MIND MAPPING FORMULAS FOR QUANTITATIVE METHODS

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MIND MAPPING FORMULAS FOR QUANTITATIVE METHODS
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Mind Mapping Formulas For Quantitative Methods/ Nor Helme Bin Padeli & Musalifah Binti Mustafa

Preface

Empowering learning methods is no longer optional. It is a necessity, reflecting a deep commitment to innovation in teaching and learning. This book introduces a mind mapping approach to visually and efficiently understanding formulas in quantitative methods. Designed to help students grasp essential concepts more easily, it uses user-friendly illustrations to support memory and comprehension.

By incorporating structured mind maps and simplified visual formulas through the EduVision approach, understanding becomes clearer and retention faster. This method meets the needs of today's learners, who are constantly exposed to complex information and require engaging, interactive, and widely accepted learning tools.

This innovation is hoped to serve as a catalyst for transforming quantitative education, boosting academic achievement and encouraging active student participation. May it become a valuable companion for educators. A small step with the potential for a profound impact.

Clarity unlocks confidence. When knowledge is visual, understanding becomes powerful.

CONTENTS

ELEMENTS OF
DISTRIBUTI

Element 1 : Number of Classes (k)

Formula :

$k = 1 + 3.3 \log_{10} n$

k = estimated number of classes

n = number of data points.

Element 2 : Range

Formula :

Range = Highest data - Lowest data

Used to determine the spread of the distribution.

Element 3 : Class Width

Formula :

Class Width = Range ÷ k

Rounded to a convenient value (typically an integer).

https://padlet.com/musalifah/my_elements_table

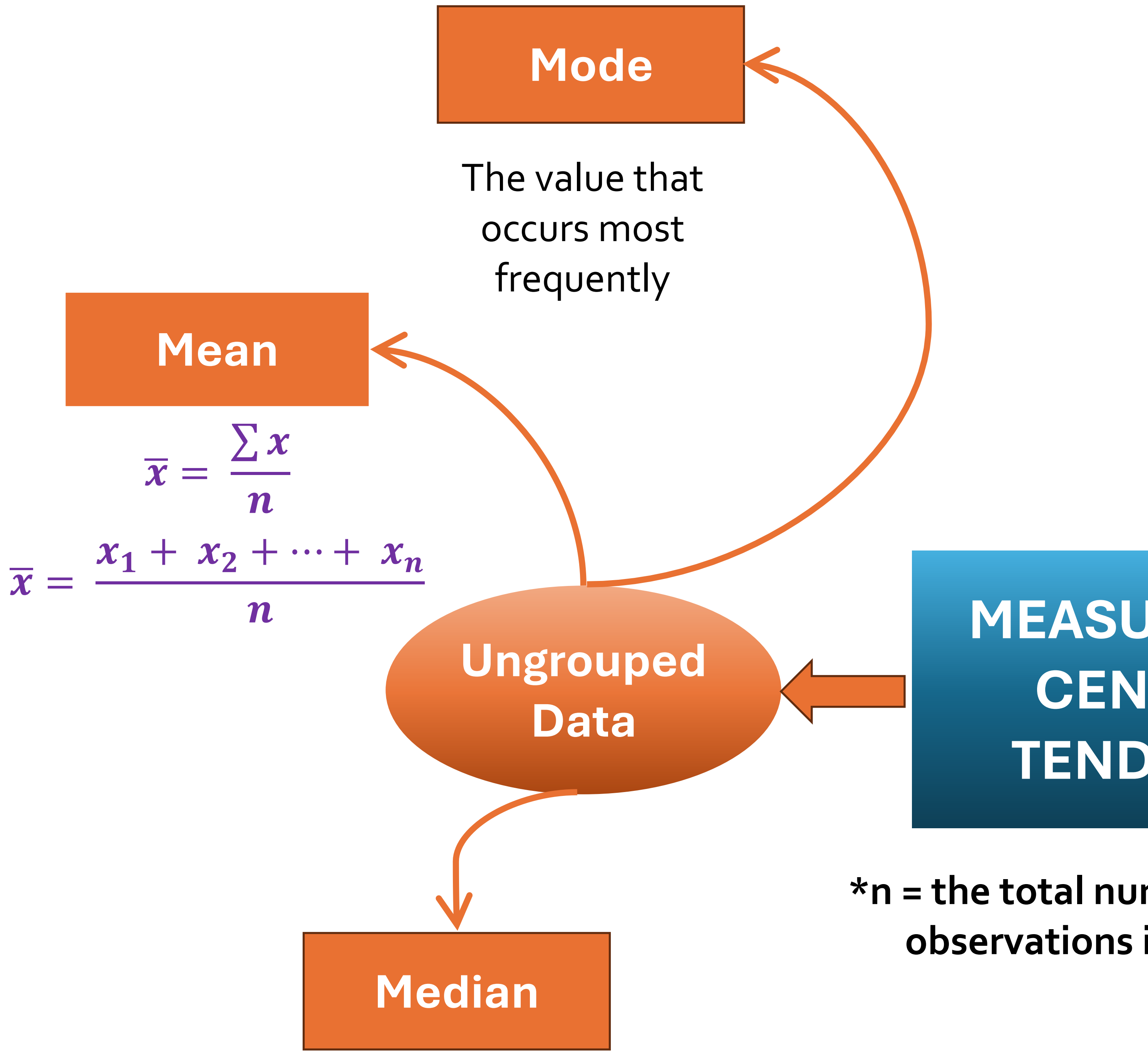
FREQUENCY
ON TABLE

Example

Number of Classes = 7

Class Interval	Tally	Frequency (f)	Cumulative Frequency	Relative Frequency
146 – 151	////	4	4	0.08
152 – 157	~~////~~ //	7	11	0.14
158 – 163	~~////~~ ~~////~~	10	21	0.20
164 – 169	~~////~~ ////	9	30	0.18
170 – 175	~~////~~ ~~////~~ ~~////~~	15	45	0.30
176 – 181	//	2	47	0.04
182 - 187	///	3	50	0.06
		50		1

Class Width = 6



The middle value when the data is sorted in order :
If n is an odd number, take the middle value in the sequence. If n is an even number, take the average of the two (2) middle values.

Positioning Point $= \frac{n+1}{2}$

https://vrcacademy.com/tutorials/mean-median-mode-ungrouped-data/

Mode

$$\hat{x} = L_b + \left[\frac{f_0 - f_1}{(f_0 - f_1) + (f_0 - f_2)}\right] \times C$$

L_b = lower boundaries of the class mode
C = class width of the class mode
f_o = frequency of the class mode
f_1 = frequency of the class before the class mode
f_2 = frequency of the class after the class mod

URES OF TRAL ENCY

Grouped Data

Mean

$$\bar{x} = \frac{\sum f_x}{\sum f}$$

mber of values or n the dataset

Median

$$\tilde{x} = L_m + \left[\frac{\frac{\sum f}{2} - \sum f_{m-1}}{f_m}\right] \times C$$

$\sum f$ = sum of frequencies
L_m = lower class boundary for median class
$\sum f_{m-1}$ = cumulative frequency before the median class
f_m = frequency of the median class
C = median class size/ class width

https://padlet.com/musalifah/my_tendency_groupeddata/

MEASURES OF

Ungrouped Data

Standard D

Population Variance :

$$\sigma^2 = \frac{\sum(x_i - \mu)^2}{N}$$

* μ = the population mean (average)

$$\sigma = \sqrt{}$$

Sample Variance :

$$s^2 = \frac{\sum(x_i - \overline{x})^2}{n-1}$$

@

$$s^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}$$

$$s = \sqrt{}$$

https://www.youtube.com/watch?v=neX8fsHgqyc

DISPERSION

Grouped Data

eviation

$$\sqrt{\sigma^2}$$

$$\sqrt{s^2}$$

Population Variance :

$$\sigma^2 = \frac{1}{N}\sum f(x - \mu)^2$$

Sample Variance :

$$s^2 = \frac{1}{\sum f - 1}\left[\sum fx^2 - \frac{(\sum fx)^2}{\sum f}\right]$$

@

$$s^2 = \frac{1}{\sum f - 1}\sum f(x - \overline{x})^2$$

https://padlet.com/musalifahefolio1/my_dispersion_groupeddata

PCS 1

Pearson's Coefficient Of Skewness 1 (PCS 1)

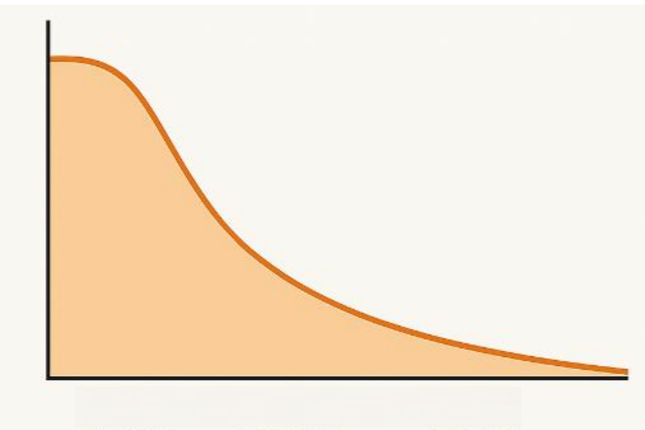
$$\frac{mean - mode}{standard\ deviation} = \frac{\bar{x} - \hat{x}}{s}$$

SKEWN

Interpre

POSITIVE SKEW
(Right-Skewed)

- Tail Direction : Long tail on the right
- Mean > Median > Mode
- Shape : Peak appears on the left.



