

Math 114

Week 6



Prof. Volk

Spring 2026

Homework 5: 25 Questions

Due Tuesday
11:59 pm

Questions 1 & 3	• Give examples and explain concepts and terms related to budgets, expenses, and insurance.
Question 2 & 4	• Decide if statements related to personal finance are clearly true.
Questions 5 & 6	• Solve applications involving calculating the cost per year of expenses.
Questions 7-10	• Solve applications involving comparing spending and wage patterns.
Questions 11 & 12	• Solve applications involving finding total expenses, least expensive options, or most profitable options.
Questions 13-15	• Calculate the accumulated balance or interest for accounts earning simple interest or compound interest.
Question 16 & 17	• Decide if statements related to compounding interest and percentage rates are clearly true.
Question 18	• Evaluate expressions using the four basic rules of algebra.
Questions 19 & 20	• Find the present value for an account.
Question 21 & 22	• Find the time it will take for the balance in an account to reach a given amount.
Questions 23 & 24	• Calculate total and annual returns on investments.
Question 25	• Calculate and interpret price-to-earning ratios.

Due Wednesday
11:59 pm

Quiz 5: 10 Questions

Question 1

- Solve applications involving calculating the cost per year of expenses.

Question 2

- Solve applications involving calculating interest payments.

Questions 3

- Solve applications involving calculating monthly expenses.

Question 4

- Solve applications involving calculating net cash flow.

Questions 5

- Calculate the accumulated balance or interest for accounts earning simple interest or compound interest.

Questions 6

- Calculate and interpret balances, interest, and deposit amounts using the savings plan formula.

Questions 7

- Evaluate expressions involving powers and roots.

Questions 8 & 9

- Find the present/future value for an account.

Question 10

- Calculate and interpret price-to-earning ratios.

Points through due date:

Test (125 points)

Project (25 points)

HWs 1-4 (80 points)

Quizzes 1-3 (30 points)

260 points = 100%

*10 points bonus for CRC

*5 points bonus for Bio

A

234-260

B

208-233

C

182 - 207

Homework 6: 20 Questions

Due Sunday
11:59 pm

Questions 1

- Interpret multiple bar graphs, stack plots, contour maps, and other graphical displays.

Questions 2 - 4

- Identify populations, samples, population parameters, and sample statistics in a given study

Questions 5 - 12

- Identify sampling methods and sources of bias.

Questions 13-14

- Identify flaws and sources of bias in a study.

Questions 15

- Determine whether a claim made by a statistical study is appropriate.

Questions 16

- Construct and interpret tables for frequency, relative frequency, and cumulative frequency.

Questions 17 - 20

- Distinguish between qualitative and quantitative data.

Quiz 6: 10 Questions

Due Monday
11:59 pm

Question 1

- Identify populations, samples, population parameters, and sample statistics in a given study

Questions 2 - 4

- Identify sampling methods and sources of bias.

Questions 5

- Determine whether a claim made by a statistical study is appropriate.

Questions 6 - 7

- Identify flaws and sources of bias in a study.

Question 8

- Construct and interpret tables for frequency, relative frequency, and cumulative frequency.

Question 9

- Distinguish between qualitative and quantitative data.

Question 10

- Construct and interpret time-series graphs, bar graphs, and pie charts.

For the following situation, find the average monthly expense that you would use in budgeting for the given expense. Note: Annual means once a year, and semiannual means twice a year.

Prorate the following expenses and find the corresponding monthly expense.

Lan pays a semiannual premium of \$700 for automobile insurance, a monthly premium of \$170 for health insurance, and an annual premium of \$450 for life insurance.

\$700

Every 6 months

\$170

Every 1 months

\$450

Every 12 months

$$\frac{\$700}{6} + \frac{\$170}{1} + \frac{\$450}{12}$$

$$\$116.67 + \$170 + \$37.50$$

\$324.17



The expenses and income of an individual are given in table form to the right. Find the net monthly cash flow (it may be negative or positive). Assume that amounts shown for salaries and wages are after taxes and that
1 month = 4 weeks.

Income	Expenses
Salary: \$35,300/year	House payments: \$770/month
Pottery Sales: \$196/month	Groceries: \$100/week
	Household expenses: \$135/month
	Health insurance: \$450/month
	Car insurance: \$500 twice a year
	Savings plan: \$25/month
	Donations: \$660/year
	Miscellaneous: \$500/month

$$\text{Monthly Income} = \frac{35300}{12} + 196 = \$3137.67$$

$$\text{Monthly Expenses} = 770 + 4(100) + 135 + 450 + \frac{500}{6} + 25 + \frac{660}{12} + 500$$

$$\text{Monthly Expenses} = \$2418.33$$

$$\text{Net Monthly Cash Flow} = \$3137.67 - \$2418.33 = \mathbf{+719.34}$$



Find the monthly interest payment in the situation below.

Vic bought a new plasma TV for \$2300. He made a down payment of \$100 and then financed the balance through the store. Unfortunately, he was unable to make the first monthly payment and now pays 5% interest per month on the balance (while he watches his TV).

\$2300 Total Cost

\$100 Down Payment

\$2200 Financed

5% of \$2200 Monthly Interest

\$110 Monthly interest



Calculate the amount of money you'll have at the end of the indicated time period.

You invest \$2000 in an account that pays simple interest of 2% for 20 years.

Simple Interest: $\$2000 \times 2\% \times 20$

Simple Interest: \$800

Future Value: \$2800



Use the compound interest formula to determine the accumulated balance after the stated period.

\$8000 invested at an APR of 8% for 5 years.

$$8000(1.08)^5 = 11754.62461$$

$$\text{round}\left(\text{11754.62461}_{\text{8M5}}, 2\right) = 11754.62 \quad \left(\frac{\square}{\square}\right)$$



Use the appropriate compound interest formula to compute the balance in the account after the stated period of time

\$3,000 is invested for 18 years with an APR of 6% and monthly compounding.



Savings Plan Formula (Regular Payments)

$$A = \text{PMT} \times \frac{\left[\left(1 + \frac{\text{APR}}{n} \right)^{(nY)} - 1 \right]}{\left(\frac{\text{APR}}{n} \right)}$$

A = accumulated savings plan balance

PMT = regular payment (deposit) amount

APR = annual percentage rate (as a decimal)

n = number of payment periods per year

Y = number of years

Use the compound interest formula to determine the accumulated balance after the stated period.

\$8000 invested at an APR of 8% for 5 years.

	A	B
1	How much to save now	=PV(
2	How much will I have in the future	=FV(
3	How much to save/pay monthly	=PMT(

(\$11,754.62)

=FV(.08,5,0,8000

FV(rate, nper, pmt, [pv], [type])

Description

Returns the future value of an investment based on periodic, constant payments and a constant interest rate

Example

=FV(0.06/12, 10, -200, -500, 1)

rate	is the interest rate per period. For example, use 6%/4 for quarterly payments at 6% APR
nper	is the total number of payment periods in the investment
pmt	is the payment made each period; it cannot change over the life of the investment
[pv]	is the present value, or the lump-sum amount that a series of future payments is worth now. If omitted, Pv = 0
[type]	is a value representing the timing of payment: payment at the beginning of the period = 1; payment at the end of the period = 0 or omitted

Find the savings plan balance after 3 years with an APR of 7% and monthly payments of \$100.

