

9. C - Samples, Studies, Simulation and Expected Value

- **Convenience sample:** select any members of the population who are conveniently and readily available.
- **Self-selected sample:** select only members of the population who volunteer for the sample.
- **Systematic sample:** order the population in some way, and then select from it at regular intervals.
- **Random sample:** all members of the population are equally likely to be chosen.
- **Bias:** a systematic error introduced by the sampling method where part of the population is overrepresented or underrepresented.
- **Observational study:** a study method that measures or observes members of a sample in such a way that they are not affected by the study.
- **Controlled experiment:** a study method that divides a sample into two groups. A treatment is imposed on one group but not on the other “control” group. Then the effect on the treated group is compared to the control group.
- **Survey:** a study method that asks every member of the sample a set of questions.
- **Expected value:** the sum of each outcome’s value multiplied by its probability. If A is an event that includes outcomes A_1, A_2, A_3, \dots and $Value(A_n)$ is a quantitative value associated with each outcome, the expected value of A is given by $Value(A) = P(A_1) \cdot Value(A_1) + P(A_2) \cdot Value(A_2) + \dots$

Analyzing Samples

Public Opinion: A newspaper wants to find out what percent of the city population favors a property tax increase to raise money for local parks. What is the sampling method used for each situation? Does the sample have bias? Explain.

- A) A newspaper article on the tax increase invites readers to express their opinions on the newspaper’s website.

Answer: This is a self-selected sample. It might have a bias, depending on who visits the website. The people who respond may overrepresent or underrepresent some views. For example, some property owners who are against the tax might organize a campaign to get friends and neighbors to visit the website.

- B) A reporter interviews people leaving the city’s largest park.

Answer: This is a convenience sample, since it is convenient for the reporters to stay in one place. Because the location is near a park, the sample may overrepresent park supporters and the results will have a bias.

- C) A survey service calls every 50th listing from the local phone book.

Answer: This is a systematic sample because the phone listing is ordered alphabetically. The regular sampling interval is every 50 listings. This sample may have a bias if there is some link between people who are listed (or not listed) in a phone book and people who pay property taxes.

Analyzing Study Methods

Which type of study method is described in each situation? Should the sample statistics be used to make a general conclusion about the population?

- A) Researchers randomly choose two groups from 10 volunteers. Over a period of 8 weeks, one group eats ice cream before going to sleep, and the other does not. Volunteers wear monitoring devices while sleeping, and researchers record dream activity.

Answer: This is an example of a controlled experiment. The statistics for this study are based on such a small sample that the findings are unreliable as a general conclusion.

B) Students in a science class record the height of bean plants as they grow.

Answer: This is an observational study. The statistics may provide a general conclusion about the growth rate of a bean plant. However, soil type, amount of sunlight and water, fertilizer, and other factors could affect the growth rate.

C) Student council members ask every tenth student in the lunch line if they like the cafeteria food.

Answer: This is a survey. The results are not reliable because people waiting in line are more likely to enjoy the cafeteria food than those who brought their lunch from home.

Making Random Selections

There are 28 students in a homeroom. Four students are chosen at random to represent the homeroom on a student committee. How can a random number table be used to fairly choose the students?

Step 1 Select a line from a random number table.

18823 18160 93593 67294 09632 62617 86779

Step 2 Group the line from the table into two digit numbers.

18 82 31 81 60 93 59 36 72 94 09 63 26 26 17 86 77 9

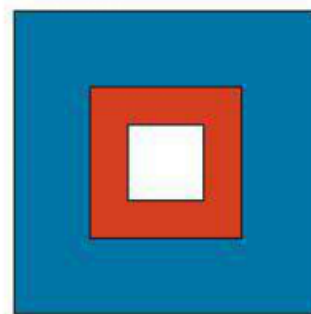
Step 3 Match the first four numbers less than 28 with the position of the students' names on a list. Duplicates and numbers greater than 28 are discarded because they don't correspond to any student on the list.

18 82 31 81 60 93 59 36 72 94 09 63 26 26 17 86 77 9

The students listed 18th, 9th, 26th, and 17th on the list are chosen fairly.

Calculating an Expected Value

Suppose you are at a carnival and are throwing darts at a board like the one at the right. There is an equally likely chance that your dart lands anywhere on the board. You receive 20 points if your dart lands in the white area, 10 points if it lands in the red area, and -5 points if it lands in the blue area. How many points can you expect to get given that the areas for each region are white, 36 in.²; red, 108 in.²; and blue, 432 in.²? The total area is 576 in.².



Value (points)

$$= P(\text{white area})(\text{white points}) + P(\text{red area})(\text{red points}) + P(\text{blue area})(\text{blue points})$$

$$= \frac{36}{576} \cdot 20 + \frac{108}{576} \cdot 10 + \frac{432}{576} \cdot (-5)$$

Substitute the ratio of each area to the total area and the points for each section.

$$= 1.25 + 1.875 + (-3.75)$$

Multiply.

$$= -0.625$$

Add and subtract.

You can expect to get -0.625 points.