SYMMETRIC
(Zero Skewness)

- Tail Direction : Tails are balanced
- Mean = Median = Mode
- Shape : Bell-shaped (e.g. normal distribution)

PCS 2

Pearson's Coefficient Of Skewness 2 (PCS 2)

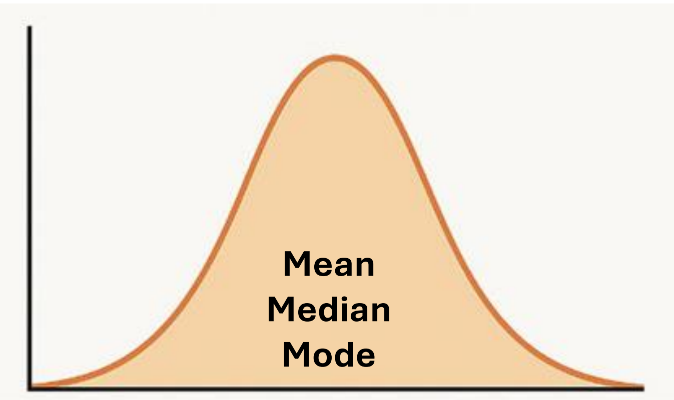
$$\frac{3\ (mean - median)}{standard\ deviation} = \frac{3\ (\bar{x} - \tilde{x})}{s}$$

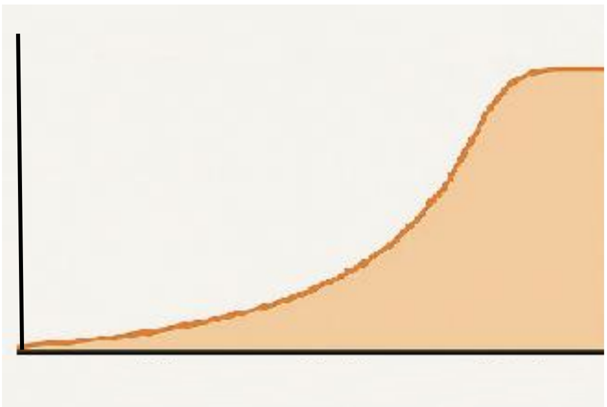
NESS

tation

NEGATIVE SKEW (Left-Skewed)

- Tail Direction : Long tail on the left
- Mean < Median < Mode
- Shape : Peak appears on the right.





https://padlet.com/musalifahefolio1/my_skewness/

VENN DIAGRAMS IN PROBABILITY

1. P(A) is the probability of event A.
2. P(A and B) represents the probability of both A and B happening.
3. P(A∩B) uses set notation, where ∩ represents the intersection (i.e., both A and B occurring).
4. P(B|A) is the probability of event B happening given that A' already happened.
5. "and" = "intersection" = ∩

Structure :

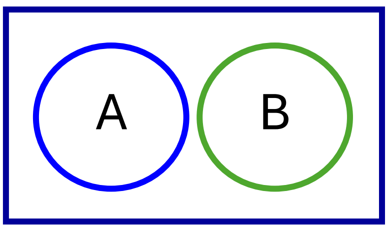
- Circles represent sets (A, B)
- Overlap = A ∩ B (intersection)
- Entire Area = A U B (union)
- Outside Circles = Complement (A', B')

Case 1 : When two (2) events cannot occur at the same

Example : In a single roll of a dice, getting an odd number and an even number simultaneously is impossible.

P(AUB) = P(A) + P(B)

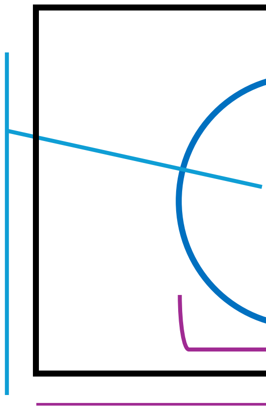
P(A∩B) = 0



Case

Exampl
getting
number
same d
P(AUB)

Represents



Represents
in the u

Case 3 : Represent

Set A = {1, 3, 8, 10}

Set B = {1, 3, 7, 9}

Answer :

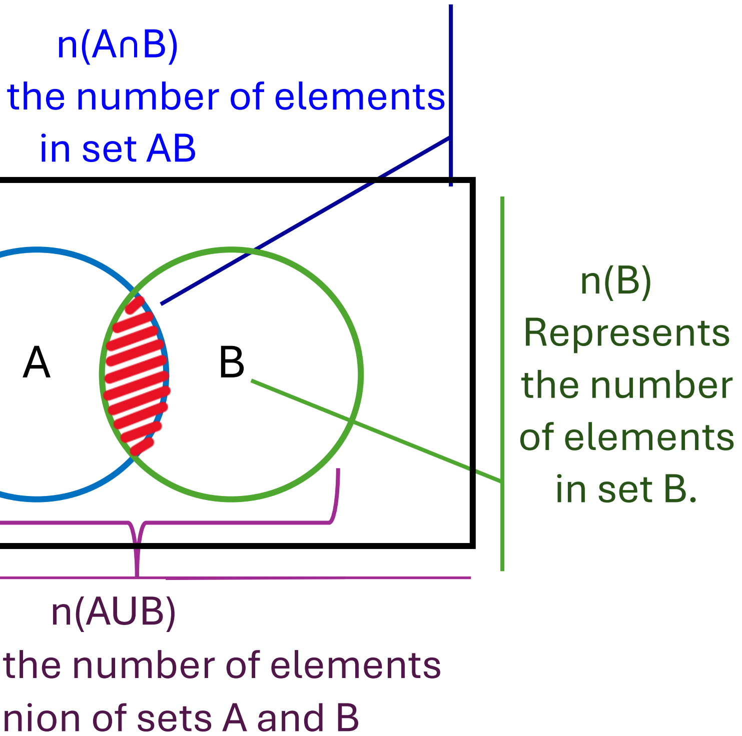
Intersection (A ∩ B) = {1

https://stats.libretexts.org/Bookshelves/Introductor
penStax%29/03%3A_Probability_Topics/3.06%3A_Ve

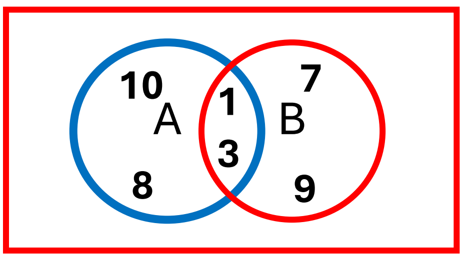
2 : Events can happen at the same time.

e: When selecting a card, a red card and an even-red card can both occur in the raw.

= P(A) + P(B) - P(A∩B)



ation of Sets A and B.

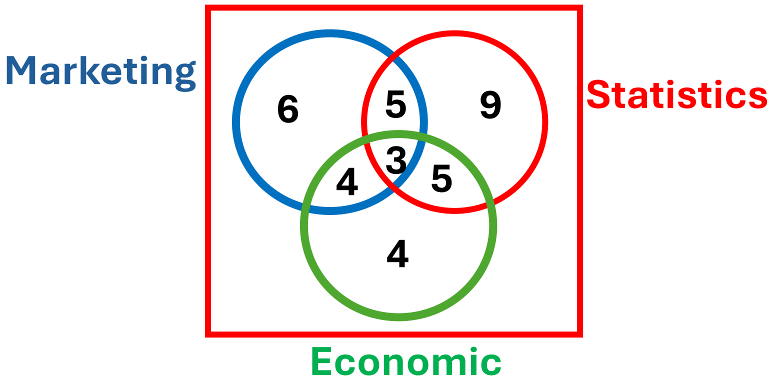


, 3}

y_Statistics/Introductory_Statistics_2e_%28O
nn_Diagrams

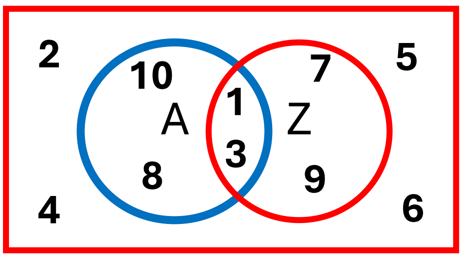
Case 4 : Exploring Overlapping Sets.

In a group of students :
18 read Marketing, 22 read Statistics, 16 read Economics, 6 read Marketing only, 9 read Statistics only, 5 read Marketing and Statistics only, 5 read Statistics and Economics only.
How many read all the subjects?