	A	B
1	How much to save now	=PV(
2	How much will I have in the future	=FV(
3	How much to save/pay monthly	=PMT(

(\$3,993.01)

=FV(0.07/12,3*12,100)

FV(rate, nper, pmt, [pv], [type])

Description

Returns the future value of an investment based on periodic, constant payments and a constant interest rate

Example

=FV(0.06/12, 10, -200, -500, 1)

rate	is the interest rate per period. For example, use 6%/4 for quarterly payments at 6% APR
nper	is the total number of payment periods in the investment
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[Learn more about FV](#)

[Give feedback](#)

How much must be deposited today into the following account in order to have \$55,000 in 6 years for a down payment on a house? Assume no additional deposits are made.

An account with annual compounding and an APR of 4%

	A	B
1	How much to save now	=PV(
2	How much will I have in the future	=FV(
3	How much to save/pay monthly	=PMT(

(\$43,467.30)

=PV(0.04/1,6*1,0,55000)

PV(rate, nper, pmt, [fv], [type])

Description

Returns the present value of an investment: the total amount that a series of future payments is worth now

Example

=PV(0.08/12, 12*20, 500, , 0)

rate	is the interest rate per period. For example, use 6%/4 for quarterly payments at 6% APR
nper	is the total number of payment periods in an investment
pmt	is the payment made each period and cannot change over the life of the investment
[fv]	is the future value, or a cash balance you want to attain after the last payment is made
[type]	is a logical value: payment at the beginning of the period = 1; payment at the end of the period = 0 or omitted

[Learn more about PV](#)

[Give feedback](#)

Use the compound interest formula for compounding more than once a year to determine the accumulated balance after the stated period.

\$12,000 deposit at an APR of 4% with semiannual compounding for 5 years

	A	B
1	How much to save now	=PV(
2	How much will I have in the future	=FV(
3	How much to save/pay monthly	=PMT(

(\$14,627.93)

=FV(.04/2,5*2,0,12000)

FV(rate, nper, pmt, [pv], [type])

Description

Returns the future value of an investment based on periodic, constant payments and a constant interest rate

Example

=FV(0.06/12, 10, -200, -500, 1)

rate	is the interest rate per period. For example, use 6%/4 for quarterly payments at 6% APR
nper	is the total number of payment periods in the investment
pmt	is the payment made each period; it cannot change over the life of the investment
[pv]	is the present value, or the lump-sum amount that a series of future payments is worth now. If omitted, Pv = 0
[type]	is a value representing the timing of payment: payment at the beginning of the period = 1; payment at the end of the period = 0 or omitted

[Learn more about FV](#)

[Give feedback](#)

Compute the total and annual returns on the following investment.

Seventeen years after purchasing shares in a mutual fund for \$5900, the shares are sold for \$11,100.

$$\text{total return} = \frac{(11100 - 5900)}{5900} \times 100\% = 88.1\%$$

$$\text{annual return} = \left(\frac{11100}{5900} \right)^{(1/17)} - 1 = .038 \times 100\% = 3.8\%$$



$$\text{total return} = \frac{(A - P)}{P} \times 100\%$$

$$\text{annual return} = \left(\frac{A}{P} \right)^{(1/Y)} - 1$$

\$1000 is deposited in an account that pays an APR of 6.5% compounded annually.

How long will it take for the balance to reach \$160,000?

	A	B
1	How much to save now	=PV(
2	How much will I have in the future	=FV(
3	How much to save/pay monthly	=PMT(

$$\text{total return} = \frac{(160000 - 1000)}{1000} \times 100\% = 15900\%$$

$$\frac{\log(1 + 159)}{\log(1 + .065)} = \frac{\log(160)}{\log(1.065)} = 80.59$$

81 years

(Round up to the nearest year.)

$$\text{total return} = \frac{(A - P)}{P} \times 100\%$$

$$\frac{\log(1 + \text{total return})}{\log(1 + \text{annual return})} = \text{Years}$$

Company XYZ closed at \$99.86 per share with a P/E ratio of 10.91. Answer the following questions.

- How much were earnings per share?
- Does the stock seem overpriced, underpriced, or about right given that the historical P/E ratio is 12-14?

$$\frac{P}{E} = 10.91 \quad \longrightarrow \quad \frac{\$99.86}{E} = 10.91 \quad \longrightarrow \quad \frac{\$99.86}{10.91} = E$$

$$E = \$9.15$$

Underpriced



How long will it take money to **triple** at an APR of 8.5% compounded annually?

Principal + 200% increase = triple

$$\frac{\log(1 + \text{total return})}{\log(1 + \text{annual return})} = \text{Years}$$

$$\frac{\log(1 + 200\%)}{\log(1 + 8.5\%)} = \text{Years}$$

$$\frac{\log(1 + 2)}{\log(1 + .085)} = \frac{\log(3)}{\log(1.085)} = 13.47$$

14 years 

(Round up to the nearest year.)

Compute the total and annual returns on the following investment.

Seventeen years after purchasing shares in a mutual fund for \$5900, the shares are sold for \$11,100.



Try This Problem in Pairs

Consider the following loan. Complete parts (a)-(c) below.

An individual borrowed \$84,000 at an APR of 3%, which will be paid off with monthly payments of \$466 for 20 years.



a. Identify the amount borrowed, the annual interest rate, the number of payments per year, the loan term, and the payment amount.

The amount borrowed is \$ the annual interest rate is %, the number of payments per year is , the loan term is years, and the payment amount is \$.

b. How many total payments does the loan require? What is the total amount paid over the full term of the loan?

There are payments toward the loan and the total amount paid is \$.

c. Of the total amount paid, what percentage is paid toward the principal and what percentage is paid for interest?

The percentage paid toward the principal is % and the percentage paid for interest is .

(Round to the nearest tenth as needed.)

Consider a student loan of \$15,000 at a fixed APR of 9% for 30 years.

- a. Calculate the monthly payment.
- b. Determine the total amount paid over the term of the loan.
- c. Of the total amount paid, what percentage is paid toward the principal and what percentage is paid for interest.

Formula of the Day

$$A = P \frac{r(1+r)^n}{(1+r)^n - 1}$$

A = payment Amount per period
P = initial principle (loan amount)
r = interest rate per period
n = total # of payments (periods)

FILEHOMEINSERTPAGE LAYOUTFORMULASDATA

B5

X

✓

f_x

=PMT(B1/12,B2*12,B3)

	A	B	C	D	E
1	Annual Interest Rate	10%			
2	Term in Years	10			
3	Loan Amount	25000			
4					
5	Monthly Payment	\$120.69			

1

+

◀

▶

100%

=PMT(B1/12,B2*12,B3)

Try This Problem in Pairs



current mortgage rates



Use Excel PMT function to calculate the monthly payment for the following two situations of financing a home:

Situation A:
\$300,000 borrowed at 6.735% interest for 30 years

	A	B	C
1	borrowed	\$300,000	
2	rate	6.735%	
3	years	30	
4	PMT	=PMT(B2/12,B3*12,B1)	
5			

	A	B
1	borrowed	\$300,000
2	rate	6.735%
3	years	30
4	PMT	(\$1,942.80)

Situation B:
\$300,000 borrowed at 5.133% interest for 15 years

	A	B
1	borrowed	\$300,000
2	rate	5.133%
3	years	15
4	PMT	(\$2,393.22)

Average rates

Jul 15, 2022

Loan amount

\$300K

Down payment

3%

State

Virginia

Credit score

700 - 719

30-yr fixed

6.735%

15-yr fixed

5.133%

=PMT(B2/12,B3*12,B1)

PMT(rate, nper, pv, [fv], [type])

Comparing Loans Example

Someone needs to borrow \$13,000 to buy a car and the person has determined that monthly payments of \$250 are affordable. The bank offers a 4-year loan at 8% APR, a 5-year loan at 8.5%, or a 6-year loan at 9% APR. Which loan best meets the person's needs? Explain.



