment so that no clear conclusions can be drawn. Good experimental design attempts to minimize confounding by comparing subjects who receive treatment, to a *control group* that receives none. Subjects are randomly assigned to the two groups; randomization is used to produce two groups that are essentially similar prior to treatment. The groups are observed again after treatment. Random sampling eliminates bias but not variability. Different samples will usually yield different outcomes. However, this variability can be minimized by choosing a large enough sample. Differences unlikely to occur by chance provide evidence that the differences can be attributed to the effects of the treatment. Such differences are called *statistically significant*.

Statistical inference draws conclusions from data. Generally, these conclusions concern the estimation of a population parameter based on a statistic provided by a sample. Statistical inference is based on the idea that one needs to see how trustworthy a procedure is if it is repeated many times. An important method of inference is determining confidence intervals. With confidence intervals, we take as our basic estimate of an unknown population parameter the appropriate sample statistic. A confidence interval adds a margin of error so we obtain a range of values "statistic ± margin of error" that tells us the accuracy of our estimate. By revisiting the 68-95-99.7 rule, the 95% confidence interval is discussed. We can be sure that the true population parameter for 95% of all samples will be within this interval. Confidence intervals are easy to obtain if the sampling distribution of our statistic is normal or approximately normal. Fortunately, this is the case with sample proportion and sample mean.

Skill Objectives

1. Identify the population in a given sampling or experimental situation.

2. Identify the sample in a given sampling or experimental situation.

3. Explain the difference between a population and a sample.

4. Analyze a sampling example to detect sources of bias.

5. Identify several examples of sampling that occur in our society.

6. Use a table of random digits to select a random sample from a small population.

7. Select a numbering scheme for a population from which a random sample will be selected from a table of random digits.

8. Explain the difference between an observational study and an experiment.

9. Recognize the confounding on the effects of two variables in an experiment.

10. Explain the difference between the experimental group and the control group in an experiment.

11. Design a randomized comparative experiment and display it in graphical form.

12. Explain what is meant by statistically significant.

13. Describe the placebo effect.

14. Discuss why double blindness is desirable in an experiment.

15. Define statistical inference.

16. Explain the difference between a parameter and a statistic.

17. Identify both the parameter and the statistic in a simple inferential setting.

18. Compute the sample proportion when both the sample size and number of favorable responses are given.

19. Using an appropriate formula, calculate the standard deviation of a given statistic.

20. Explain the difference between the population mean and the sample mean.

21. Given a sample proportion and sample size, list the range for a 95% confidence interval for the population proportion.

22. Calculate differing margins of error for increasing sample sizes.

23. Discuss the effect of an increased sample size on the statistic's margin of error.

Teaching Tips

1. Spending time explaining carefully the structure of the table of random digits found in the text might save time and student error when working the exercises. Students sometimes think that the space between each block of five digits somehow separates them so that you must move on to the next block after selecting a number from one block. Explaining that the space serves the same purpose as a comma when writing ordinary numbers (for ease of reading) helps their understanding.

2. A second question often raised is about the numbering of lines in the table of random digits. Students who have done programming on personal computers are aware that to avoid having the computer always return to the start of the list, it may be necessary to insert a programming code to seed the random number generator. In a sense, then, by specifying which row to use in the table, we are avoiding the predictability of always returning to the beginning of the list.

3. Some students have trouble understanding that the maximum number needed to name items in a population determines the number of digits to be used in all the numbers. If there are 100 items in a population and the numbering scheme begins with zero, then the largest number needed is 99, which has two digits. Consequently, the numbering will progress: 00, 01, 02, 03, . . ., 99. On the other hand, if the numbering scheme begins with one, then the largest number needed is 100, requiring three digits. The numbering would then proceed: 001, 002, . . . 010, 011, 012, . . ., 099, 100.

4. One way to explain that each of the ten digits, 0 through 9, has equal likelihood of being in a particular spot in a table of random digits is to imagine that a jar is filled with ten Ping-Pong balls, each painted with a single digit, and that all ten digits are used. Then the jar is shaken up to mix the balls and a blindfolded person reaches in the jar and selects a Ping-Pong ball. That number is written down, the ball is returned to the jar, and the jar is shaken once again. The process is then repeated many times to construct the table.

