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Sampling Techniques

Statistics involves collecting, analysing, and interpreting data. Statistics are often used by businesses, advertisers, governments, and the media, both to inform us and persuade us.

In the context of mathematics, a population includes all members (people or objects) of a group that possess common characteristics from which information is being collected. A sample is a part of the population chosen for participation in a study. Samples are often used because they are less costly, take less time and more easily conducted. The accuracy of any statistical study depends on how the sample is chosen. The following are some of the different sampling methods available to researchers:

due to physical constraints

- cluster sample
- convenience sample
- simple random sample
- stratified sample
- systematic sample
- voluntary sample

SAMPLING METHOD	DEFINITION	EXAMPLE
Simple Random	Every item in the population has an equal chance of being selected.	Drawing five names to survey from a hat containing 30 names.
Stratified Sample	The population is divided into subgroups (by age, gender, nationality, etc.) and a random sample is selected from each subgroup in proportion to its size in the population.	A school is divided into 4 groups by grade. There are 300 grade nines, 350 grade tens, 270 grade elevens and 320 grade twelves. 10% of each group chosen to be a part of the sample.
Cluster Sample	The population is divided into clusters and a certain number of clusters are chosen. Every member of these clusters is part of the sample.	A VP enters the cafeteria and randomly selects two tables. All students at those two tables are surveyed.
Convenience Sample	The sample contains those members of the population from which data are most easily collected.	To survey woodworkers in Ontario, we ask people at several lumber yards and home improvement stores scattered about the province.
Voluntary Sample	The sample contains those members of the population who have chosen to respond to the survey. Often a reward is offered to those who participate in the survey.	The psychology students at University of Toronto are given an extra 2% at the end of the year if they volunteer for any two upper-year psychology surveys.
Systematic sample	Every n^{th} member of the population is selected.	Ronald McDonald hands out coupons for free Cheeseburger Happy Meals to every 10^{th} kid who enters the restaurant.

must biased

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Example 1

Alicia wants to know which band Ontario high school students think is the best. Alicia's friend Jason goes to a different school, so they each survey students at their own school. Alicia uses the completed surveys from both schools to draw conclusions.

a. Identify the population and the sample.

population = Ontario high school students
sample = high school students from 2 highschools (same city)

b. Is the sample representative of the population?

NO, Ontario is very large + music choice may vary by location.

Example 2

Determine the best sampling technique for each survey. Provide a reason for your answer

a. The school newspaper wants to determine which presidential candidate in the upcoming student council elections is supported by the majority of students.

cluster sample – ask students in a random location at school (↑ foyer, parking lot ...)
– easy + fast

b. A light bulb manufacturer wants to determine the lifespan of a certain type of light bulb, in hours.

systematic sample – select every 100th to test
– check quality throughout the entire batch

c. The Parent – Teacher Association wants to determine the average number of hours per week that students spend on homework.

Convenience sample – ask students at school their kid attends

d. The producers of "Canadian Idol" want to determine which of the two remaining candidates should be the next Canadian Idol.

Voluntary sample – ask those who are interested + knowledgeable
– ask at the show itself

Example 3

There are 570 students taking mathematics this semester. The table below shows the number of math students in each grade. A total of 90 math students are to be surveyed using a stratified random sample. How many students from each grade level should be surveyed?

Grade	# of Math students	% of Math students	# of students to be surveyed
9	115	$\frac{115}{570} \times 100 = 20.2$	18
10	125	$= 21.9$	20
11	150	$= 26.3$	24
12	180	$= 31.6$	28
total	570	100	90

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To make an accurate prediction about a population, it is necessary to use a **representative sample**. The characteristics of a representative sample are:

- Random - every member of the population has an equal chance at being selected
- Unbiased - fair and impartial.

Bias is the intentional or unintentional prejudice of data collected in a survey. There are several types of bias:

TYPE OF BIAS	DEFINITION	EXAMPLE
Sampling Bias	chosen sample doesn't represent whole population	A survey asks students at a high school football game whether a fund for extra curricular activities should be used to buy new equipment for the football team or instruments for the school band. (all interested in football; lots of others may not agree)
Response Bias	Survey questions asked poorly	A group of professional football players are asked if they have ever taken banned performance enhancing substances. (won't say if not annonymous)
Measurement Bias	external factors influence results	A highway engineer suggests that an economical way to survey traffic speeds on an expressway would be to have police officers who patrol the highway record the speed of the traffic around them every 30 minutes. (people will slow)
Non-Response Bias	Results are skewed if survey is not answered	You hand out surveys to your classmates to be returned to you next week. (only interested in topic asked will respond.)

Example 4

Favourite Subject Survey

☺ Sponsored by the "Friends of Mathematics" Society ☺

Circle the most appropriate response.

Gender: Male Female

Grade: 9 10 11 12

My favourite subject is: MATH English Science

Please return the survey by the end of the day.

a. Identify the types of bias that *might* result from the survey.

- response bias (bold font on math)
- measurement bias (shows sponsorship)
- non response bias (may not be returned)

b. Re-write the survey in a way that does not present the bias identified in part (a).

Favourite Subject Survey ← no sponsor!

Circle the most appropriate response.

Gender: Male Female

Grade: 9 10 11 12

My favourite subject is: Art English History Math Phys Ed Science } all

The survey will be collected in 5 minutes.