D5					
=PMT(D2/12,D4*12,D3)					
	A	B	C	D	E
1		Loan 1	Loan 2	Loan 3	
2	APR	8%	8.50%	9%	
3	amount	13000	13000	13000	
4	years	4	5	6	
5	PMT	(\$317.37)	(\$266.71)	(\$234.33)	

fx

=PMT(rate,nper,pv)|

Compound Interest Formula for Interest Paid n Times per Year

$$A = P \left(1 + \frac{\text{APR}}{n} \right)^{(nY)}$$

A = accumulated balance after Y years

P = starting principal

APR = annual percentage rate (as a decimal)

n = number of compounding periods per year

Y = number of years

Annual Return

Consider an investment that grows from an original principal P to a later accumulated balance A in Y years.

The **annual return** is the annual percentage yield (APY) that would give the same overall growth.

$$\text{annual return} = \left(\frac{A}{P} \right)^{(1/Y)} - 1$$

Two Definitions of Statistics

- Statistics is the *science* of collecting, organizing, and interpreting data.
- Statistics are the *data* that describe or summarize something.

Definitions

- The **population** in a statistical study is the *complete* set of people or things being studied.
- The **sample** is the subset of the population from which the raw data are actually obtained.
- **Population parameters** are specific numbers describing the characteristics of the population.
- **Sample statistics** are numbers describing the characteristics of the sample found by consolidating or summarizing the raw data collected from the sample.

Common Sampling Methods (1 of 2)

Simple random sampling: We choose a sample of items in such a way that every sample of the same size has an equal chance of being selected.

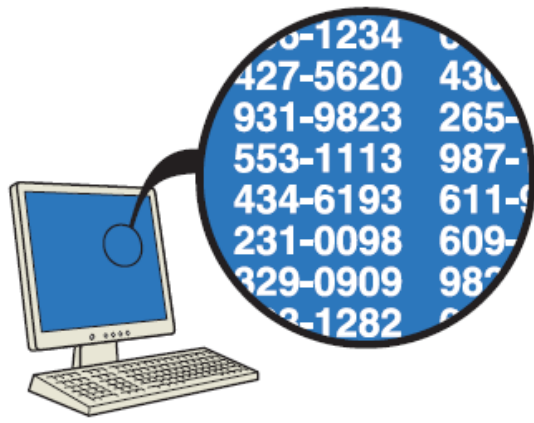
Systematic sampling: We use a simple system to choose the sample, such as selecting every 10th or every 50th member of the population.

Convenience sampling: We choose a sample that is convenient to select, such as people who happen to be in the same classroom.

Common Sampling Methods (2 of 2)

Cluster sampling: We first divide the population into groups, or *clusters*, and select some of these clusters at random. We then obtain the sample by choosing *all* the members within each of the selected clusters.

Stratified sampling: We use this method when we are concerned about differences among subgroups, or *strata*, within a population. We first identify the subgroups and then draw a simple random sample within each subgroup. The total sample consists of all the samples from the individual subgroups.



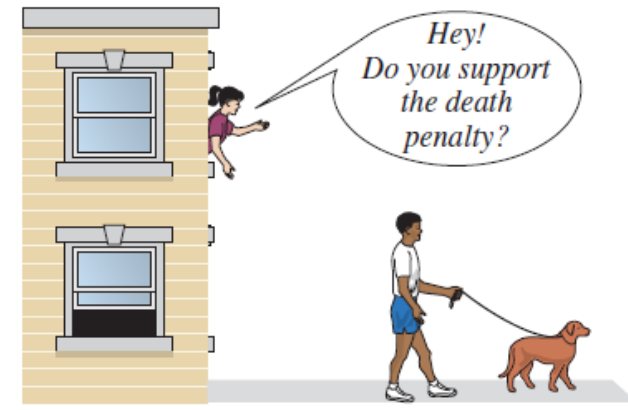
Simple Random Sampling:

Every sample of the same size has an equal chance of being selected. Computers are often used to generate random numbers.



Systematic Sampling:

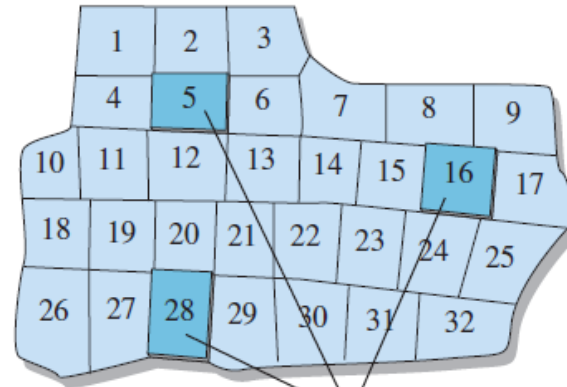
Select every n th member.



Convenience Sampling:

Use results that are readily available.

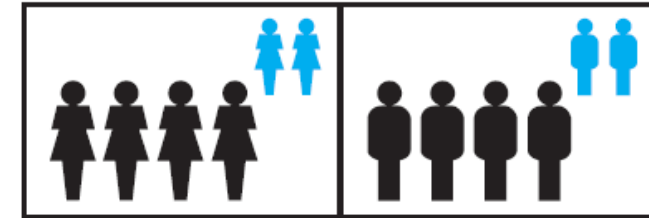
Election precincts in Carson County



Interview all voters in shaded precincts.

Cluster Sampling:

Divide the population into clusters, randomly select some of those clusters, then choose all members of the selected clusters.



Stratified Sampling:

Partition the population into at least two strata, then draw a sample from each.

Module 6: **Learning Outcomes**



Identify populations, samples, population parameters, and sample statistics in a given study.



Distinguish between qualitative and quantitative data.



Identify sampling methods and sources of bias.



Construct and interpret tables for frequency, relative frequency, and cumulative frequency.

Compute the total and annual returns on the following investment.

Seventeen years after purchasing shares in a mutual fund for \$5900, the shares are sold for \$11,100.

$$\text{total return} = \frac{(11100 - 5900)}{5900} \times 100\% = 88.1\%$$

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$$\text{total return} = \frac{(A - P)}{P} \times 100\%$$

$$\text{annual return} = \left(\frac{A}{P} \right)^{(1/Y)} - 1$$

$$\text{total return} = \frac{(A - P)}{P} \times 100\%$$

TYPES OF DATA



Liberty University Observatory

www.liberty.edu/observatory
Facebook: LU Astronomical Observatory

Earn 5 points extra credit if you
take a selfie inside the
observatory and show it to me.



74 72 68 66 57 55 48 46 38 32 32 21 20 10 34 32 33 34 38 37

Complete the frequency table below.

Scores	Frequency	Relative Frequency	Cumulative Frequency
94 to 99	4	$\frac{4}{20}$ 20 %	
88 to 93	2	$\frac{2}{20}$ 10 %	
82 to 87	3	$\frac{3}{20}$ 15 %	
76 to 81	2		
70 to 75	5		
64 to 69	4		
Total	20		

How to complete a frequency table (by example)



Volk, Andrew Harrison (General Math and Science)

Booking Page



Choose a meeting type



Meeting with Volk in Office!

25 MIN

I am keeping aside some time in the day for listening, sharing, and helping each other with our questions, queries, or concerns. Feel free to book time with me!



Speed Meeting with Volk in Office

10 MIN

Quick question or need some advice? Schedule a 10-minute meeting.