5. Stress that randomization has radically different purposes in the two types of statistical problems discussed in this chapter. When selecting a sample for, say, a political poll, the purpose is to obtain a group of people that closely mirrors the entire population politically, ethnically, economically, and so forth. On the other hand, in medical experimentation, where the subjects are always volunteers, there is no possibility of such a mirroring of the general population. Here, the random allocation of subjects to the treatment and control groups is to try to assure that these two groups are as alike as possible, so that any difference in the outcome of the experiment can be attributed only to the treatment.

6. Students need to know the level of precision expected in the answer. It may be a good idea to develop a standard for this chapter for ease in comparing responses.

7. To introduce the idea of confidence intervals informally, ask the students the following question: "Suppose that a sample produces a value of $\hat{p}$ = 45%. How confident are you that the actual value of p is exactly 45%?" Most of them will admit they have very little confidence in this as an exact value. Then ask, "How confident are you that p lies between 44% and 46%? Or between 43% and 47%?" As you expand the interval surrounding 45%, the students will see clearly that our confidence increases as the interval grows.

8. A review of the normal curve and the 68–95–99.7 rule can help lay the foundation for the 95% confidence interval. Drawing a normal curve with appropriate labeling of mean and standard deviation markings for each confidence-interval problem may help reinforce the relationship between the 95% confidence interval and the two-standard deviation range on either side of the mean.

9. Point out that the margin of error determines the *length* of the confidence interval. For example, if the margin of error is 3%, then the confidence interval has length 6%.

10. Students often need extra practice on how changing the sample size affects the error margin. Giving them lots of examples with samples whose sizes are perfect squares makes the arithmetic easier; however, it's important for them to see that not all problems in real world settings have easy answers. After they feel comfortable with the ideas involved, you may want to extend their practice to include irrational numbers and determine an appropriate precision level for the answers.

Research Paper

In 1937, Jerzy Neyman invented the measure of uncertainty called the confidence interval. Neyman (1894–1981) was born in Bendery, Moldavia. Students can further research the life of Neyman and his contributions to mathematics and statistics. Also, the life and contributions of the British born Egon Pearson (1895–1980) can be suggested as a topic for a paper.

Collaborative Learning

Sampling

You can give your students the experience of sampling within the classroom. Hand out index cards and ask each student to write down on the card the number of siblings in his or her family. Collect the cards and then have several (10 or more) students randomly choose different samples of 5 cards each. Ask them to calculate the mean number of siblings in their sample. When all the sample means have been announced, have the students construct a histogram of the results. Then calculate the mean for the entire class, and compare it with the results of the sampling.

Solutions

Skills Check:

1. b	2. a	3. c	4. b	5. a	6. c	7. a	8. b	9. a	10. a
11. c	12. b	13. b	14. b	15. c	16. b	17. b	18. c	19. a	20. a

Exercises:

1. Population: U.S. residents aged 18 and older. Sample: The 1,002 who responded.

2. All households in the United States.

3. Students passing the student center may not fairly represent all students. For example, they may underrepresent commuters or students whose classes are far from the center. In addition, a woman student may be reluctant to stop men, thus underrepresenting male students.

4. Population: "constituents," probably adults living in her district. Sample: the 361 who wrote letters. Those who wrote probably feel strongly about gun control, and may not represent all constituents (voluntary response).

5. (a) This isn't clear: possibly its readers, possibly all adults in its circulation area.
(b) Larger; People with strong opinions, especially negative opinions, are more likely to respond. This is bias due to voluntary response.

6. Answers will vary.
(a) Print a coupon in the campus newspaper asking students to check their opinion, cut out the coupon, and mail it in.
(b) Ask all the students in a large sociology course to record their opinion as part of an exam in the course. (This is a convenience sample.)

7. If we assign labels 01 to 33 to the complexes in alphabetical order and start at line 117 in Table 7.1, our sample is 16 = Fairington, 32 = Waterford Court, and 18 = Fowler.

