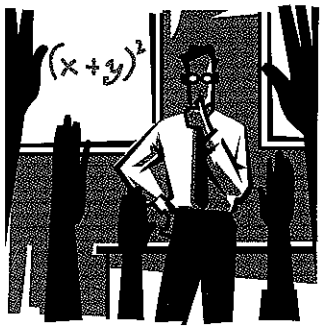
left to right using the last two digits from each entry. This procedure gives us the two-digit numbers 18, 95, 72, 70, 22, 45, 41, 95, 57, 69, 93, 29, 37, 68, 37, 07, 80, 55, 01, and so on. Since, we want eight numbers from 01 to 50, and we do not use repetitions, this leaves the following numbers: 18, 22, 45, 41, 29,37, 07, and 01 (check this).

We have eight different numbers in the desired range, so we look up the states to which they correspond. Our simple random sample consists of the following eight states:

18–Washington	22–Florida	45–Vermont	41–West Virginia
29–Arkansas	37–Kentucky	07–Nevada	01–Alaska

SOLUTION OF THE INITIAL PROBLEM



A university mathematics department is going to conduct a study on "Improving Problem-Solving Skills." The researchers will ask for student volunteers from a pre-calculus class, select a group of five students, and teach them some problem-solving techniques. Twenty-five of Professor Spark's students have indicated they would like to participate in the study. How can the professor select 5 students from the 25 volunteers in a fair way, so that no one can claim the professor showed favoritism?

SOLUTION Choose a simple random sample using a table of random numbers. Assign the 25 students the numbers 00, 01, . . . , 24 in order. Looking at the first two digits of each number in the last column of Figure 9.4 and going down that column, we obtain the numbers 99, 20, 04, 33, 49, 39, 29, 44, 77, 41, 54, 90, 70, 16, 07, 94, 62, 45, 06, 78, ... The first five numbers in this list that are 24 or less are 20, 04, 16, 07, and 06. The students that were assigned those numbers will be able to participate in the study.

PROBLEM SET 9.1

Problems 1 through 8

Identify the population being studied, the sample that is actually observed, and the variable.

1. A light bulb company says its bulbs last 2000 hours. To test this claim, an independent laboratory purchases a package of 8 bulbs, which are kept lit until they burn out. Five of the bulbs burn out before 2000 hours.
2. Divers recover a chest of 1000 gold coins from a sunken Spanish galleon found off the coast of Panama. The archaeologists working on the salvage project take 20 coins from the top of the chest and test them to see if they are pure gold.
3. The registrar's office at a university is interested in the percentage of full-time students who commute to school on a regular basis. One hundred full-time students are randomly selected and briefly interviewed. Of these students, 75 commute on a regular basis.
4. The mathematics department at a university is concerned about the amount of time mathematics students regularly set aside for studying. The department distributes a questionnaire in three mathematics classes having 82 students.
5. In Hewlett-Packard's 2003 annual survey, 4100 Hewlett-Packard customers were asked how they felt about their relationship with the company. Almost two-thirds of the customers believed they had a good relationship with Hewlett-Packard. *Source*: www.interex.org.
6. A newly developed biosensor called Cyranose is an electronic nose that is able to sniff out lung cancer. The device works by picking up the scent of compounds exhaled in the breath of patients with lung cancer. Doctors in Cleveland, Ohio, tested Cyranose on 59 people in the Cleveland area. Some of the people tested were patients with lung cancer, some had other lung cancer disorders, and some were healthy. The biosensor detected lung cancer successfully in the 14 patients who had lung cancer. *Source*: www.worldhealth.net.

7. Of the 7140 registered voters in a certain city, 3460 are Democrats, 3250 are Republicans, and 430 are Independents. A preelection canvassing of adults in a given neighborhood reveals the following numbers of registered voters: 185 Democrats, 210 Republicans, and 25 Independents.

8. There are 12,545 students attending a city's six high schools. The school district conducts a survey to determine students' access to the Internet. Of the 550 students contacted, 385 have a computer at home and 325 have Internet service at home.

9. For each immigrant entering the United States, the government creates a record that includes the country of origin, an identification number, and profession. Which of these variables are quantitative and which are qualitative?