Attendance Code:

 **8686**

Enter the above code into the
Top Hat app now

Enter Join Code

826488

to join this course

Text **8686** to

(315) 636-0905

to answer via SMS

Math 114
Thursday Week 6

Prof. Volk

Spring 2026

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Project (25 points)

HWs 1-5 (100 points)

Quizzes 1-3,5 (40 points)

290 points = 100%

*10 points bonus for CRC

A

Above 260

B

232-260

C

203 - 231

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Liberty University Observatory

www.liberty.edu/observatory
Facebook: LU Astronomical Observatory

Earn 5 points extra credit if you
take a selfie inside the
observatory and show it to me.



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Total	20		

How to complete a frequency table (by example)

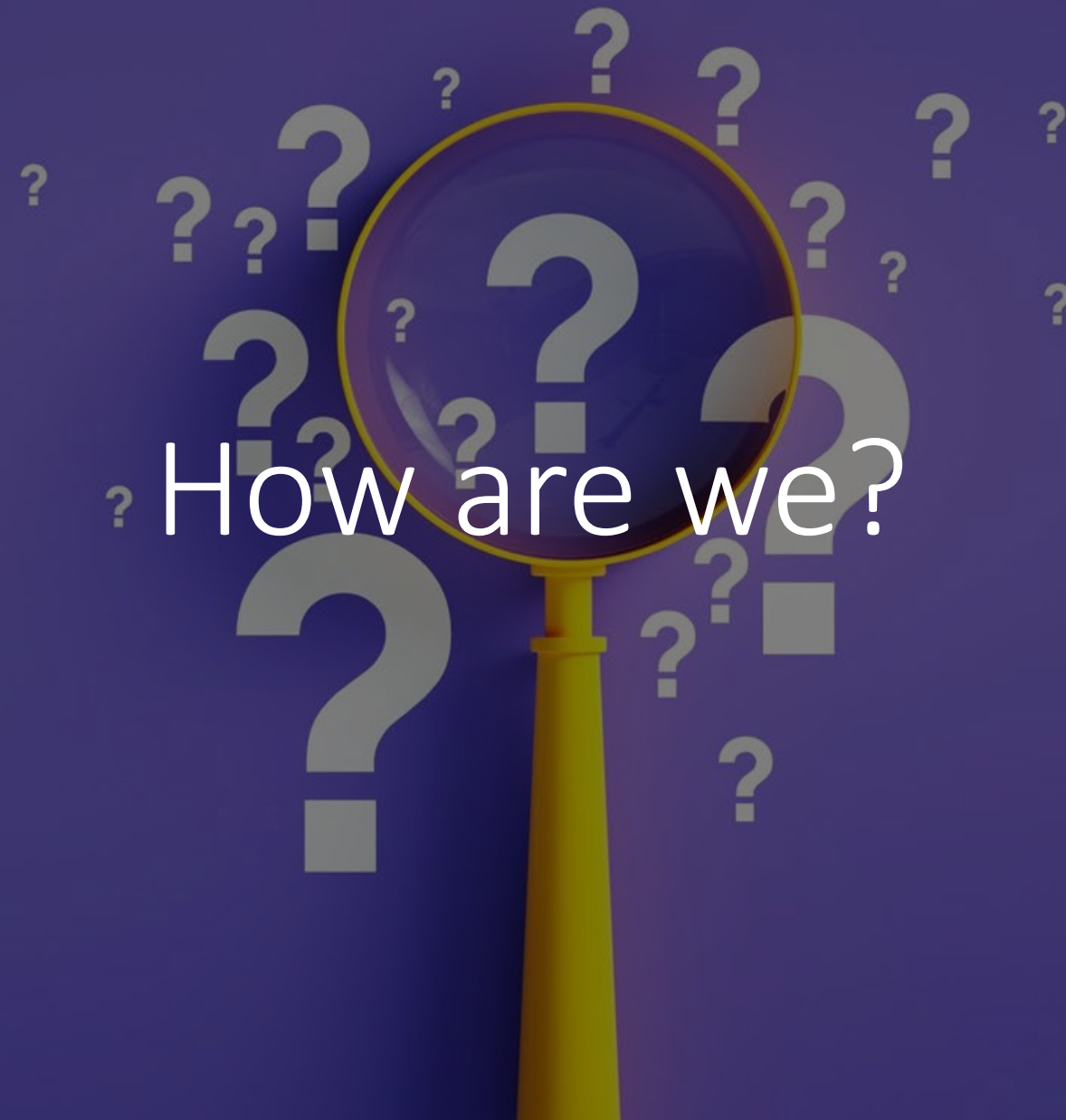
Example: Binned Exam Scores

Consider the following 20 scores from a 100-point exam:

76 80 78 76 94 75 98 77 84 88 81 72 91 72 74 86 79 88 72 75

Determine appropriate bins and make a frequency table including columns for relative and cumulative frequency.

Scores	Frequency	Relative Frequency	Cumulative Frequency
90-99	3	$3/20=15\%$	3
80-89	6	$6/20=30\%$	9
70-79	11	$11/20=55\%$	20
Total	20	100%	20



How are we?

Prayer

REQUESTS

Example: Data Types (1 of 2)

Classify each of the following types of data as either qualitative or quantitative.

a. Brand names of shoes in a consumer survey

Brand names are nonnumerical; qualitative

b. Heights of students

Heights are measurements; quantitative

Example: Data Types (2 of 2)

Classify each of the following types of data as either qualitative or quantitative.

c. Audience ratings of a film on a scale of 1 to 5, where 5 means excellent

Although the film rating categories involve numbers, the numbers represent subjective opinions about a film, not counts or measurements. These data are therefore qualitative, despite being stated as numbers.



Concept Check

What is a 'Population' in statistical terms?

- a) A group of people living in a specific area.
- b) The entire group that you wish to study.
- c) A sample subset.
- d) The researchers conducting the study

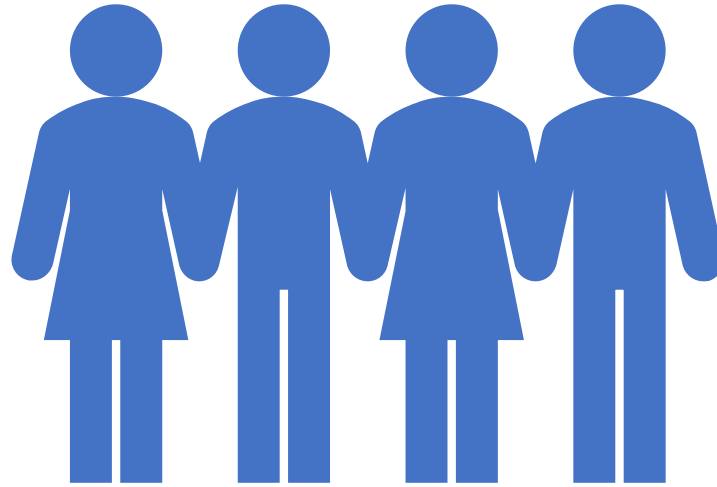


Concept Check

How is 'Statistics' defined as a Discipline?

- a) Numerical facts only.
- b) The science of organizing parties.
- c) The science of collecting, analyzing, and interpreting data.
- d) The art of making graphs





Importance of a Representative Sample





Validity

- Ensures the conclusions drawn are accurate
- Example: Using a random sample for political polling





Generalizability

- Allows findings to be extrapolated to the broader population



How much must be deposited today into the following account in order to have a \$140,000 college fund in 15 years? Assume no additional deposits are made.
An account with monthly compounding and an APR of 6.4%

...

\$ should be deposited today.

(Do not round until the final answer. Then round to the nearest cent as needed.)

Concept Check

Why is a 'Representative Sample' important?