Answer : **3**

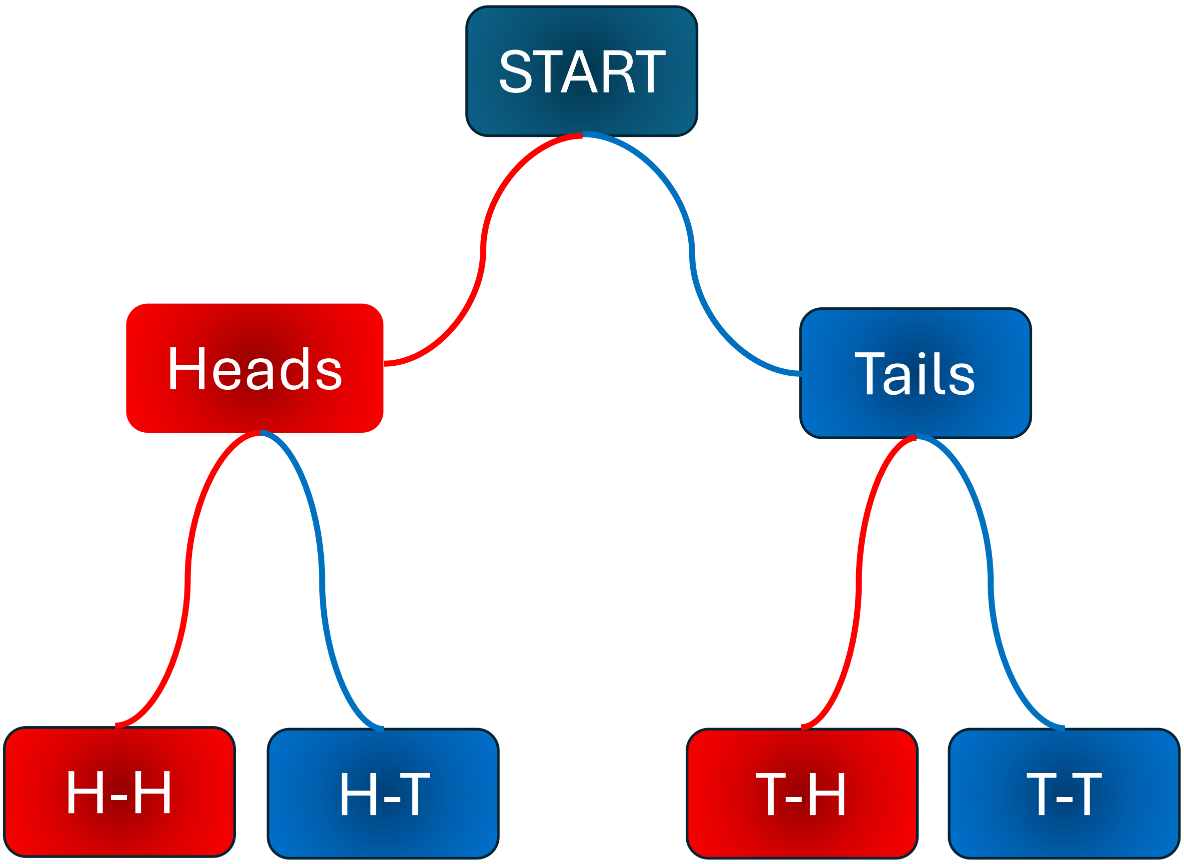
Case 5 : Complement of a Set Z.



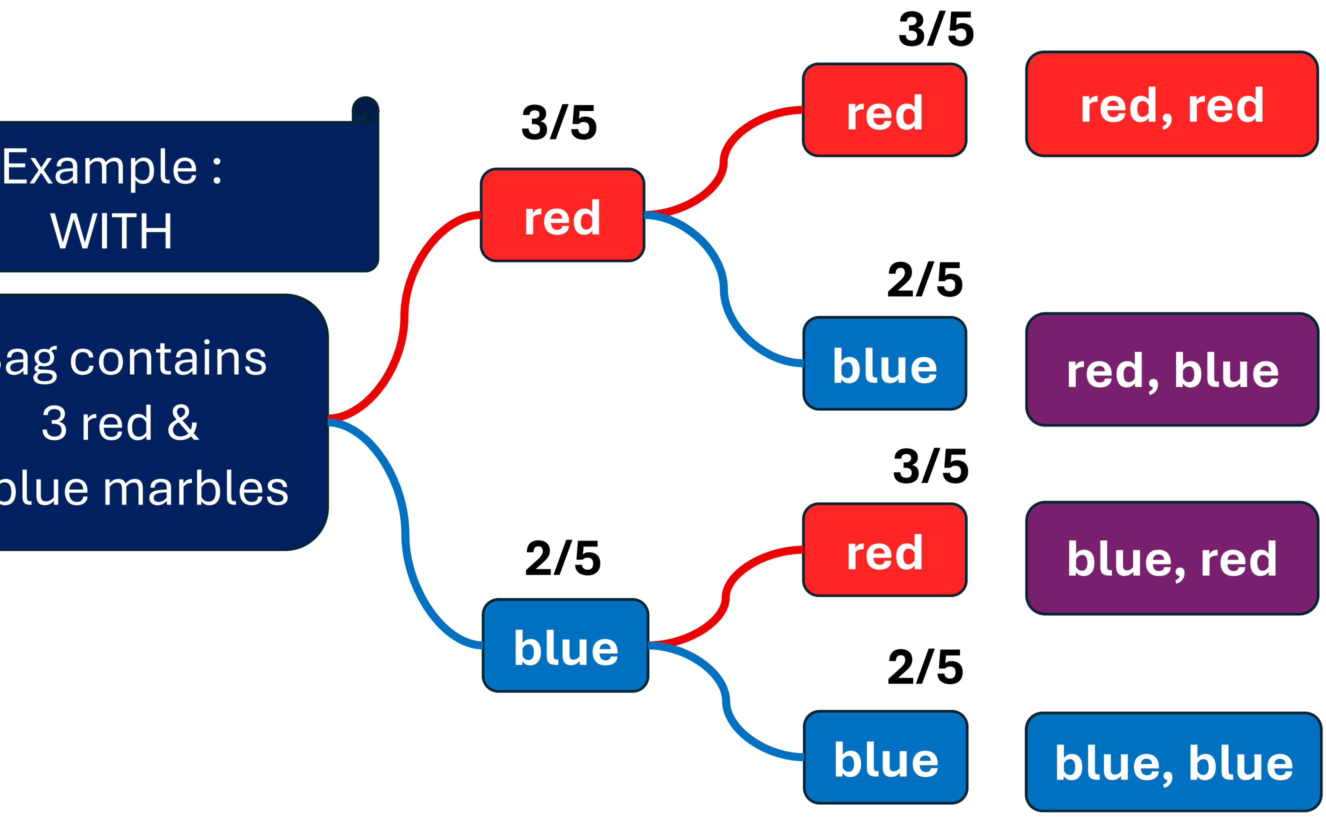
Answer :
Set Z' (elements not in Z but still within the universal) :
{2, 4, 5, 6, 8, 10}

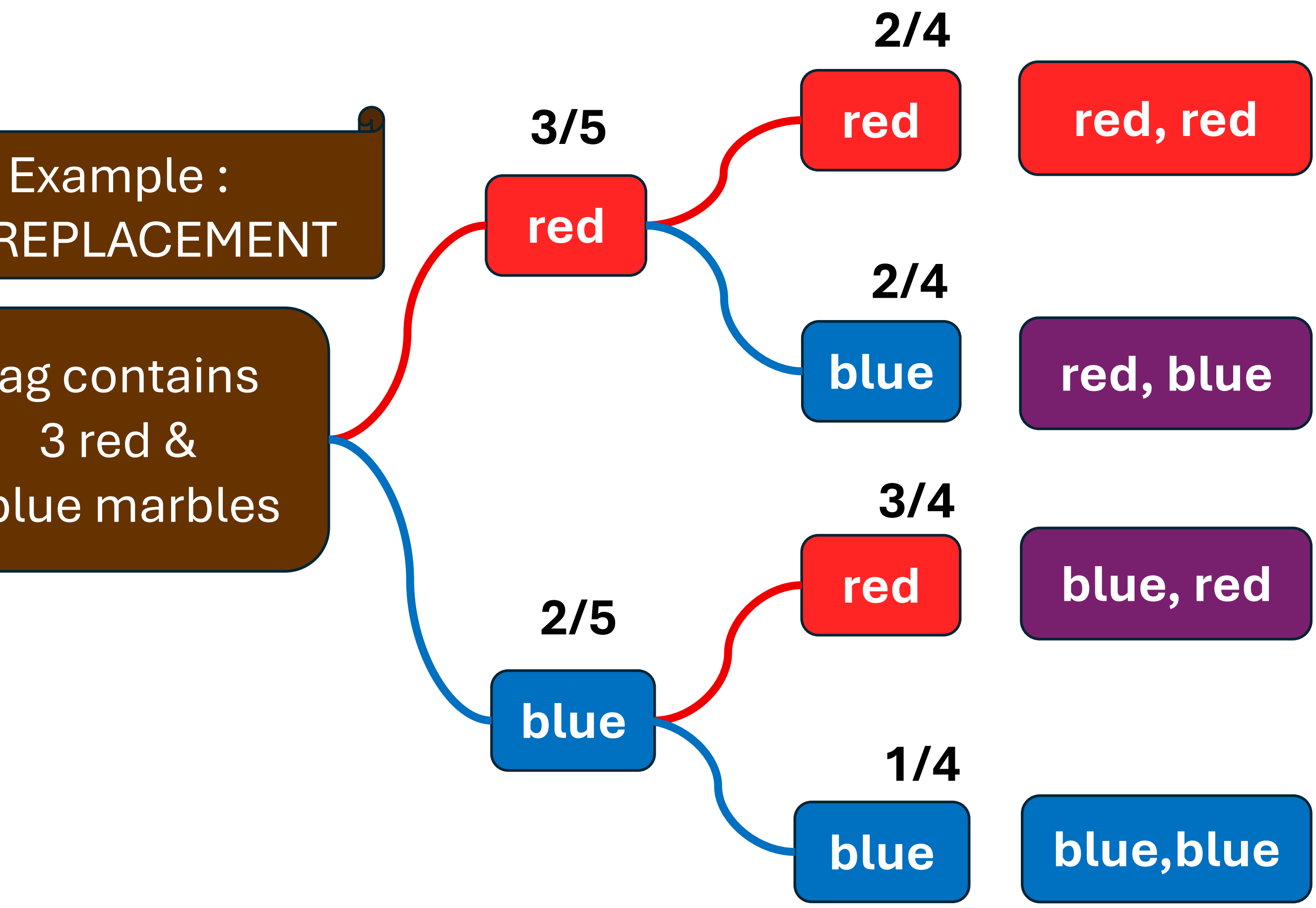
PROBABILITY WITH TREE DIAGRAM

Nodes
Represent events or choices
Branches
Show possible outcomes
Probabilities
Each branch is labelled with



https://www.youtube.com/watch?v=w4wKXVwtGac


Example :
WITH
ag contains
3 red &
lue marbles
3/5
red
2/5
blue
3/5
red
red, red
2/5
blue
red, blue
3/5
red
blue, red
2/5
blue
blue, blue