8. If we assign labels 01 to 32 in alphabetical order and start at line 105 in Table 7.1, our sample is 29 = Shen, 07 = Delluci, 19 = Molina, 14 = Glauser, 17 = Johnson, 13 = Garcia. (Don't forget to skip the second 29.)

9. (a) 001 to 371.
(b) Area codes labeled 214, 235, 119, 033, 199.

10. (a) 00001 to 14959.
(b) People labeled 12609, 14592, 06928. (Look at groups of 5 digits.)

11. If you always start at the same point in the table, your sample is predictable in advance. Repeated samples of the same size from the same population will always be the same - that's not random.

12. (a) False: The number of 0's in a row is random.
(b) True.
(c) False: All strings of four digits have the same chance to occur, one in 10,000.

13. (a) Because $\frac{200}{5} = 40$ we divide the list into 5 groups of 40. (By the way, if the list has 204 rooms, we divide it into 5 groups of 40 and final group of 4. A sample contains a room from the final group only when the first room chosen is among the first 4 in the list.) Label the first 40 rooms 01 to 40. Line 120 chooses room 35. The sample is rooms 35, 75, 115, 155, and 195.

(b) Each of the first 40 rooms has chance 1 in 40 to be chosen. Each later room is chosen exactly when the corresponding room in the first 40 is chosen. So every room has equal chance, 1 in 40. The only possible samples consist of 5 rooms spaced 40 apart in the list. An SRS gives *all* samples of 5 rooms an equal chance to be chosen.

14. Students over 21 have chance $\frac{3}{30}$ and students under 21 have chance $\frac{2}{20}$, so each student has chance 1 in 10. The sample always contains exactly 3 students over 21 and 2 students under 21. An SRS would allow any sample of 5 of the 50 students.

15. (a) All people aged 18 and over living in the United States.

(b) Of the 1800 called, 669 did not respond. The rate is $\frac{669}{1800} \approx 0.37 = 37\%$.

(c) It is hard to remember exactly how many movies you saw in exactly the past 12 months.

16. Answers will vary.
Fewer people are home to answer in the summer vacation months. This is particularly true in Italy, where most people vacation in August. High nonresponse increases the risk that those who do respond are not typical of the entire population.

17. Answers will vary.
People are more reluctant to “change” the Constitution than to “add to” it. So the wording “adding to” will produce a higher percent in favor.

18. Yes. The study gives one of two treatments (animation or textbook) to each subject. Imposing treatments is the mark of an experiment. The explanatory variable is method of instruction (text or animation). The response variable is increase in understanding, probably measured by testing before and after instruction.

19. No treatment was imposed on the subjects. This observational study collected unusually detailed information about the subjects, but made no attempt to influence them.

20. Answers will vary.

(a) The study gathered information from interviews and records, but did not impose any treatment on the subjects. The explanatory variable is a measure (not spelled out in detail) of time spent watching TV as a child. The response variables are measures of aggressive behavior, from police records and perhaps also from the interviews.

(b) Children who watch large amounts of TV may have relatively little parental supervision. Their parents may be less likely to read to them, supervise their school work or even see that they always go to school, and discipline them. Undisciplined children who skip school may show more frequent aggressive behavior. We can't say that this is directly due to watching TV. A group of children who watched the same amount of TV but had more parental supervision in other areas might show different behavior.

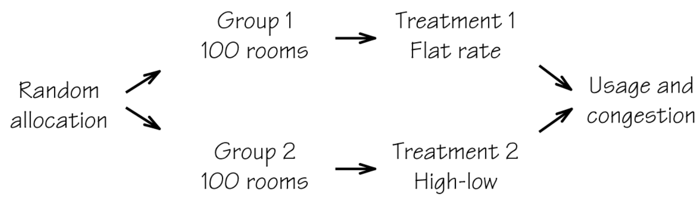
21. Answers will vary.

(a) It is an observational study that gathers information (e.g., through interviews) without imposing any treatment.