- a) It's easier to manage.
- b) It ensures the validity and generalizability of conclusions.
- c) It supports the researcher's bias.
- d) It makes the study look more impressive



Bias

A systematic error
that affects study
validity

Impact: Undermines
credibility and
affects decision-
making





Forms of Bias

Selection Bias

Response Bias

Observer Bias

Confounding Bias 

Concept Quiz

What is 'Observer Bias'?

- a) A bias against watching TV.
- b) When researchers unconsciously influence the study.
- c) When respondents lie in their answers.
- d) When only certain groups are sampled



Math 114
Friday Week 6

Prof. Volk

Fall 2025

Points through due date:

Test (125 points)

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11:59 pm

Questions 1

- Interpret multiple bar graphs, stack plots, contour maps, and other graphical displays.

Questions 2 - 4

- Identify populations, samples, population parameters, and sample statistics in a given study

Questions 5 - 12

- Identify sampling methods and sources of bias.

Questions 13-14

- Identify flaws and sources of bias in a study.

Questions 15

- Determine whether a claim made by a statistical study is appropriate.

Questions 16

- Construct and interpret tables for frequency, relative frequency, and cumulative frequency.

Questions 17 - 20

- Distinguish between qualitative and quantitative data.

Quiz 6: 10 Questions

Due Monday
11:59 pm

Question 1

- Identify populations, samples, population parameters, and sample statistics in a given study

Questions 2 - 4

- Identify sampling methods and sources of bias.

Questions 5

- Determine whether a claim made by a statistical study is appropriate.

Questions 6 - 7

- Identify flaws and sources of bias in a study.

Question 8

- Construct and interpret tables for frequency, relative frequency, and cumulative frequency.

Question 9

- Distinguish between qualitative and quantitative data.

Question 10

- Construct and interpret time-series graphs, bar graphs, and pie charts.

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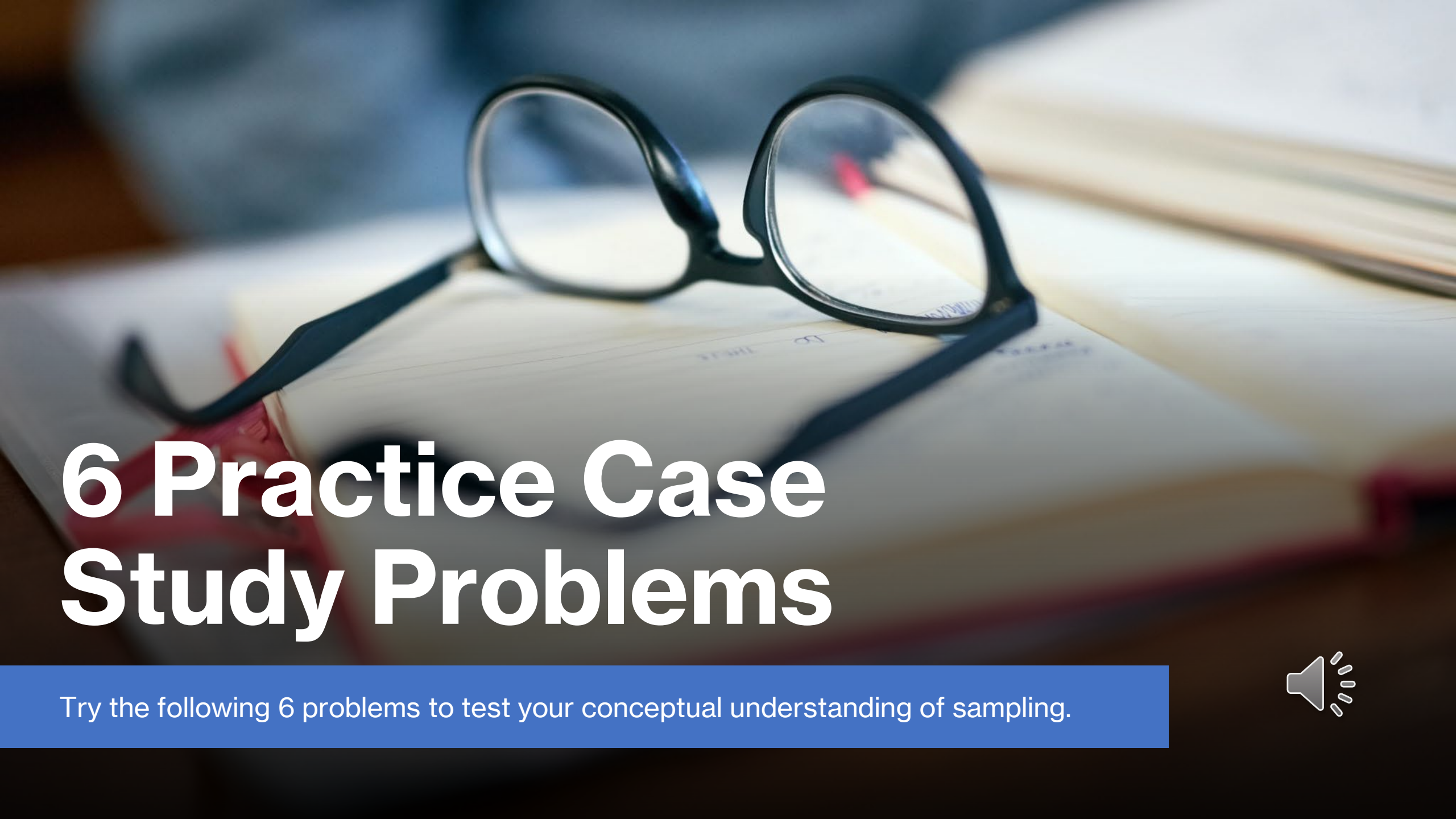
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Travel to
MOROCCO
and **SPAIN**



Spring Break: March 12–22, 2026
Deadline: October 15, 2025



6 Practice Case Study Problems

Try the following 6 problems to test your conceptual understanding of sampling.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 1:

Researchers survey every 10th shopper entering a supermarket on a given Saturday.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 2:

A political pollster surveys 500 registered voters in each state.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 3:

A researcher surveys people closest to her at a bus stop regarding public transport usage.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 4:

Students are divided into four groups based on their majors, and 50 students from each group are surveyed about their study habits.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 5:

A health organization randomly selects 100 schools in a country and surveys all teachers in those schools about mental health resources.



Identify

a. Sampling Method

b. Sample

c. Population,

Case 6:

A study involves picking names out of a hat from the entire list of employees at a large corporation to answer an engagement survey.



Answers



Case Study	Sampling Method	Sample	Population
Case Study 1	Systematic Sampling	Every 10th shopper on that Saturday	All shoppers entering the supermarket on that Saturday
Case Study 2	Stratified Sampling	500 voters from each state	All registered voters in each state
Case Study 3	Convenience Sampling	People closest to her at the bus stop	All people who use the bus stop
Case Study 4	Stratified Sampling	50 students from each major group	All students divided by their majors
Case Study 5	Cluster Sampling	All teachers in the selected 100 schools	All teachers in all schools in the country
Case Study 6	Simple Random Sampling	Names picked from the hat	All employees of the large corporation





Volk, Andrew Harrison (General Math and Science)

Booking Page



Choose a meeting type



Meeting with Volk in Office!

25 MIN

I am keeping aside some time in the day for listening, sharing, and helping each other with our questions, queries, or concerns. Feel free to book time with me!



Speed Meeting with Volk in Office

10 MIN

Quick question or need some advice? Schedule a 10-minute meeting.