10. The birth record of a baby includes the date and time of birth, the weight, the name of the baby, and the gender. Which of these variables are quantitative and which are qualitative?

11. An ecologist surveys trees in one acre of a forest, recording the location of each tree, the variety of tree (such as pine, oak, or Douglas fir), the approximate age, the approximate height, and the health of the tree (critical, poor, good, excellent). Which of these variables are quantitative and which are qualitative? Which of the qualitative variables are ordinal and which are nominal?

12. An investor sells a bond, and the total dollar amount of the transaction is recorded, as are the name of the bond and its rating. Which of these variables are quantitative and which are qualitative? Which of the qualitative variables are ordinal and which are nominal?

Problems 13 through 16

Identify and discuss any sources of bias in the sampling method.

13. A Minnesota-based toothpaste company claims that 90% of dentists prefer the formula in its toothpaste to any other. To substantiate this claim, the company conducts a study. Managers send questionnaires to 100 dentists in the Minneapolis–St. Paul area asking if they prefer the company's toothpaste formula to others.

14. A magazine devoted to exercise, vitamins, and healthy living is interested in the habits of older adults related to exercise and nutritional supplements. The current issue includes an article on the subject and a questionnaire for readers to fill out and mail in.

15. A soft drink company produces a lemon-lime drink that it says people prefer by a margin of two to one over its main competitor, a cola. To prove this claim, the company sets up a booth in a large shopping mall, where customers are allowed to try both drinks. The customers are filmed for possible inclusion in a television commercial and are asked which drink they prefer.

16. A sociologist working for a large school system is interested in demographic information about the families with children in the schools served by the system. Two hundred students are randomly selected from the school system's database and a questionnaire is sent to the home address of the parents or guardian.

Problems 17 through 20

Identify the population being studied and the sample actually observed. Discuss any sources of bias in the sampling procedure.

17. A biologist wants to estimate the number of fish in a lake. She catches 250 fish, tags them, and releases them back into the lake. Later, she catches 500 fish and finds that 18 of them are tagged.

18. A college professor is up for promotion. Teaching performance, as judged through student evaluations, is a significant factor in the decision. The professor has to choose one of his classes to complete student evaluations. The day of the evaluations, he passes out questionnaires and then remains in the room to answer any questions students might have about how to fill out the form.

19. A drug company wishes to claim that 9 of 10 doctors recommend the active ingredients in its product. It commissions a study of 20 doctors. If at least 18 doctors say they recommend the active ingredients in the product, the company will feel justified in making this claim. If not, the company will commission another study.

20. Two college students are running for student body president. Candidate Johnson believes that the student body resources should be used to enhance the social atmosphere of the college and that the first priority should be dances, concerts, and other social events. Candidate Jackson believes that sports should be the first priority and wants to use student body resources to subsidize student sporting events and enlarge the recreation facility. The student newspaper conducts a poll. An interviewer goes to a coffeehouse near the college one evening and asks students which candidate they prefer. Another interviewer goes to the gym and asks students which candidate they prefer.

21. Suppose city council members would like to survey a representative sample of city residents to determine whether they favor adding fluoride, a known tooth decay preventive, to the city's water system. The sampling could be done in any of the following three ways:

(i) All adults entering the city's public library on a Saturday could be questioned.

(ii) Ten city blocks could be randomly selected and every adult resident on each block questioned.

(iii) Two telephone numbers could be published in the newspaper. People who favor adding fluoride to the water system would call one telephone number while those who are against adding fluoride would call the other number.

a. For each of the three sampling methods, discuss possible sources of bias and then indicate which of the three methods would be likely to yield the most representative sample.

b. Describe a sampling method that might yield a more representative sample than any of the three described in this problem.

22. A school board would like to survey a representative sample of parents of children in the district to determine if parents would be willing to pay a book fee for needed textbook upgrades. The sampling could be done in any of the following three ways:

(i) Parents attending a Parent–Teacher Association meeting could be questioned.

(ii) A questionnaire could be left at the office of every school in the district so that parents visiting the school could fill out the survey.