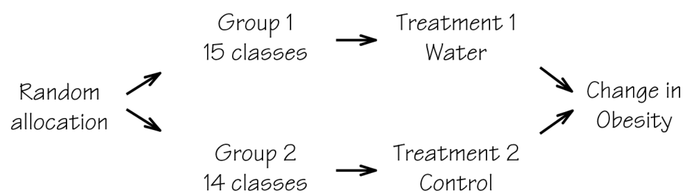
(b) “Significant” means “unlikely to be due simply to chance.”

(c) Nondrinkers might be more elderly or in poorer health than moderate drinkers.

22. The design resembles Figure 7.3. Be sure to show randomization, the groups sizes and the treatments, and the response variable.



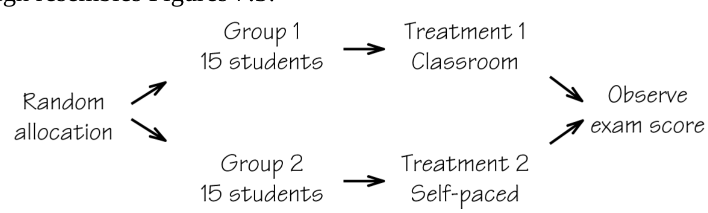
23. The design resembles Figure 7.3. Be sure to show randomization, two groups and their treatments, and the response variable (change in obesity).



If we label the 29 classes 01 to 29 and choose 15 for the treatment group, this group contains classes 17, 09, 22, 13, 07, 02, 27, 01, 18, 25, 29, 19, 14, 15, 08. We used lines 103 to 106 of Table 7.1, skipping many duplicate pairs of digits. The remaining 14 classes make up the control group.

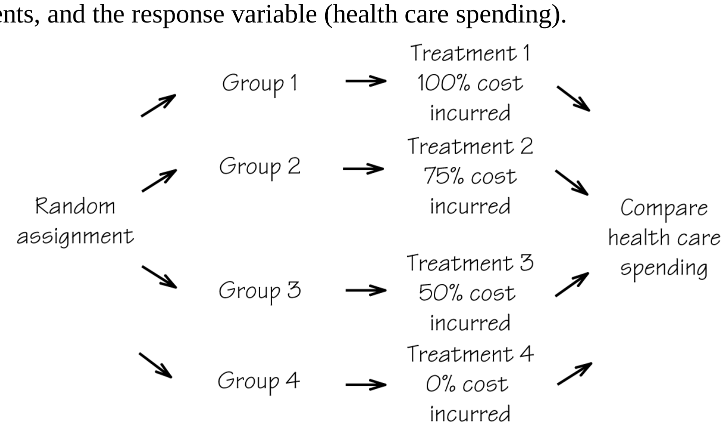
24. (a) Students choose the instruction method they prefer. The two groups of students may differ in many ways. For example, self-paced instruction may attract more older students who live off-campus or more students who work many hours each week.

(b) The design resembles Figures 7.3:



If we label the subjects 01 to 30, Group 1 contains subjects numbered 07, 20, 24, 17, 09, 06, 15, 23, 16, 19, 18, 08, 30, 27, and 12. The remaining 15 subjects make up Group 2.

25. This is a randomized comparative experiment with four branches, similar to Figure 7.4 with one more branch. The "flow chart" outline must show random assignment of subjects to groups, the four treatments, and the response variable (health care spending).



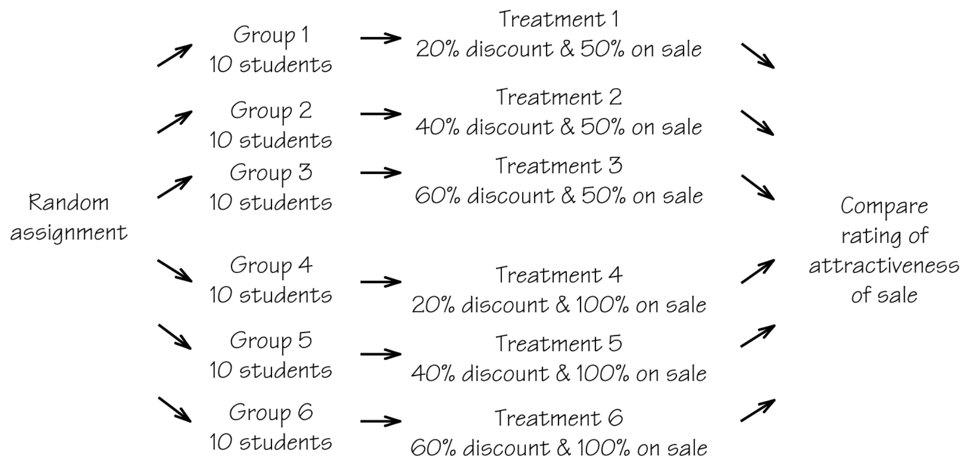
We can't show the group sizes because we don't know how many people or households are available to participate.