Conclusion

- You have now completed a comprehensive overview of foundational statistical concepts, including immediate feedback through interactive case studies
- This knowledge will serve as an indispensable foundation for rigorous statistical research
- Thank you for participating!





QUESTIONS?



Introduction



This chapter aims to provide a comprehensive overview of essential statistical concepts



Topics covered include statistical terminology, the dual meanings of the term "Statistics," the importance of representative samples, and an understanding of bias



Each section will conclude with a concept quiz, followed by interactive case studies



$y = g(x)$

Secant Lines

Tangent Line

$x+h$

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$
$$f(x) = \lim_{h \rightarrow 0} \frac{(x+h)^2 - x^2}{h}$$
$$= \lim_{h \rightarrow 0} \frac{x^2 + 2xh + h^2 - x^2}{h}$$
$$= \lim_{h \rightarrow 0} \frac{2xh + h^2}{h}$$
$$= \lim_{h \rightarrow 0} h(2x + h)$$

$g(x+h) - g(x)$

Statistical Terminology





Population

- The entire group you wish to study
- Example: All registered voters in a country

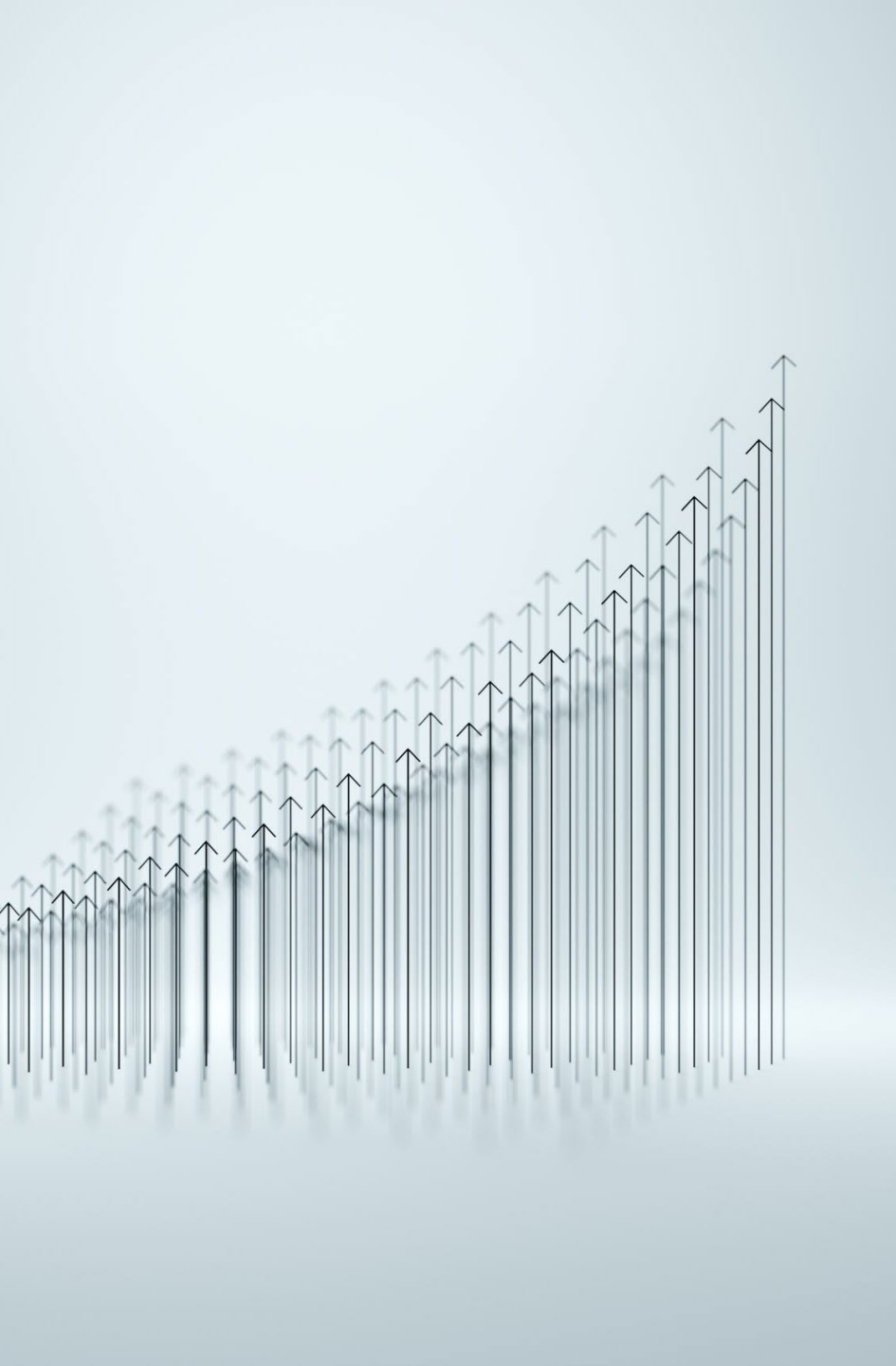




Sample

- A subset of the population is chosen to represent it
- Example: Surveying 1,000 voters





Population Parameter

- Numerical values like mean or standard deviation that summarize the entire population



Sample Statistics

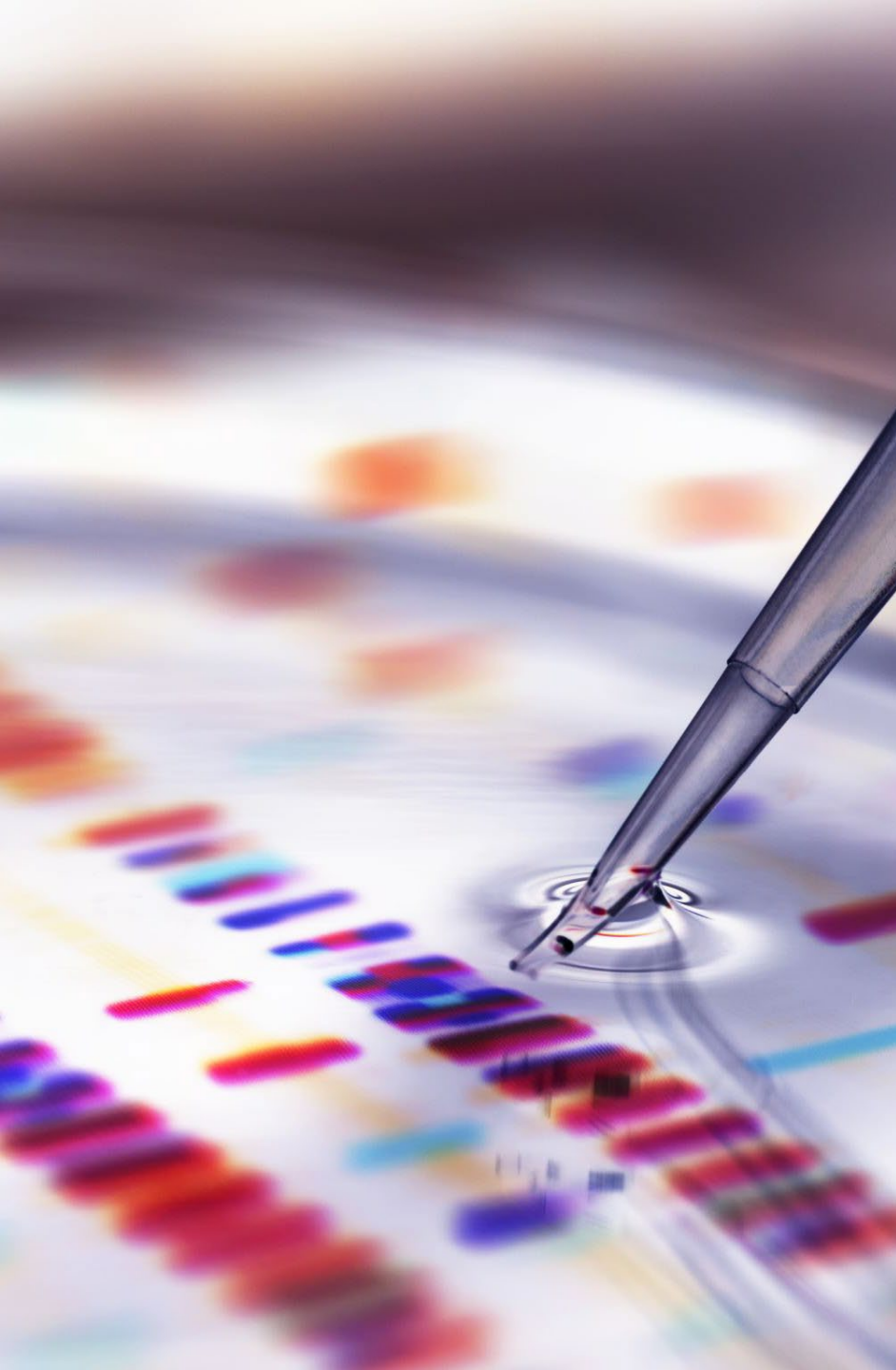
Numerical values that summarize the sample and serve as estimates for population parameters