Example :
REPLACEMENT
ag contains
3 red &
lue marbles
3/5
red
2/5
blue
2/4
red
red, red
2/4
blue
red, blue
3/4
red
blue, red
1/4
blue
blue,blue

ORGANIZIN
WITH TWO-W

How It Works

- Rows represent one variable (e.g. Gender.)
- Columns represent another variable (e.g. Sports Participation.)
- Cells show how many individuals fall into each combination (e.g. Female who plays sports)
- Grand total : Overall total of all entries

Columns → Sports Participation status. Yes or No

Marginal Totals sho
row/ column sums

https://www.youtube.com/watch?v=clrff5Lg2SU

IG DATA
AY TABLES

Example

Rows → Gender categories : Male or Female

	Plays Sports	Does Not Play Sports
Male	18	7
Female	12	13
Column Total	30	20

Grand Total → Total number of participants

Cells → Frequency of combined outcomes

Two-way tables help us analyse how two (2) variables interact :

P (Male Plays Sports) = 18/50 = 0.36

P (Female) = 25/50 = 0.5

P (Plays Sports | Female) = 12/25 = 0.48

CORRE

PEARSON'S (*r*)

Range : -1.0 ≤ *r* ≤ +1.0

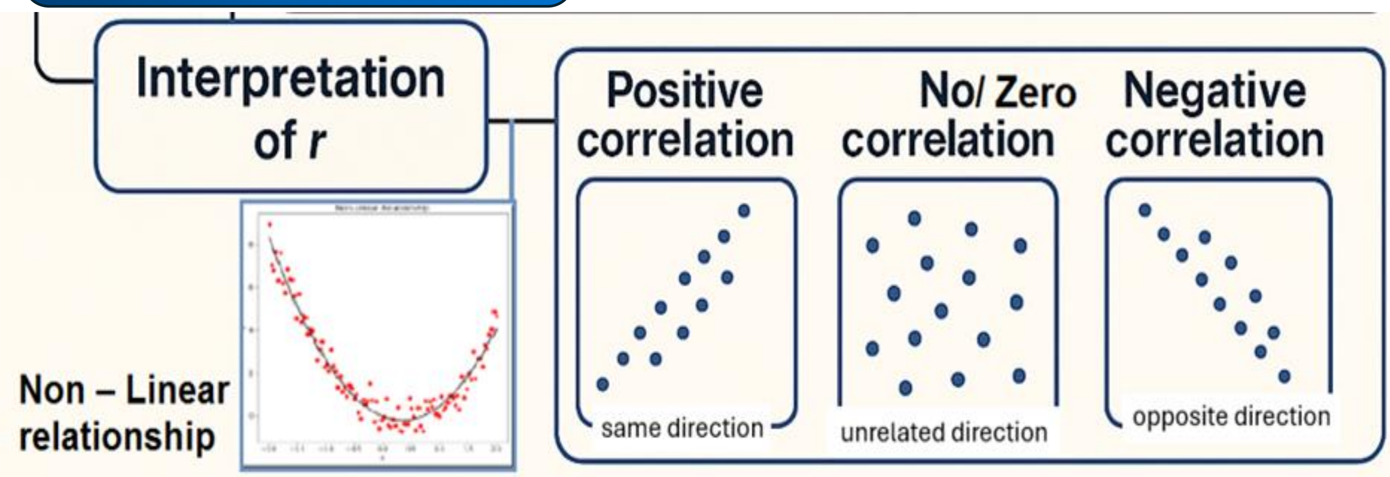
Writing comments, for example :
The correlation coefficient is *r* = - 0.72, which falls in the range of strong negative correlation according to the **book's scale**.
This suggests that as Variable A increases, Variable B tends to decrease.

Formula

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Interpretation

Strength of correl
Very strong positive co
Strong positive correla
Moderate positive corr
Weak positive correlat
Zero correlation
Weak negative correla
Moderate negative cor
Strong negative correl
Very strong negative c



https://www.questionpro.com/blog/pearson-correlation-coefficient/

ELATION

SPEARMAN'S (p)

ation	Value of correlation
orrelation	0.8 to 1.0
ation	0.6 to 0.79
relation	0.4 to 0.59
tion	0.1 to 0.39
	0
tion	-0.1 to-0.39
relation	-0.4 to -0.59
ation	-0.6 to-0.79
orrelation	-0.8 to-1.0

Range : - 1.0 < = p < = 1.0

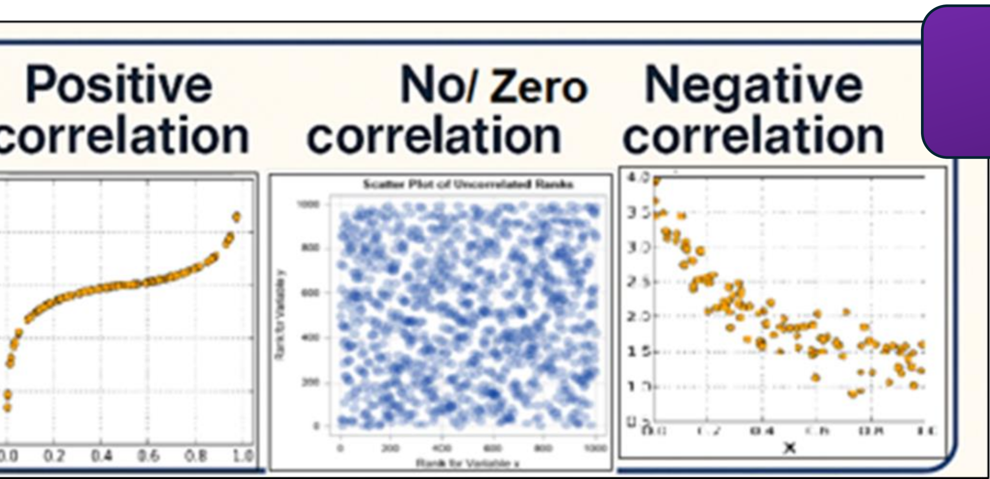
Writing comment, for example :
Coefficient between students' motivation scores and their class rankings was p = - 0.58 indicating a moderate negative monotonic relationship.
This suggests that students with higher motivation tends to have better (lower) class rankings.
The result was statistically significant at $p < 0.01$

Formula

$$p = 1 - \frac{(6\sum d^2)}{n(n^2 - 1)}$$

*d = rank variable 1 - rank variable 2

Interpretation



https://www.youtube.com/watch?v=DE58QuNKA-c

$$b = \frac{n\left(\sum xy\right) - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)^2}$$