26. This is a randomized comparative experiment with four branches, similar to Figure 7.4 with one more branch. The "flow chart" outline must show random assignment of subjects to groups, the group sizes and treatments, and the response variables (number and severity of headaches). It is best to use groups of equal size, with 9 of the 36 subjects in each group. If we label the subjects 01 to 36 in alphabetical order, the first group contains subjects labeled 05 = Chen, 16 = Imrani, 17 = James, 20 = Maldonado, 19 = Liang, 32 = Vaughn, 04 = Bikalis, 25 = Padilla, and 29 = Trujillo. We used lines 130 to 132 of Table 7.1 and skipped many duplicate pairs of digits.

27. (a) There are 6 treatments, each combination of a level of discount and fraction on sale. In table form, the treatments are

	Discount level		
	20%	40%	60%
50% on sale	1	2	3
100% on sale	4	5	6

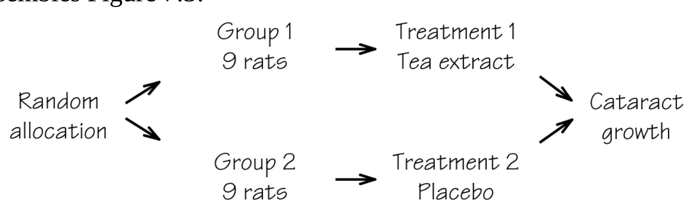
(b) The outline randomly assigns 10 students to each of the 6 treatment groups, then compares the attractiveness ratings. It resembles Figure 7.4, but with 6 branches.



Label the subjects 01 to 60 and read line 123 of Table 7.1. The first group contains subjects labeled 54, 58, 08, 15, 07, 27, 10, 25, 60, 55.

28. *Randomized* means that chance was used to assign subjects to the treatments. *Double-blind* means that people working with the subjects did not know which treatment a subject received. *Comparative* means that controlled release (CR) was compared with at least one other treatment.

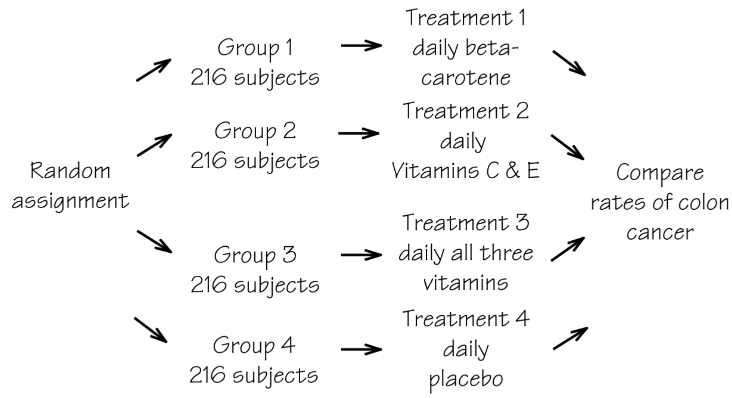
29. The design resembles Figure 7.3:



(b) Label the rats 01 to 18. The tea group contains 15, 06, 13, 09, 18, 03, 05, 16, 17.

30. The assignment in the previous exercise put 3 of the 7 genetically defective rats in the tea group. Continue from the point in line 130 at which that assignment ended: the tea group for the second random assignment contains rats 17, 05, 04, 16, 18, 07, 13, 02, 08, with again 3 of the 7 defective rats. On average, in the long run, half the defective rats (3) will be assigned to each group.