Dual Meanings of "Statistics"



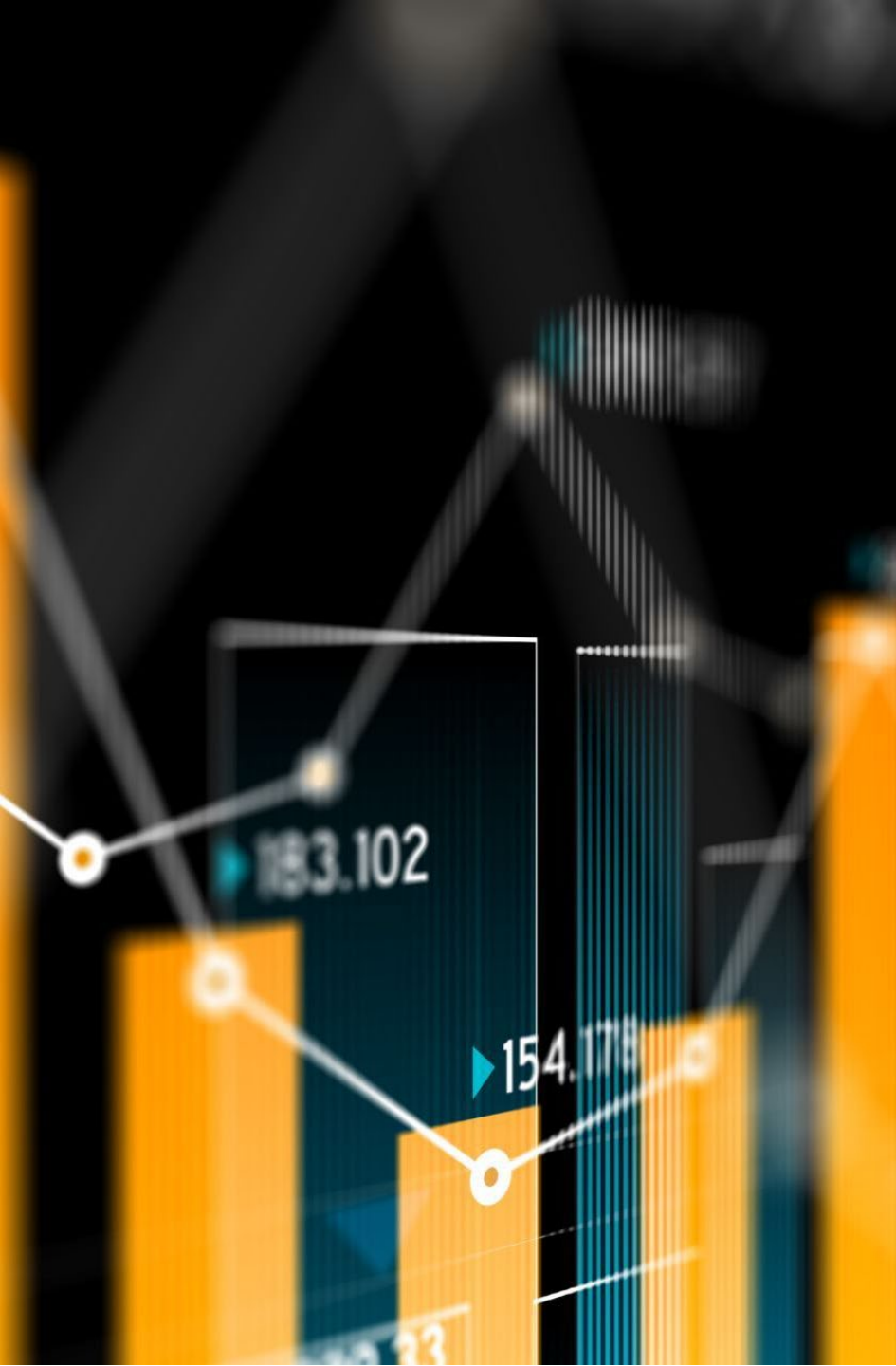


Statistics as a Discipline

The science of data collection, analysis, and interpretation







Statistics as Numerical Facts

Specific numbers
derived from data,
such as a city's median
income





One Notes Sheet for Test

Show 3 people what you got so far.

Simple Random Sampling

Definition: In simple random sampling, each individual in the population has an equal chance of being included in the sample.

Example: If you have a list of 1000 employees in a company, you could use a random number generator to pick 100 employees for a job satisfaction survey. 

Stratified Sampling



Definition: Stratified sampling involves dividing the population into distinct subgroups (or "strata") based on a specific characteristic, and then drawing samples from each subgroup.



Example: For a national political poll, you could divide the population into states and then randomly select 100 registered voters from each state to participate in the survey.



Cluster Sampling



Definition: In cluster sampling, the population is divided into clusters, often based on geographical or organizational similarities. A random selection of clusters is then made, and all individuals in those clusters are surveyed.



Example: A health organization wishes to survey teachers about mental health resources. It randomly selects 10 schools in a district and surveys all teachers in those schools.



Convenience Sampling



Definition: Convenience sampling involves selecting individuals who are easiest to access or collect data from, rather than selecting from the population at large.



Example: A researcher standing at a bus stop might survey the people closest to them about public transportation usage.



Systematic Sampling



Definition: Systematic sampling involves selecting individuals at regular intervals from a sorted list of the population. The starting point is generally random.



Example: Researchers want to survey shoppers about a new product. They survey every 10th shopper entering a supermarket on a given Saturday.





Understanding Bias



Unit 5A

Fundamentals of Statistics

Example: Population and Sample (1 of 2)

Describe the population, sample, population parameters, and sample statistics.

Agricultural inspectors for Jefferson County measure the levels of residue from three common pesticides on 25 ears of corn from each of the 104 corn-producing farms in the county.

Solution

The inspectors seek to learn about the **population** of all ears of corn grown in the county.

Example: Population and Sample (2 of 2)

Agricultural inspectors for Jefferson County measure the levels of residue from three common pesticides on 25 ears of corn from each of the 104 corn-producing farms in the county.

They do this by studying a **sample** that consists of 25 ears from each farm.

The **population parameters** are the average levels of residue from the three pesticides on all corn grown in the county.