LE

R

$$a = \frac{\sum y}{n} - b\frac{\left(\sum x\right)}{n}$$

@

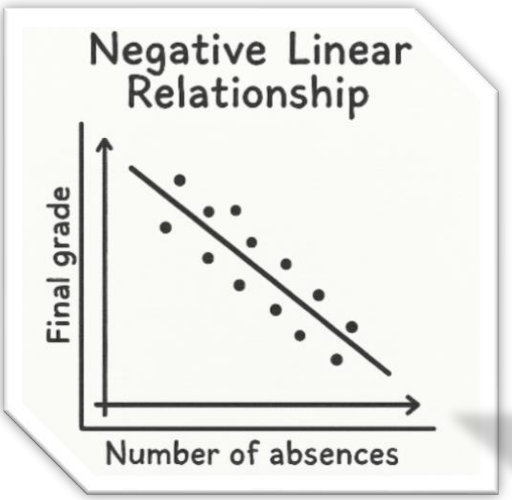
$$a = \bar{y} - b\bar{x}$$

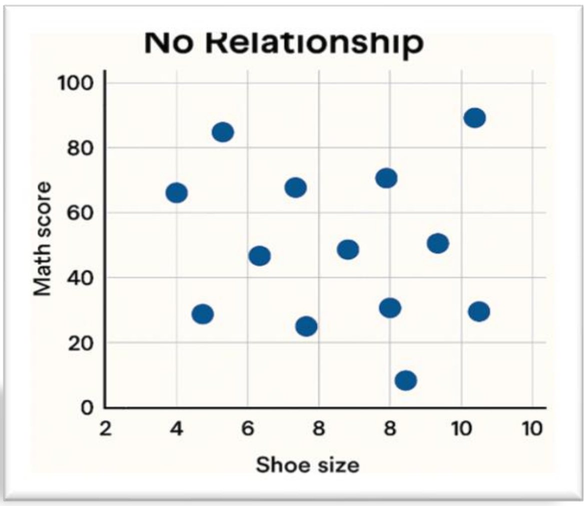
Regre

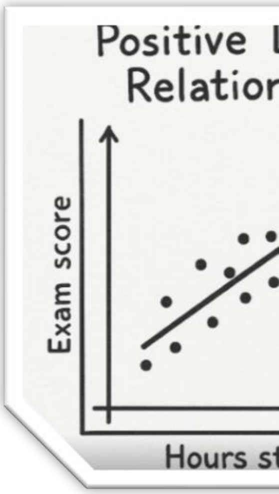
y =

b = t

a = the







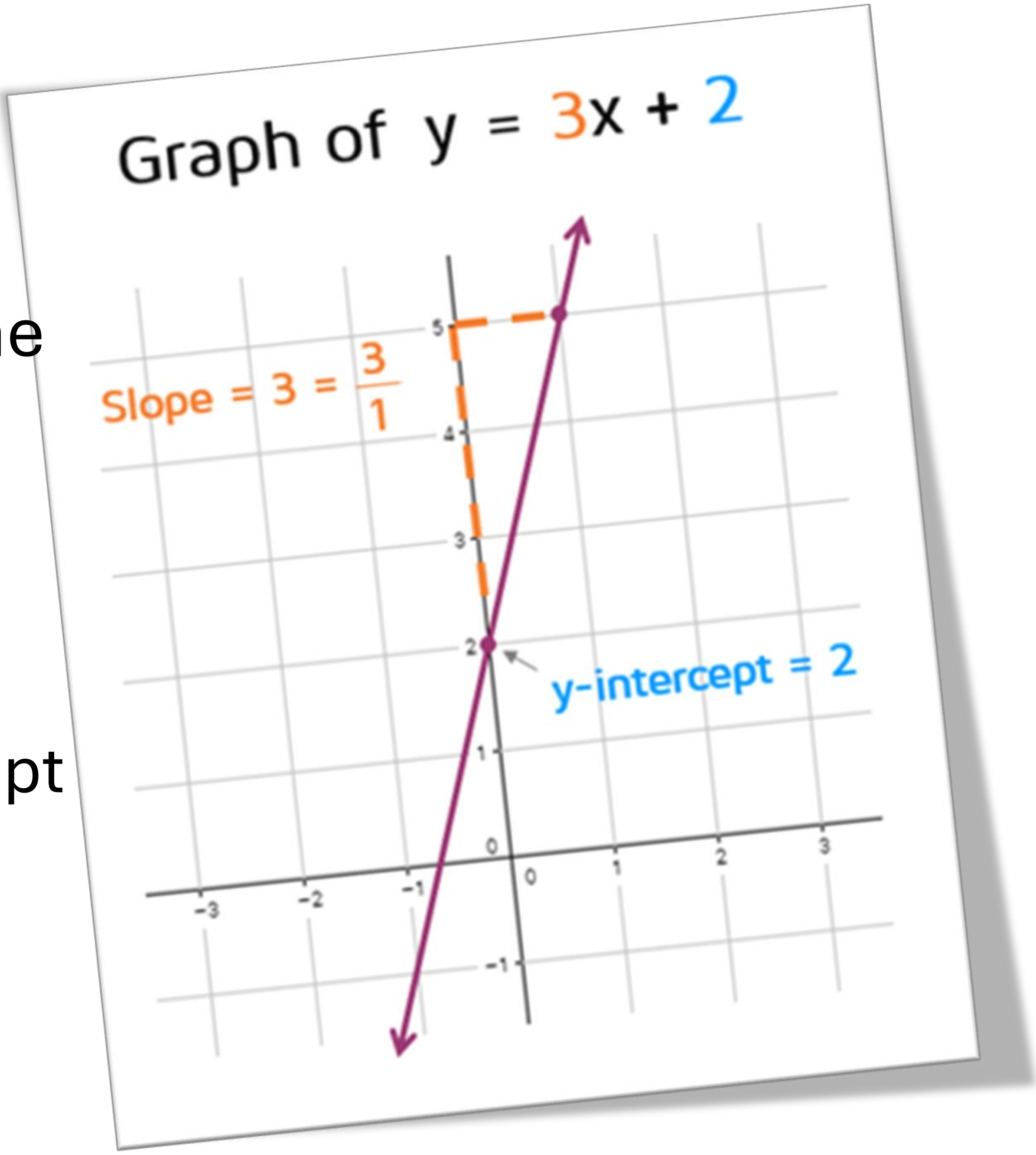
AST SQUARES REGRESSION

ession Line

$b\,x + a$

the slope

e y-intercept



https://wakelet.com/wake/YzXdaTIr61N3epaTzsa7Z t -

$t =$

Types of Tests

Test Type	Symbol in H_1	When to Use
Two-tailed	$\mu \neq H_0$	Testing for any difference
Left-tailed	$\mu < H_0$	Testing if mean is less than H_0
Right-tailed	$\mu > H_0$	Testing if mean is greater than H_0

3

T

Null Hypothesis (H_0)

- No effect or no change
- Default assumption
- Symbols: =, ≤, ≥

Examples :
- $H_0 : \mu = 50$
- $H_0 : \mu \geq 50$
- $H_0 : \mu \leq 50$

1

H_0 vs H_1

Alternative Hypothesis (H_1)

- There is an effect or change
- Statement we try to prove
- Symbols : ≠, >, <

Examples :
- $H_1 : \mu \neq 50$ Two-tailed test
- $H_1 : \mu < 50$ Left-tailed test
- $H_1 : \mu > 50$ Right-tailed

HYPOTHESIS TES

https://wakelet.com/wake/tjEttL_aje

https://wakelet.com/wake/YzXdaTIr6

2

SIGNIFICANCE LEVEL

Common choices :
0.05, 0.01 or 0.10
Defines rejection region

- α → one-tailed (or one-sided) test
- $\alpha/2$ → two-tailed test

- test

$$\frac{\overline{x} - \mu}{s/\sqrt{n}}$$

z – test

$$z = \frac{\overline{x} - \mu}{\sigma/\sqrt{n}}$$

TEST STATISTIC

STING

CGvBWW2PZN3

61N3epaTzsa7Z

4 CRITICAL VALUE

1. Choose The Right Table

Population σ known & n ≥ 30 : z - table
Population σ unknown or n < 30 : t – table

2. Refer α

Two tailed	Use α/2
Left tailed	Use α
Right tailed	Use α

3. Find The Critical Value From The Table

From z - table :
Look for the z-score corresponding to your tail area.

From t – table :
1. Degrees of freedom (df = n - 1)
2. Match df and the **α** or **α/2**

5 COMPARE & DECIDE

Reject H_o

Test statistic falls in rejection region.
Test statistic > Critical value

Do not Reject H_o

Test statistic falls within acceptance region.
Test statistic < Critical value

Review Question

The frequency distribution table shows the monthly amount invested by employees in Milo Co. under company's profit-sharing plan. From the table, simplify the answer for :

i. Mean
ii. Mode
iii. Median
iv. Variance
v. Standard deviation
vi. Pearson's Coefficient Of Skewness 1
vii. Pearson's Coefficient Of Skewness 2
viii. Histogram & Frequency Polygon.
ix. Ogive less than
x. Mode using Histogram
xi. Median using more than Ogive

Amount Invested (RM)	Number Of Employees
30 – 34	3
35 – 39	7
40 – 44	11
45 – 49	22
50 – 54	40
55 – 59	24
60 – 64	9
65 – 69	4
Total	**n = 120**

Amount Invested (RM)	Number Of Employees (*f*)
30 – 34	3
35 – 39	7
40 – 44	11
45 – 49	22
50 – 54	40
55 – 59	24
60 – 64	9
65 – 69	4
Total	$\sum f = 120$

5. Divide the total weighted va
frequency :

Mean ($\bar{x}$)

1. **Find the midpoint of each class interval :**
   Midpoint = (Lower limit + Upper limit)/ 2
   Example : For 30–34, midpoint = (30+34)/2 = **32**

2. **Multiply each midpoint by its frequency *(fx)* :**
   This gives the total contribution of each class to the overall sum.
   Example : For 30 – 34, ***fx*** = (3 x 32) = **96**

x	*fx*
32	**96**
37	259
42	462
47	1034
52	2080
57	1368
62	558
67	268
	$\sum fx$ = 6125

3. **Sum all the products of midpoint × frequency :**
   This gives the total weighted value.
   $$\sum f = 6125$$

4. **Sum all the frequencies ($\sum f$) :**
   This gives the total number of employees.
   $$\sum f = 120$$

lue by the total

$$\bar{x} = \frac{\sum f_x}{\sum f}$$

$$\bar{x} = \frac{6125}{120}$$

$$\bar{x} = 51.04$$

Mode ($\hat{x}$)

1. **Build the Class Boundaries column** :
   Lower Class Boundaries = Lower class – 0.5
   Upper Class Boundaries = Upper Class + 0.5
   Example : For 30 – 34
   Lower Class Boundaries =30 – 0.5 = 29.5
   Upper Class Boundaries = 34 + 0.5 = 34.5

Amount Invested (RM)	Numbe Employ (f)
30 – 34	3
35 – 39	7
40 – 44	11
45 – 49	22
50 – 54	40
55 – 59	24
60 – 64	9
65 – 69	4
Total	$\sum f$ = 1

2. **Find the highest frequency :**
   frequency of the class mode (f_0) = 40

6. **Find f_1 and f_2** :
   frequency of the class before the class mode
   (f_1) = 22
   frequency of the class after the class mode
   (f_2) = 24