31. (a) This is a randomized comparative experiment with four branches, similar to Figure 7.4 with one more branch. The "flow chart" outline must show random assignment of subjects to groups, the group sizes and treatments, and the response variable (colon cancer). It is best to use groups of equal size, 216 people in each group.



(b) With labels 001 to 864, the first five chosen are 731, 253, 304, 470, and 296.

(c) Those working with the subjects did not know the contents of the pill each subject took daily.

(d) The differences in colon cancer cases in the four groups were so small that they could easily be due to the chance assignment of subjects to groups.

(e) People who eats lots of fruits and vegetables may eat less meat or more cereals than other people. They may drink less alcohol or exercise more.

32. The average earnings of men exceeded those of women by so much that it is very unlikely that the chance selection of a sample would produce so large a difference if there were not a difference in the entire student population. But the black-white difference was small enough that it might be due to the accident of which students were chosen for the sample.

33. During the experiment, only the experimental cars had center brake lights, so they attracted attention. Once most cars had them, they were less noticed and so did a poorer job of preventing collisions. This is an example of an experiment that could not be completely realistic.

34. Any differences in disclosure between black and white subjects were so small that they could just be chance variation. Females disclosed more than males, and the difference between the genders was so large that it would rarely happen just by chance.

35. (a) What percent of college students say that being very wealthy is one of their goals in life? Consider themselves conservatives? Have had five drinks in one sitting in the past week?

(b) Will offering nightly tutoring sessions improve performance in a math course? Will showing videos of drunken students reduce binge drinking?

36. 621 is a statistic (describes this sample); 35% is a parameter (describes the population of residential telephone numbers).

37. Both are statistics because both describe the sample (the subjects who took part in the study).

38. (a) The mean is $p = 0.5$; the standard deviation is as follows.

$$\sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.5(1-0.5)}{14,941}} = \sqrt{\frac{0.5(0.5)}{14,941}} \approx 0.0041$$

(b) $0.5 \pm (2)(0.0041) = 0.5 \pm 0.0082$

$$0.5 - 0.0082 = 0.4918 \text{ to } 0.5 + 0.0082 = 0.5082$$

(c) $0.5 \pm (3)(0.0041) = 0.5 \pm 0.0123$

$$0.5 - 0.0123 = 0.4877 \text{ to } 0.5 + 0.0123 = 0.5123$$

39. (a) The mean is $p = 0.14$; the standard deviation is as follows.

$$\sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.14(1-0.14)}{500}} = \sqrt{\frac{0.14(0.86)}{500}} \approx 0.0155$$

(b) $0.14 \pm (2)(0.0155) = 0.14 \pm 0.031$

$$0.14 - 0.031 = \underline{0.109} \text{ to } 0.14 + 0.031 = \underline{0.171}$$

40. The mean remains $p = 0.5$. The standard deviation is $\sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.5(1-0.5)}{n}} = \sqrt{\frac{0.5(0.5)}{n}}$.

For $n = 1000$: standard deviation is $\sqrt{\frac{0.5(0.5)}{1000}} \approx 0.0158$

For $n = 4000$: standard deviation is $\sqrt{\frac{0.5(0.5)}{4000}} \approx 0.0079$

For $n = 16,000$: standard deviation is $\sqrt{\frac{0.5(0.5)}{4000}} \approx 0.00395$

The 95% ranges are as follows.
For $n = 1000$: $0.5 \pm (2)(0.0158) = 0.5 \pm 0.0316$

$$0.5 - 0.0316 = 0.4684 \text{ to } 0.5 + 0.0316 = 0.5316$$

For $n = 4000$: $0.5 \pm (2)(0.0079) = 0.5 \pm 0.0158$

$$0.5 - 0.0158 = 0.4842 \text{ to } 0.5 + 0.0158 = 0.5158$$

For $n = 16,000$: $0.5 \pm (2)(0.00395) = 0.5 \pm 0.0079$

$$0.5 - 0.0079 = 0.4921 \text{ to } 0.5 + 0.0079 = 0.5079$$

We see that $\hat{p}$ becomes more likely to take values very close to the true p as the sample size n increases.