The **sample statistics** describe the average levels of residue that are actually measured on the corn in the sample.

Basic Steps in a Statistical Study

1. State the goal of your study.
2. Choose a representative sample from the population.
3. Collect raw data from the sample and summarize these data by finding sample statistics of interest.
4. Use the sample statistics to infer the population parameters.
5. Draw conclusions.



Definition Representative Sample

- A **representative sample** is a sample in which the relevant characteristics of the sample members are generally the same as those of the population.

Example: Sampling Methods (1 of 5)

Identify the type of sampling used in each of the following cases and comment on whether the sample is likely to be representative of the population.

a. You are conducting a survey of students in a dormitory. You choose your sample by knocking on the door of every 10th room.

Choosing every 10th room makes this a systematic sample. The sample may be representative, as long as students were randomly assigned to rooms.

Example: Sampling Methods (2 of 5)

b. To survey opinions on a possible property tax increase, a research firm randomly draws the addresses of 150 homeowners from a public list of all homeowners.

The records presumably list all homeowners, so drawing randomly from this list produces a simple random sample. It has a good chance of being representative of the population.

Example: Sampling Methods (3 of 5)

c. Agricultural inspectors for Jefferson County check the levels of residue from three common pesticides on 25 ears of corn from each of the 104 corn-producing farms in the county.

Each farm may have different pesticide use, so the inspectors consider corn from each farm as a subgroup (stratum) of the full population. By checking 25 ears of corn from each of the 104 farms, the inspectors are using stratified sampling. If the ears are collected randomly on each farm, each set of 25 is likely to be representative of its farm.

Example: Sampling Methods (4 of 5)

d. To see how people like its new product, a small beverage company conducts a taste test, offering the taste test to customers at a local grocery store.

A sample that consists of customers at a local grocery store is a convenience sample, chosen because it is easy to do so. However, this sample will be representative of the larger population of consumers only if those who shop at the grocery store and take the taste test are a representative group. This may or may not be the case. For example, if the grocery store is in a neighborhood with a large population from a single ethnic group, then the customer taste preferences may not be representative of those from all ethnic groups.

Example: Sampling Methods (5 of 5)

e. Anthropologists determine the average brain size of early Neanderthals in Europe by studying skulls found at three sites in southern Europe.

By studying skulls found at selected sites, the anthropologists are using a convenience sample. They have little choice, because only a few skulls remain from the many Neanderthals who once lived in Europe. However, it seems reasonable to assume that these skulls are representative of the larger population.

Definition: Bias

- A statistical study suffers from **bias** if its design or conduct tends to favor certain results.

Types of Statistical Study

- In an **observational study**, researchers observe or measure characteristics of the sample members but do not attempt to influence or modify these characteristics.
- In an **experiment**, researchers apply a treatment to some or all of the sample members and then observe the effects of the treatment.

Treatment and Control Groups

- The **treatment group** in an experiment is the group of sample members who receive the treatment being tested.
- The **control group** in an experiment is the group of sample members who do *not* receive the treatment being tested.

It is important for the treatment and control groups to be selected randomly and to be alike in all respects except for the treatment.

Placebos and the Placebo Effect

- A **placebo** lacks the active ingredients of the treatment being tested in a study, but looks or feels enough like the treatment so that participants cannot distinguish whether they are receiving the placebo or the real treatment.
- The **placebo effect** refers to the situation in which patients improve simply because they believe they are receiving a useful treatment.

Anonymizing

In statistical terminology, the practice of keeping people in the dark about who is in the treatment group and who is in the control group is called **anonymizing**.

Anonymizing in Experiments

- An experiment is **single-anonymous** if the participants do not know whether they are members of the treatment group or members of the control group, but the experimenters do know.
- An experiment is **double-anonymous** if neither the participants nor the experimenters (people administering the treatment) know who belongs to the treatment group and who belongs to the control group.

Example: What's Wrong with This Experiment? (1 of 4)

For each of the experiments described, identify any problems and explain how the problems could have been avoided.

- a. A chiropractor performs adjustments on 25 patients with back pain. Afterward, 18 of the patients say they feel better. He concludes that the adjustments are an effective treatment.

Example: What's Wrong with This Experiment? (2 of 4)

Solution

The 25 patients who receive adjustments represent a treatment group, but this study lacks a control group. The patients may be feeling better because of a placebo effect rather than any real effect of the adjustments. The chiropractor might have improved his study by hiring an actor to do a fake adjustment (one that feels like a real manipulation, but doesn't actually conform to chiropractic guidelines) on a control group. Then he could have compared the results in the two groups to see whether a placebo effect was involved.

Example: What's Wrong with This Experiment? (3 of 4)

b. A new drug for a type of attention deficit disorder is supposed to make the affected children less disruptive. Randomly selected children suffering from the disorder are divided into treatment and control groups. Those in the control group receive a placebo that looks just like the real drug. The experiment is single-anonymous. Experimenters interview the children one on one to decide whether they became more polite.

Example: What's Wrong with This Experiment? (4 of 4)

Solution

Because the experimenters know which children received the real drug, during the interviews they may inadvertently speak differently or interpret behavior differently with these children. The experiment should have been double-anonymous, so that the experimenters conducting the interviews would not have known which children received the real drug and which children received the placebo.

Definition of Retrospective Study

- A **retrospective study** (or *case-control study*) is an observational study that uses data from the past, such as official records or past interviews, and in which the sample naturally divides into a group of **cases** who engaged in the behavior under study and a group of **controls** who did not.

Example: Which Type of Study? (1 of 4)

For each of the following questions, what type of statistical study is most likely to lead to an answer? Why?

a. What is the average income of stock brokers?

An observational study can tell us the average income of stock brokers. We need only survey (observe) the brokers.

Example: Which Type of Study? (2 of 4)

b. Do seat belts save lives?

It would be unethical to do an experiment in which some people were told to wear seat belts and others were told *not* to wear them. Instead, we can conduct a *retrospective study*. People who wore seat belts in crashes represent the cases and people who did not wear them are the controls. By comparing the death rates in accidents between cases and controls, we can learn whether seat belts save lives. (They do.)

Example: Which Type of Study? (3 of 4)

c. Can lifting weights improve runners' times in a 10-kilometer race?

We need an *experiment* to determine whether lifting weights can improve runners' 10K times. One group of runners will be put on a weight-lifting program, and a control group will be asked to stay away from weights. We must try to ensure that all other aspects of their training are similar. Then we can see whether the runners in the lifting group improve their times more than those in the control group. Note that we cannot use anonymity in this experiment because there is no way to prevent participants from knowing whether they are lifting weights.

Example: Which Type of Study? (4 of 4)

d. Can a new herbal remedy reduce the severity of colds?

We should use a *double-anonymous experiment*, in which some participants get the actual remedy while others get a placebo. We need *double-anonymous* conditions because the severity of a cold may be affected by mood or other factors that experimenters might inadvertently influence.

Frequency Tables

A basic **frequency table** has two columns:

- The first column lists all the **categories** of data.
- The second column lists the **frequency** of each category, which is the number of data values in the category.

Relative Frequency

The **relative frequency** of any category is the fraction (or percentage) of the data values that fall in that category:

- $$\text{relative frequency} = \frac{\text{frequency in category}}{\text{total frequency}}$$

The **cumulative frequency** of any category is the number of data values in that category and all preceding categories.

Data Types and Binning

Qualitative data consists of values that can be placed into nonnumerical categories.

Quantitative data represent counts or measurements.

When dealing with quantitative data categories, it is often useful to group, or **bin**, the data into categories that cover a range of possible values.