7. Use the **Mode** Formula :

$$\hat{x} = L_b + \left[\frac{f_0 - f_1}{(f_0 - f_1) + (f_0 - f_2)}\right] \times$$

$$\hat{x} = 49.5 + \left[\frac{40 - 22}{(40 - 22) + (40 - 24)}\right] \times 5$$

$$\hat{x} = 49.5 + \left[\frac{18}{18 + 16}\right] \times 5$$

$$\hat{x} = 52.15$$

3. **Build the Lower Boundaries column :**

Lower class boundaries

Example : For 30 – 34

Lower Boundaries (L_b) = **29.5**

er Of yees	Class Boundaries	Lower Boundaries (L_b)
	29.5 – 34.5	29.5
	34.5 – 39.5	34.5
	39.5 – 44.5	39.5
	44.5 – 49.5	44.5
	49.5 – 54.5	**49.5**
	54.5 – 59.5	54.5
	59.5 – 64.5	59.5
	64.5 – 69.5	64.5
<u>20</u>		

4. **Find the lower boundary of the modal class, refer to the class boundaries of the class with the highest frequency :**

Lower Boundaries (L_b) = 49.5

5. **Find the class width (C) of the class mode :**

class width = Upper class boundaries - Lower class boundaries

Example : For 30 – 34

class width **(C) = 34.5 – 29.5 = 5**

C

Median ($\tilde{x}$)

1. **Build the cumulative frequency column :**
   Example :
   For 30 – 34 : cumulative frequency = **3**
   For 35 – 39 : cumulative frequency = 3 +

Amount Invested (RM)		Number Of Employees *(f)*	Class Boundaries	Cumulative Frequency
30 – 34		3	29.5 – 34.5	**3**
35 – 39		7	34.5 – 39.5	**10**
40 – 44		11	39.5 – 44.5	**21**
45 – 49		22	44.5 – 49.5	**43**
50 – 54	**Median Class**	40	49.5 – 54.5	**83**
55 – 59		24	54.5 – 59.5	**107**
60 – 64		9	59.5 – 64.5	**116**
65 – 69		4	64.5 – 69.5	**120**
Total		$\sum f = 120$		

7 = 10

2. **Decide the class that contain the median :**

   Total frequency $(\sum f) = 120$

   Median position = $\sum f/2 = 120/2 = 60$

   Median class = **50 – 54**

3. **Find the median by using the formula :**

   Lower boundary $(L_m) = 49.5$

   Cumulative frequency before median class $(\sum f_{m-1}) = 43$

   Frequency of median class $(fm) = 40$

   Class width $(C) = 5$

$$\tilde{x} = L_m + \left[\frac{\frac{\sum f}{2} - \sum f_{m-1}}{f_m}\right] \times C$$

$$\tilde{x} = 49.5 + \left[\frac{60 - 43}{40}\right] \times 5$$

$$\tilde{x} = 51.63$$

Variance (s^2)

$$s^2 = \frac{1}{\sum f - 1}\left[\sum f x^2 - \frac{(\sum f x)^2}{\sum f}\right]$$

Amount Invested (RM)	Number Of Employees (f)	x	fx	X^2	fx^2
30 – 34	3	32	96	1024	3072
35 – 39	7	37	259	1369	9583
40 – 44	11	42	462	1764	19404
45 – 49	22	47	1034	2209	48598
50 – 54	40	52	2080	2704	108160
55 – 59	24	57	1368	3249	77976
60 – 64	9	62	558	3844	34596
65 – 69	4	67	268	4489	17956
Total	n = 120		$\sum fx = 6125$		$\sum fx^2 = 319345$

5. Find the variance by using the formula :

$$s^2 = \frac{1}{120 - 1}\left[319345 - \frac{(6125)^2}{120}\right]$$

$$s^2 = \frac{1}{119}\left[319345 - 312630.21\right]$$

$$s^2 = 56.43$$

1. **Build the midpoint (x) column**

   Midpoint = (Lower limit + Upper limit)/ 2

   Example :

   For 30–34, $x = (30+34)/2 = 32$

2. **Build the fx column**

   Multiply each midpoint by its frequency (fx) :

   This gives the total contribution of each class to the overall sum.

   Example :

   For 30 – 34, $fx = (3 \times 32) = 96$

   Then, sum all the fx values across the table = 6125

3. **Build the x^2 column**

   Example :

   For 30 – 34 : $x^2 = (32)^2 = 1024$

   For 35 – 39 : $x^2 = (37)^2 = 1369$

4. **Build the fx^2 column**

   Example :

   For 30 – 34 : $fx^2 = 3 \times 1024 = 3072$

   For 35 – 39 : $fx^2 = 7 \times 1369 = 9583$

   Then, sum all the fx^2 values across the table = 319345

Standard deviation (s)

$$s = \sqrt{s^2}$$

$$s = \sqrt{56.43}$$

$$s = 7.51$$

Pearson's Coefficient Of Skewness 1 (PCS 1)

$$\frac{mean - mode}{standard\ deviation} = \frac{\bar{x} - \hat{x}}{s}$$

Mean ($\bar{x}$)

Median ($\tilde{x}$)

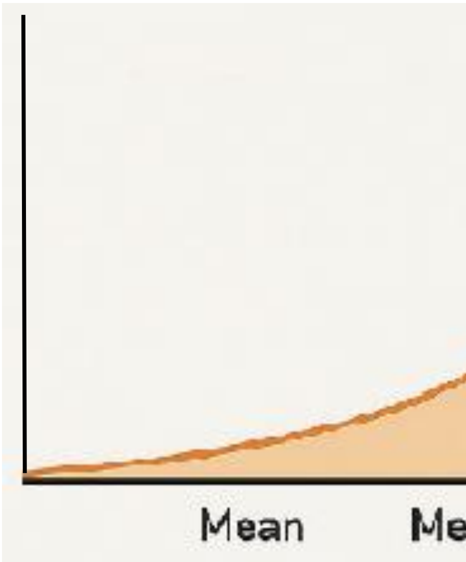
Mode ($\hat{x}$)

Standard Devi

PCS 1 = $\frac{51.04 - 52.15}{7.51}$

PCS 1 = $\frac{-1.11}{7.51}$

PCS 1 = - 0.15



Mean < median < mode : The distribution

Pearson's Coefficient Of Skewness 2 (PCS 2)

$$\frac{3\,(mean - median)}{standard\ deviation} = \frac{3\,(\bar{x} - \tilde{x})}{s}$$

$= 51.04$

$= 51.63$

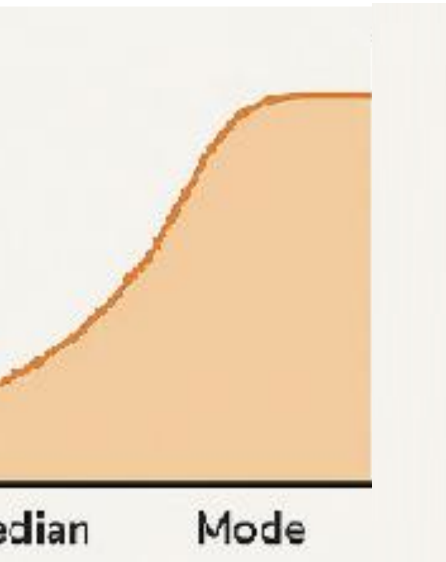
$= 52.15$

ation $(s) = 7.51$

$$\text{PCS 2} = \frac{3\,(51.04 - 51.63)}{7.51}$$

$$\text{PCS 2} = \frac{3\,(-0.59)}{7.51}$$

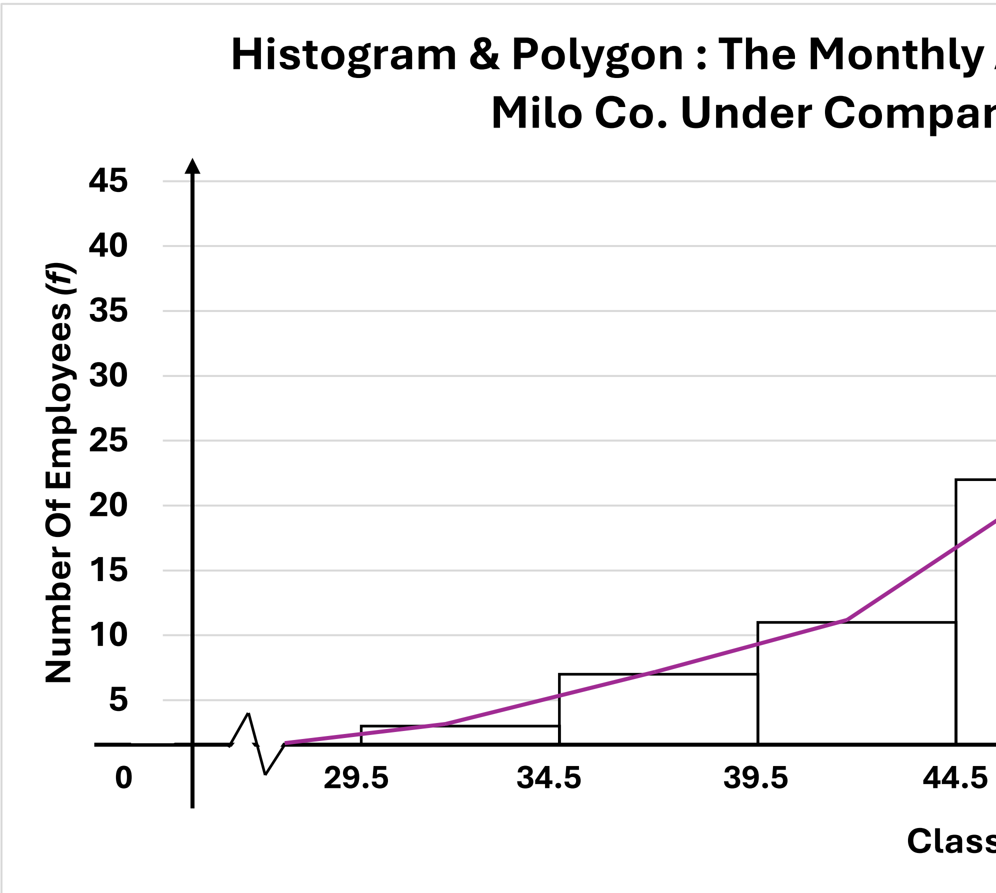
PCS 2 = - 0.24



is negatively skewed or skewed to the left.