(iii) At each school in the district, 20 parents could be questioned as they arrive to pick up their children after school.

a. For each of the three sampling methods, discuss possible sources of bias and then indicate which of the three methods would be likely to yield the most representative sample.

b. Describe a sampling method that might yield a more representative sample than any of the three described in this problem.

23. An instructor will randomly select 5 students from a class of 36. Each student is represented by a two-digit number from 00 to 35. Use the table in Figure 9.4 to select a sample of students by taking the last two digits of each random number. Begin with row 115 and proceed down the third column.

24. An automobile distributor received 80 new cars for a particular sales region. Ten cars will be randomly selected for detailed inspections before the shipment is finally accepted. The cars are numbered 00 to 79. Use the table in Figure 9.4 to select the sample of cars by taking the second and third digits of each random number. Begin with row 110 and proceed down the fourth column.

25. A university's science department has 250 graduate students. The dean will randomly select 10 of the graduate students and interview them about financial aid, program requirements, and other matters. The students are numbered 000 to 249. Use the table in Figure 9.4 to select the students by taking the first three digits of each random number. Begin with row 110 and proceed down the second column.

26. A pediatric dental group treats a combined total of 1146 patients. The patients are numbered 0000 to 1145. An independent auditor will conduct a thorough review of patient care and billing procedures on a random sample of 15 patients. Use the table in Figure 9.4 to select the sample of patients by taking the last four digits in each random number. Begin with row 130 and proceed down the first column.

27. Professional baseball has 14 American League player representatives, one for each of the American League teams. The 2004 player representatives are listed in the following table. These players serve as representatives in labor negotiations. Suppose union leaders randomly select a special committee of 5 players from the 14 player representatives. Explain how to generate the sample using a

American League	
Player	Team
Scott Schoeneweis	Anaheim Angels
Jason Johnson	Baltimore Orioles
Johnny Damon	Boston Red Sox
Jeff Liefer	Chicago White Sox
Charles Nagy	Cleveland Indians
Damon Easley	Detroit Tigers
Jason Grimsley	Kansas City Royals
Denny Hocking	Minnesota Twins
Mike Stanton	New York Yankees
Barry Zito	Oakland Athletics
Paul Abbott	Seattle Mariners
John Flaherty	Tampa Bay Devil Rays
Jeff Zimmerman	Texas Rangers
Vernon Wells	Toronto Blue Jays

Source: www.mlb.com.

random-number table, carefully describing the specific steps in your sampling procedure. Carry out your plan, and list the five players in your sample.

28. Professional baseball has 16 National League player representatives, one for each of the National League teams. The 2004 player representatives are listed in the following table. These players serve as representatives in labor negotiations. Suppose union leaders randomly select a special committee of 6 players from the 16 player representatives. Explain how to use a random-number table to generate the sample, carefully describing the specific steps in your sampling procedure. Carry out your plan, and list the six players in your sample.

National League	
Player	Team
Craig Counsell	Arizona Diamondbacks
Mike Remlinger	Atlanta Braves
Joe Girardi	Chicago Cubs
Aaron Boone	Cincinnati Reds
Todd Zeile	Colorado Rockies
Charles Johnson	Florida Marlins
Gregg Zaun	Houston Astros
Paul Lo Duca	Los Angeles Dodgers
Ray King	Milwaukee Brewers
Michael Barrett	Montreal Expos
Al Leiter	New York Mets
Doug Glanville	Philadelphia Phillies
Kevin Young	Pittsburgh Pirates
Steve Kline	St. Louis Cardinals
Kevin Jarvis	San Diego Padres
Russ Ortiz	San Francisco Giants

Source: www.mlb.com.

29. Based on figures from the 2000 census, the top 30 U.S. cities by population are listed in the following table. Suppose coordinators of a federally funded math program will select a sample of 5 of these cities to pilot the program in all elementary schools citywide.

a. Select a random sample of size 5 by beginning in column 2, row 117 of the table in Figure 9.4, and reading down the column selecting the second and third digits of each random number. List the cities in the sample.

b. Select a random sample of size 5 by beginning in column 5, row 140, and reading down the column selecting the last two digits of each random number. List the cities in the sample.