41. (a) Each digit in the table has one chance in 10 to be any of the ten possible digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. So in the long run, 60% of the digits we encounter will be 0, 1, 2, 3, 4, or 5 and 40% will be 6, 7, 8, or 9.

(b) Line 101 contains 29 digits 0 to 5. This stands for a sample with $\frac{29}{40} = 0.725 = 72.5\%$ "yes" responses. If we use lines 101 to 110 to simulate ten samples, the counts of "yes" responses are 29, 24, 23, 23, 20, 24, 23, 19, 24, and 18. Thus, three samples are exactly correct $\left(\frac{24}{40} = 0.60 = 60\%\right)$, one overestimates, and six underestimate.

42. The sample size is n = 3160. The sample proportion of coaching is $\hat{p} = \frac{427}{3160} \approx 0.135$. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.135 \pm 2\sqrt{\frac{0.135(1-0.135)}{3160}} = 0.135 \pm 2\sqrt{\frac{0.135(0.865)}{3160}} \approx 0.135 \pm 0.012$$

$$0.135 - 0.012 = 0.123 \text{ to } 0.135 + 0.012 = 0.147$$

43. The sample proportion who claim to have attended is $\hat{p} = \frac{750}{1785} \approx 0.420$. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.420 \pm 2\sqrt{\frac{0.420(1-0.420)}{1785}} = 0.420 \pm 2\sqrt{\frac{0.420(0.580)}{1785}} \approx 0.420 \pm 0.023$$

$$0.420 - 0.023 = 0.397 \text{ to } 0.420 + 0.023 = 0.443$$

44. (a) The sample proportion with a TV is $\hat{p} = \frac{692}{1048} \approx 0.660$. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.660 \pm 2\sqrt{\frac{0.660(1-0.660)}{1048}} = 0.660 \pm 2\sqrt{\frac{0.660(0.340)}{1048}} \approx 0.660 \pm 0.029$$

$$0.660 - 0.029 = 0.631 \text{ to } 0.660 + 0.029 = 0.689$$

(b) The article claims a margin of error for 95% confidence of $\pm 3\%$. Calculation gave margin of error $\pm 2.9\%$, which agrees with the article when rounded.

45. (a) The sample proportion who admit running a red light is $\hat{p} = \frac{171}{880} \approx 0.194$. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.194 \pm 2\sqrt{\frac{0.194(1-0.194)}{880}} = 0.194 \pm 2\sqrt{\frac{0.194(0.806)}{880}} \approx 0.194 \pm 0.027$$

$$0.194 - 0.027 = 0.167 \text{ to } 0.194 + 0.027 = 0.221$$

(b) It is likely that more than 171 ran a red light, because some people are reluctant to admit illegal or antisocial acts.

46. (a) $0.70(1009) \approx 706$

(b) In many samples taken by Harris's methods, the sample result will be within ± 3 points of the truth about the population 95% of the time.

(c) The sample proportion is $\hat{p} = 0.7$. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.7 \pm 2\sqrt{\frac{0.7(1-0.7)}{1009}} = 0.7 \pm 2\sqrt{\frac{0.7(0.3)}{1009}} \approx 0.7 \pm 0.029$$

$$0.7 - 0.029 = 0.671 \text{ to } 0.7 + 0.029 = 0.729$$

The calculated margin of error $\pm 2.9\%$ agrees closely with the announced 3%.

47. If Harris takes a very large number of poll samples using the same methods, the poll result will be within $\pm 3\%$ percentage points of the truth about the population in 95% of the samples. The usual language for this is “95% confidence.”

48. No. We are only 95% confident, not certain, that the truth is captured within the margin of error.

49. (a) $\frac{1468}{13{,}000} \approx 0.113 = 11.3\%$.

(b) The response rate is so low that it is likely that those who responded differ from the population as a whole. That is, there is a bias that the margin of error does not include.