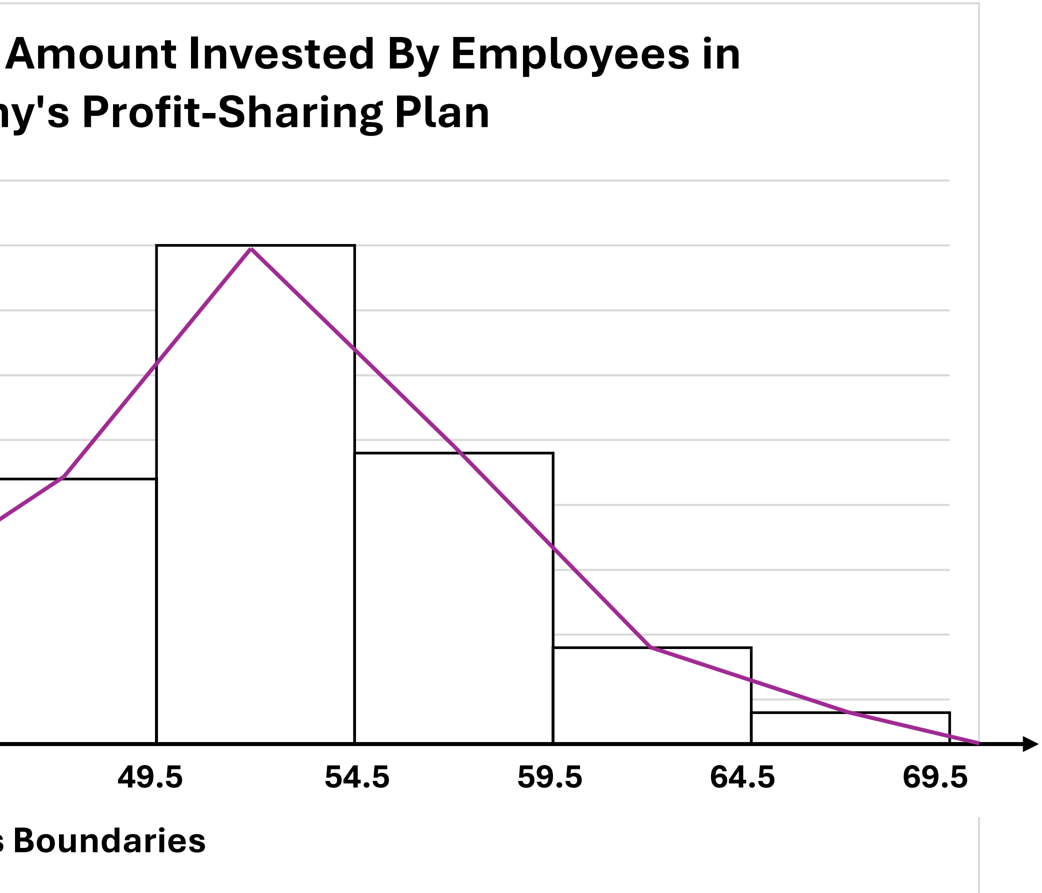
Histogram & Fre

Class Boundaries	29.5 – 34.5	34.5 – 39.5	39.5 – 44.5	44.5
Number Of Employees *(f)*	3	7	11	2