	City, State	Population in 2000
00	New York, NY	8,008,278
01	Los Angeles, CA	3,694,820
02	Chicago, IL	2,896,016
03	Houston, TX	1,953,631
04	Philadelphia, PA	1,517,550
05	Phoenix, AZ	1,321,045
06	San Diego, CA	1,223,400
07	Dallas, TX	1,188,580
08	San Antonio, TX	1,144,646
09	Detroit, MI	951,270
10	San Jose, CA	894,943
11	Indianapolis, IN	791,926
12	San Francisco, CA	776,733
13	Jacksonville, FL	735,617
14	Columbus, OH	711,470
15	Austin, TX	656,562
16	Baltimore, MD	651,154
17	Memphis, TN	650,100
18	Milwaukee, WI	596,974
19	Boston, MA	589,141
20	Washington, DC	572,059
21	Nashville-Davidson, TN	569,891
22	El Paso, TX	563,662
23	Seattle, WA	563,374
24	Denver, CO	554,636
25	Charlotte, NC	540,828
26	Fort Worth, TX	534,694
27	Portland, OR	529,121
28	Oklahoma City, OK	506,132
29	Tucson, AZ	486,699

c. Select a random sample of size 5 by beginning in column 1, row 102, and reading down the column selecting the third and fourth digits of each random number. List the cities in the sample.

d. Six of the 30 cities in the list are West Coast cities: Los Angeles, CA; San Diego, CA; San Jose, CA; San Francisco, CA; Seattle, WA; and Portland, OR. What fraction of cities in the list are West Coast cities? What fraction of cities in each sample in parts (a), (b), and (c) are West Coast cities?

e. Should one suspect bias in the sampling procedure if more than one West Coast city is selected? Explain.

30. Consider the 30 most populous cities in the United States as listed in the previous problem.

a. Select a random sample of size 10 by beginning in column 1, row 106 of the table in Figure 9.4, and reading down the column selecting the first two digits of each random number. List the cities in the sample.

b. Select a random sample of size 10 by beginning in column 4, row 127, and reading down the column selecting the second and third digits of each random number. List the cities in the sample.

c. Select a random sample of size 10 by beginning in column 3, row 111, and reading down the column selecting the first two digits of each random number. List the cities in the sample.

d. Nine of the 30 cities in the list have populations over 1 million. What fraction of cities in the list have populations over 1 million? What fraction of cities in each sample in parts (a), (b), and (c) have populations over 1 million?

e. Should one suspect bias if more than three cities with populations over 1 million are selected? Explain.

Extended Problems

31. The Nielsen Media Group selects households in the United States for its television-rating service. Results of the rating service determine which programs will be broadcast on television, which programs will be canceled, which programs will air during prime time, and so on. Research the Nielson Media Group. On the Internet, visit www.nielsenmedia.com. How many families are included in the rating service? Does the research group accept volunteers? Explain why or why not. How is the sample of families selected? Write a report summarizing your findings.

32. Many Internet news sites conduct opinion polls. For example, on the CNN site at www.cnn.com, readers may participate in "Quick Vote," a poll on issues currently in the news. Visit a news site with an opinion poll and participate in the current poll. Results of the "Quick Vote" are displayed with a disclaimer stating that it is "not a scientific survey." For the opinion poll in which you participated, describe the population, the sample, and the results of the poll. Are the results of the poll representative of Internet users in general? Explain.

33. Citizens of the United States have a civic duty to respond to a jury summons and, if chosen, to serve as a juror. How are citizens selected for jury duty? From what population is a sample of jurors taken? Is the jury a random sample of the population? The population of potential jurors may vary from state to state. Jurors are sometimes excused from jury duty. What excuses are routinely accepted? How does excusing some potential jurors from jury duty affect the selection process and the ability to determine whether the jury is representative of the population? Research juror-selection procedures in the county in which you live. Write a report to summarize your findings.

34. In order to select a random sample, we used a table of randomly generated numbers. If the numbers in the table in Figure 9.4 are indeed random, then we might expect each of the 10 digits 0 through 9 to occur approximately one-tenth of the time. Consider sets of numbers, such as census population data, tax-return data, baseball statistics, accounting balance sheets, or street addresses. It is commonly assumed that if numbers are sampled from a set of