50. Undercoverage: Gallup polls are conducted by telephone, so the sample excludes people without fixed-line telephones, that is, poor people and also people who have only cell phones. Nonresponse: it is common for half the people called to never answer or refuse to participate.

51. (a) No. The number of e-filed returns in all states is much larger than the sample size. When this is true, the margin of error depends only on the size of the sample, not on the size of the population.

(b) The sample sizes vary from 970 to 49,000, so the margins of error will also vary.

52. To halve the margin of error, we require four times as many subjects. This is justified as follows. Let E be the margin of error.

$$E = 2\sqrt{\frac{\hat{p}\left(1-\hat{p}\right)}{n}} \Rightarrow \frac{E}{2} = \frac{2\sqrt{\frac{\hat{p}\left(1-\hat{p}\right)}{n}}}{2} \Rightarrow \frac{E}{2} = \frac{2\sqrt{\frac{\hat{p}\left(1-\hat{p}\right)}{n}}}{\sqrt{4}} \Rightarrow \frac{E}{2} = 2\sqrt{\frac{\hat{p}\left(1-\hat{p}\right)}{4n}}$$

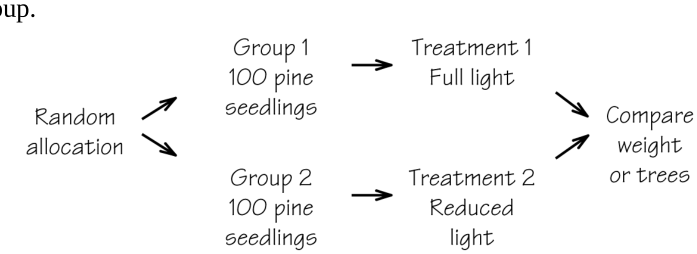
Thus, we would need $4 \times 1009 = 4036$ subjects.

53. The margin of error for 90% confidence comes from the central 90% of a normal sampling distribution. We need not go as far out to cover 90% of the distribution as to cover 95%. So the margin of error for 90% confidence is smaller than for 95% confidence.

54. (a) We impose a treatment (full light or shade) on the seedlings, rather than just observing seedlings in nature.

(b) The individuals are the 200 seedlings. The treatments are the two levels of light (full or 5%). The response variable is dry weight of young trees at the end of the experiment. (Strictly speaking, the average weights for the two treatment groups will be compared.)

(c) The design is like that in Figure 7.3, substituting the details from (b) and 100 seedlings in each group.



55. The sample proportion of successes is $\hat{p} = \frac{7}{97} \approx 0.072$. That is, there were 7.2% successes in the sample. The approximate 95% confidence interval is calculated as follows.

$$\hat{p} \pm 2\sqrt{\frac{\hat{p}\left(1-\hat{p}\right)}{n}} = 0.072 \pm 2\sqrt{\frac{0.072\left(1-0.072\right)}{97}} = 0.072 \pm 2\sqrt{\frac{0.072\left(0.928\right)}{97}} \approx 0.072 \pm 0.052$$

$$0.072 - 0.052 = 0.020 \text{ to } 0.072 + 0.052 = 0.124$$

We are 95% confident that the true proportion of articles that discuss the success of blinding is between 0.020 and 0.124 (that is, 2.0% to 12.4%).

56. (a) 0001 to 2654 (0000 to 2653 is also correct; just be sure to use four digits in all labels).

(b) Read four-digit groups from line 103. The first three that are labels are 0977, 0095, and 2269.

(c) Nonresponse. Many students will probably ignore an email from someone they don't know.

57. The distribution of the sample proportion $\hat{p}$ is approximately normal with mean $p = 0.1$ (that is, 10%) and standard deviation

$$\sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.1(1-0.1)}{97}} = \sqrt{\frac{0.1(0.9)}{97}} \approx 0.030$$

or 3%. Notice that 7% is one standard deviation below the mean. By the 68 part of the 68-95-99.7 rule, 68% of all samples will have between 7% and 13% that discuss blinding. Half the remaining 32% lie on either side. So 16% of samples will have fewer than 7% articles that discuss blinding. That is, the probability is about 0.16.

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