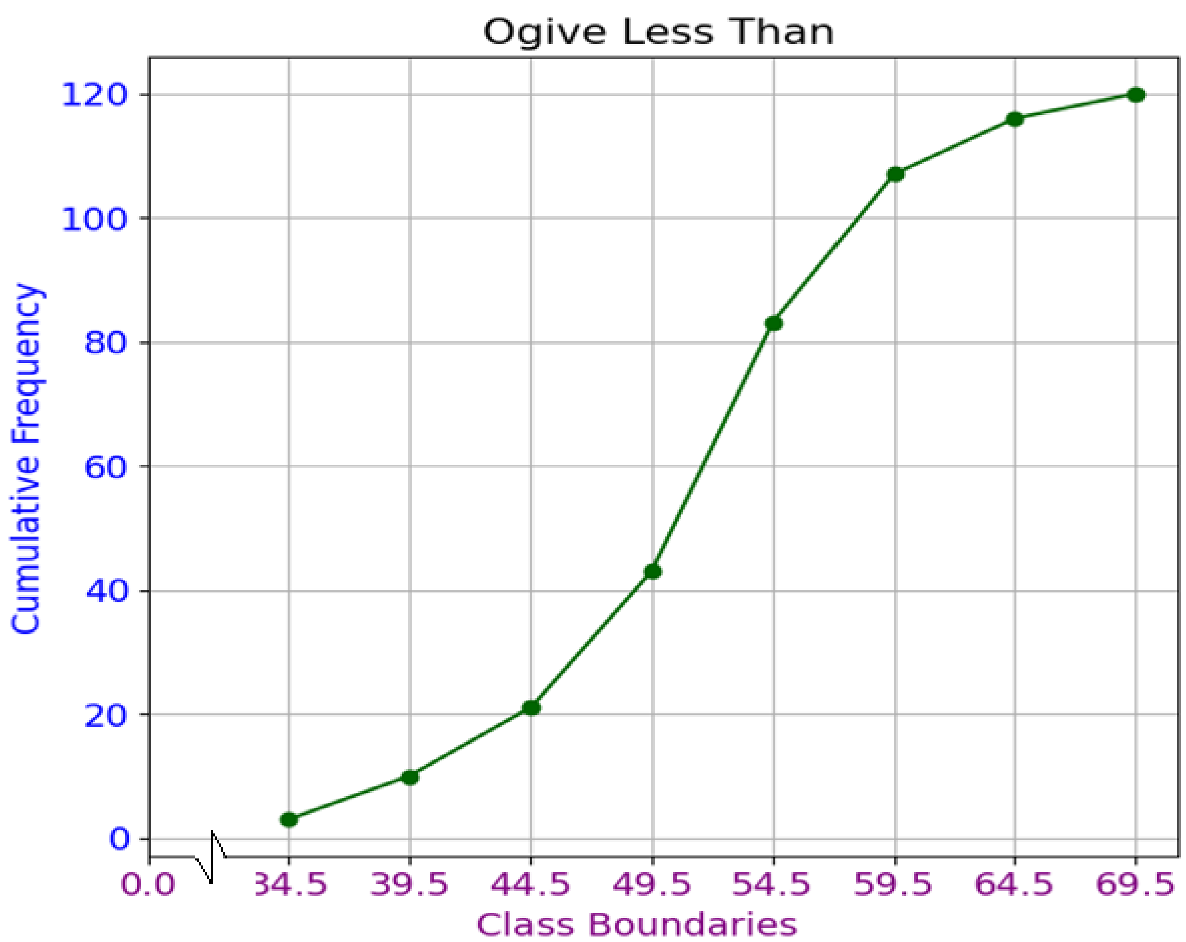
equency Polygon

– 49.5	49.5 – 54.5	54.5 – 59.5	59.5 – 64.5	64.5 – 69.5
22	40	24	9	4



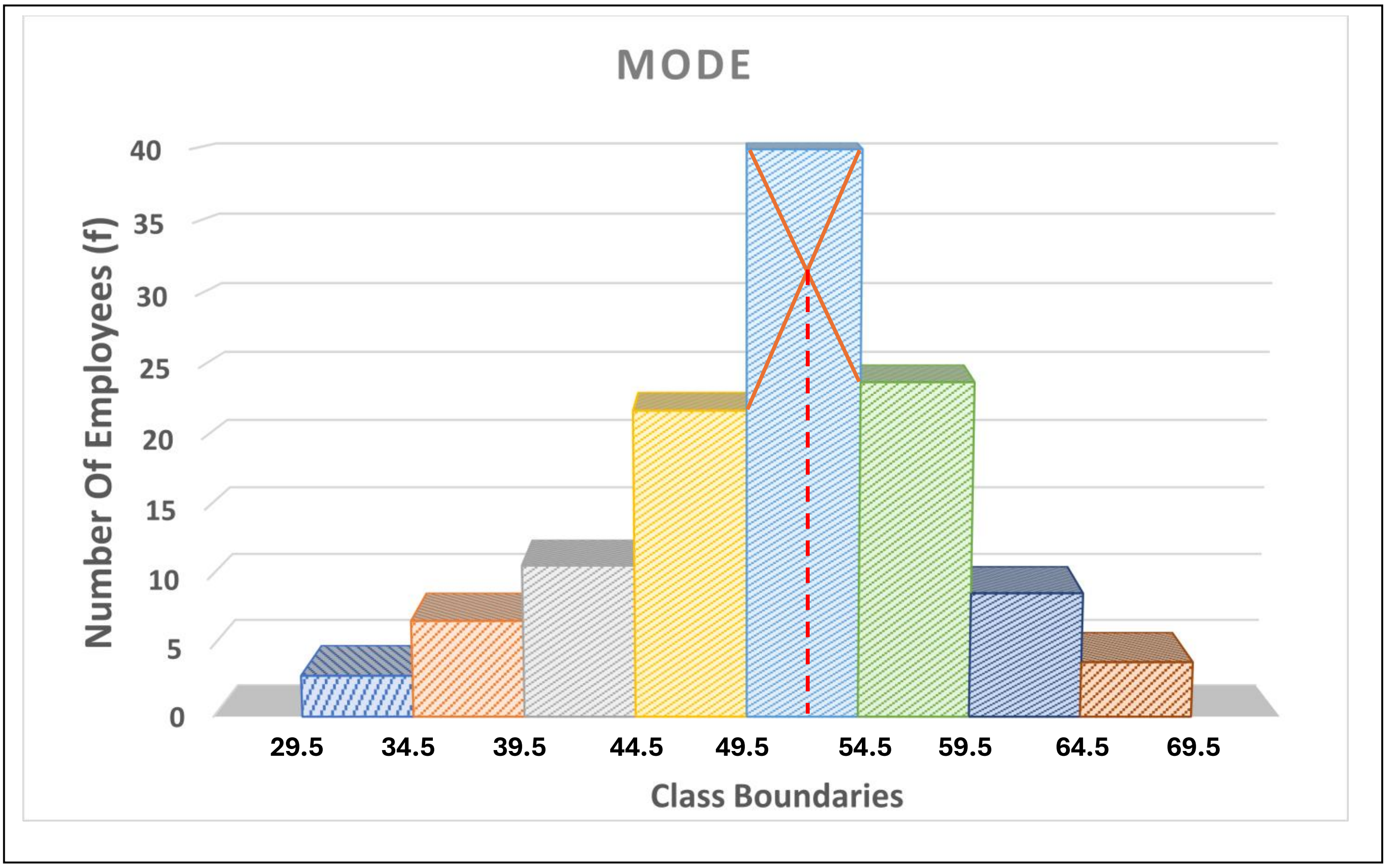
Ogive Less Than

Class Boundaries	29.5 – 34.5	34.5 – 39.5	39.5 – 44.5	44.5 – 49.5	49.5 – 54.5	54.5 – 59.5	59.5 – 64.5	64.5 – 69.5
Upper Boundaries	34.5	39.5	44.5	49.5	54.5	59.5	64.5	69.5
Cumulative Frequency	3	10	21	43	83	107	116	120



Mode using Histogram

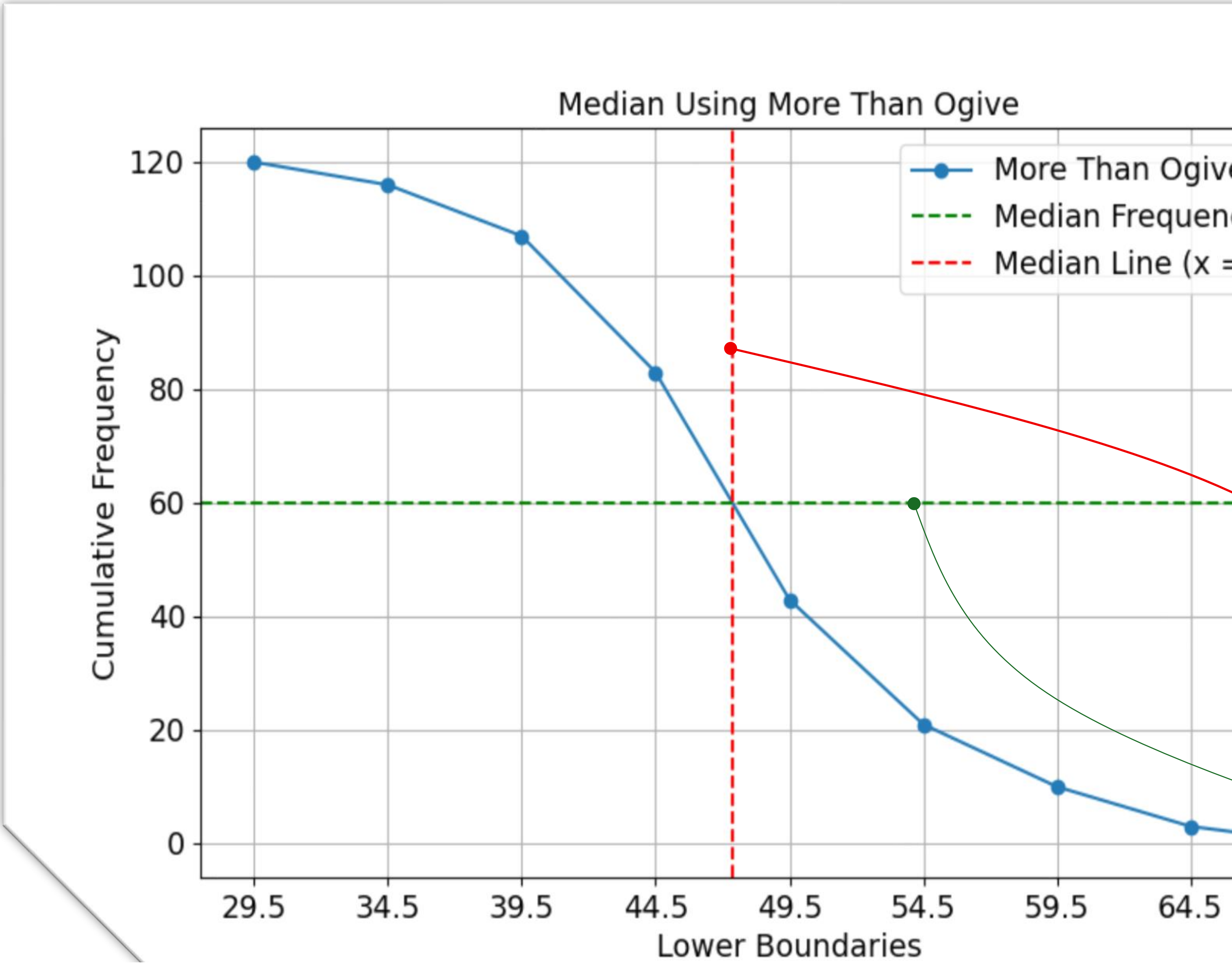
Class Boundaries	29.5 – 34.5	34.5 – 39.5	39.5 – 44.5	44.5 – 49.5	49.5 – 54.5	54.5 – 59.5	59.5 – 64.5	64.5 – 69.5
Number Of Employees *(f)*	3	7	11	22	40	24	9	4



Note :
The value **52.0** is only an **approximate estimate**. The **actual value** should be determined by **referring to the graph plotted on graph paper**.

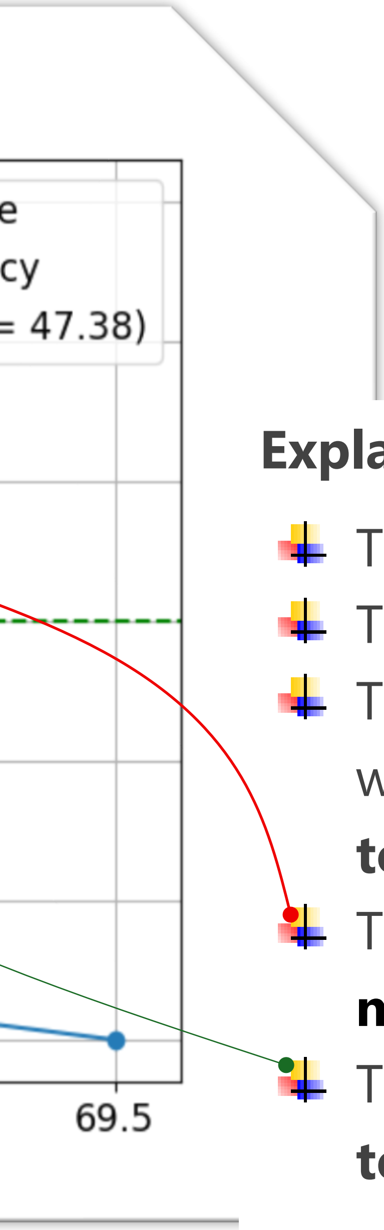
Median using M

Class Boundaries	29.5 – 34.5	34.5 – 39.5	39.5 – 44.5
Lower Boundaries	29.5	34.5	39.5
Cumulative Frequency	120	116	107



ore Than Ogive

5	44.5 – 49.5	49.5 – 54.5	54.5 – 59.5	59.5 – 64.5	64.5 – 69.5
	44.5	49.5	54.5	59.5	64.5
	83	43	21	10	3



Explanation :

- The **lower boundaries** are used as the **x-axis.**
- The **cumulative frequency** is used as the **y-axis.**
- The **median point** is estimated as the value of x when the cumulative frequency is **half of the total frequency** (which is 60).
- The **red dashed line** represents the estimated **median value**.
- The **green dashed line** represents **half of the total cumulative frequency**.

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