



RESFESHER STATISTICS

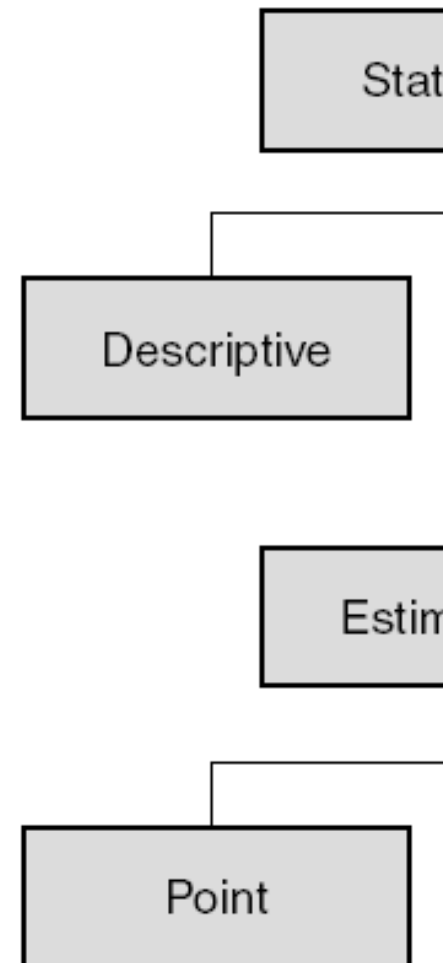
By:

Maria Theresa O. del Rosario, RPsy, PhD, JD

Objectives

- To review statistical concepts
- To show the importance of statistics in arriving at decisions, examining and predicting behavior
- To determine the correct statistical technique to be applied in establishing information in relation to the technical merits of a psychological test(reliability,validity and standardization)

Major divisions in
the field of statistics



Statistics

- refers to a set of methods and rules for organizing, summarizing, and interpreting information.

- 2 Types of Statistics

- a) descriptive

- b) inferential

Descriptive Statistics

- Describes and summarizes a given data set, which can be either a representation of the entire population or a sample of it.
- They are broken down into measures of central tendency and measures of variability, or spread.

Inferential Statistics

Is concerned with the interpretation of data set to make inferences about the characteristics of a population based on sample data.

Randomization is presumed

2 types Inferential statistics

a) estimation

b) hypothesis testing

Estimation

- making conclusions about the populations based on the best available information
 - sample data (statistics) are used as an approximation to the population parameter.

Example

How many among the working group (before the pandemic) have lost their jobs?

Should we survey all of them? No. We get a sample and from the sample data we make an estimate.

20% -Point estimate

20%-25% - Interval Estimate

Three Components To A Point Estimate

A) best guess

B) an estimate of how wrong this guess might be (based on the Assumption of Normality)

C) a measure of how confident we should be in our estimate of how wrong we might be.

Best Guess

When estimating a population mean (μ), the **sample mean ($\bar{x}$)** is typically the **point estimate** or "best guess" of the population mean.

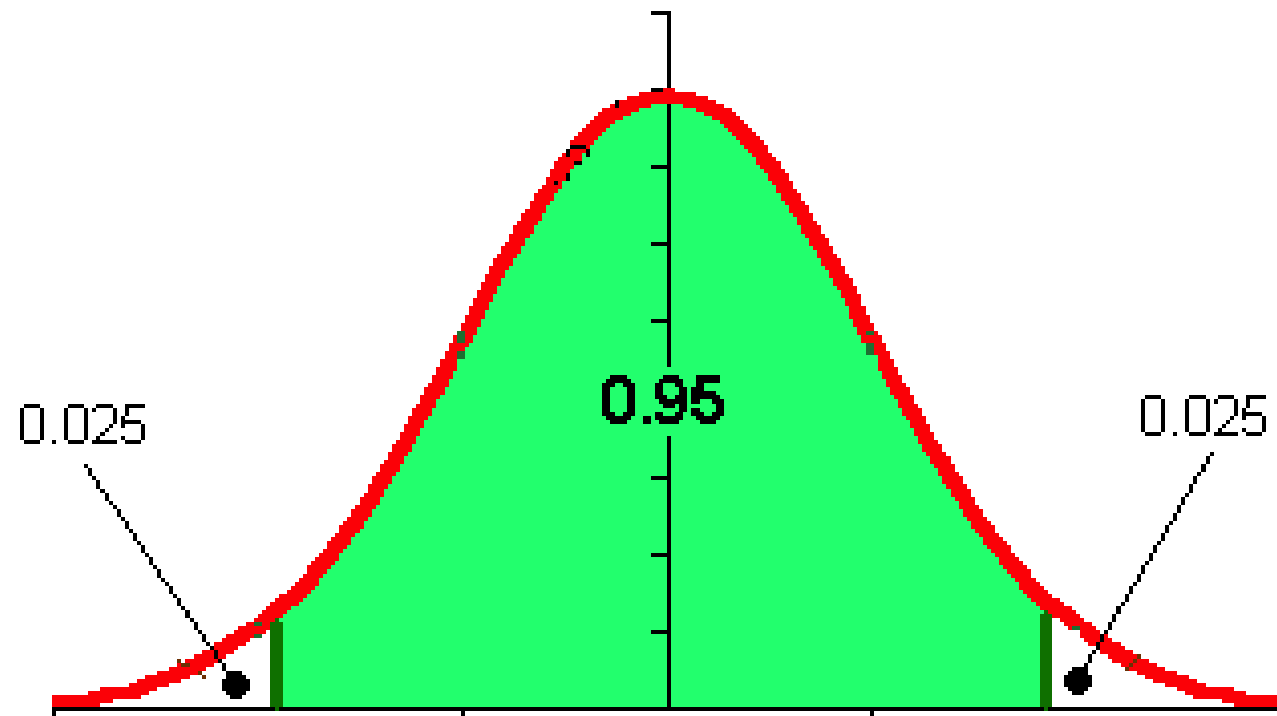
For example:

- Sample mean = 75
- Your best estimate of the population mean = 75

2. Is confidence based on the level I

Cont'n

- Even the best guess (point estimate) is subject to sampling error because it is based on a sample rather than the entire population. Therefore, I would like to quantify the uncertainty associated with that estimate. To do this, I select a confidence level, such as 90%, 95%, or 99%, and then construct a confidence interval around the point estimate.



Confidence interval

- **Best guess?** → Point estimate (mean = 75).
- **Range of plausible values?** → Confidence interval (e.g., 70-80).
- **95% confidence** does **not** automatically mean " ± 5 " around the mean. The ± 5 comes from the computed margin of error.

Effect of choosing a higher CI

A higher confidence level gives you greater confidence that your interval contains the true population mean, but it also produces a wider interval.

For example our mean is 75

- 90% CI: 72 to 78
- 95% CI: 71 to 79
- 99% CI: 69 to 81

Notice the interval becomes wider as confidence increases.

Required data for confidence interval (CI)

The confidence interval requires information about:

- sample mean
- standard deviation
- sample size
- confidence level

How to establish the CI

- Because the point estimate is subject to sampling error, calculate a confidence interval. After selecting a confidence level and considering the sample size and variability of the data, compute the margin of error and construct a range of plausible values for the population parameter.

Standard Error

- $SEM = \frac{s}{\sqrt{n}}$

s

n= sample size

s= standard deviation

Example

For example, suppose:

- Mean = 75
- SD = 10
- $n = 100$
- 95% confidence level

Then:

- The standard deviation and sample size determine the standard error.
- Together they produce the margin of error.

Cont'n

For 95% confidence, the critical value is about 1.96.

Therefore:

or approximately:

Normality

Normality affects whether the confidence interval calculation is trustworthy.

For a confidence interval for the mean, we generally want:

1. Random sampling
2. Independent observations
3. A population that is approximately normal OR a sufficiently large sample size

If the sample is:

- Highly skewed
- Contains extreme outliers
- Very small

then the confidence interval may not perform well.

Hypothesis Testing

- is a form of inferential statistics where conclusion about the population parameters are drawn of a representative sample
- random sampling

Four Possible Outcomes in Hypothesis Testing

	The null hypothesis is true (It should not be rejected)	The null hypothesis is false (It should be rejected)
Fail to reject the null hypothesis	Type A Correct decision!	Type II error (false negative)
Reject the null hypothesis	Type I error (false positive)	Type B Correct decision!



Is B guilty of the crime of murder?

H₀: No, he is innocent.

H₁: Yes, he is guilty.

pieces of evidence do not point to the
direction of the commission of the crime

Decision: Sentence him to jail

Type I error



Is B guilty of the crime of murder?

H_0 : No, he is innocent.

H_1 : Yes, he is guilty.

pieces of evidence point to the direction of
the commission of the crime

Decision: Release the detainee

Type II error

Questions

1. Distinguish a sample from the population.
2. What is random selection and its 4 types?

Multiple-Choice Question

A researcher wants to study the stress levels of college students in a university. Which of the following examples represents a properly randomly selected sample?

- A. The researcher stands outside the library and surveys the first 100 students who pass by.
- B. The researcher asks student leaders to recommend participants who they believe are willing to answer the survey.
- C. The researcher obtains a complete list of all enrolled students, assigns each student a number, and uses a random number generator to select 100 students.
- D. The researcher posts an online survey link and includes only those students who voluntarily respond.

Frequency Distribution- display of scores on a variable to reflect the frequency of the value that was collected

Scores:

1,1,2,2,2,2,2,3,3,3,3,4,4,5

Score	Frequency
-------	-----------

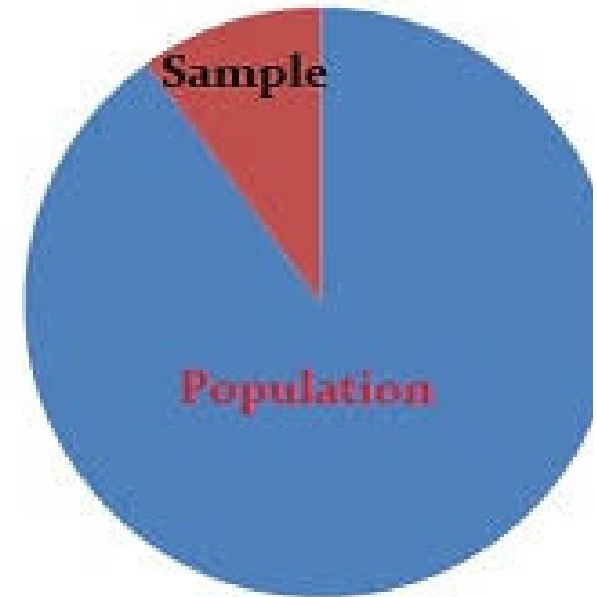
1	2
---	---

Mean?
Median?
Mode?

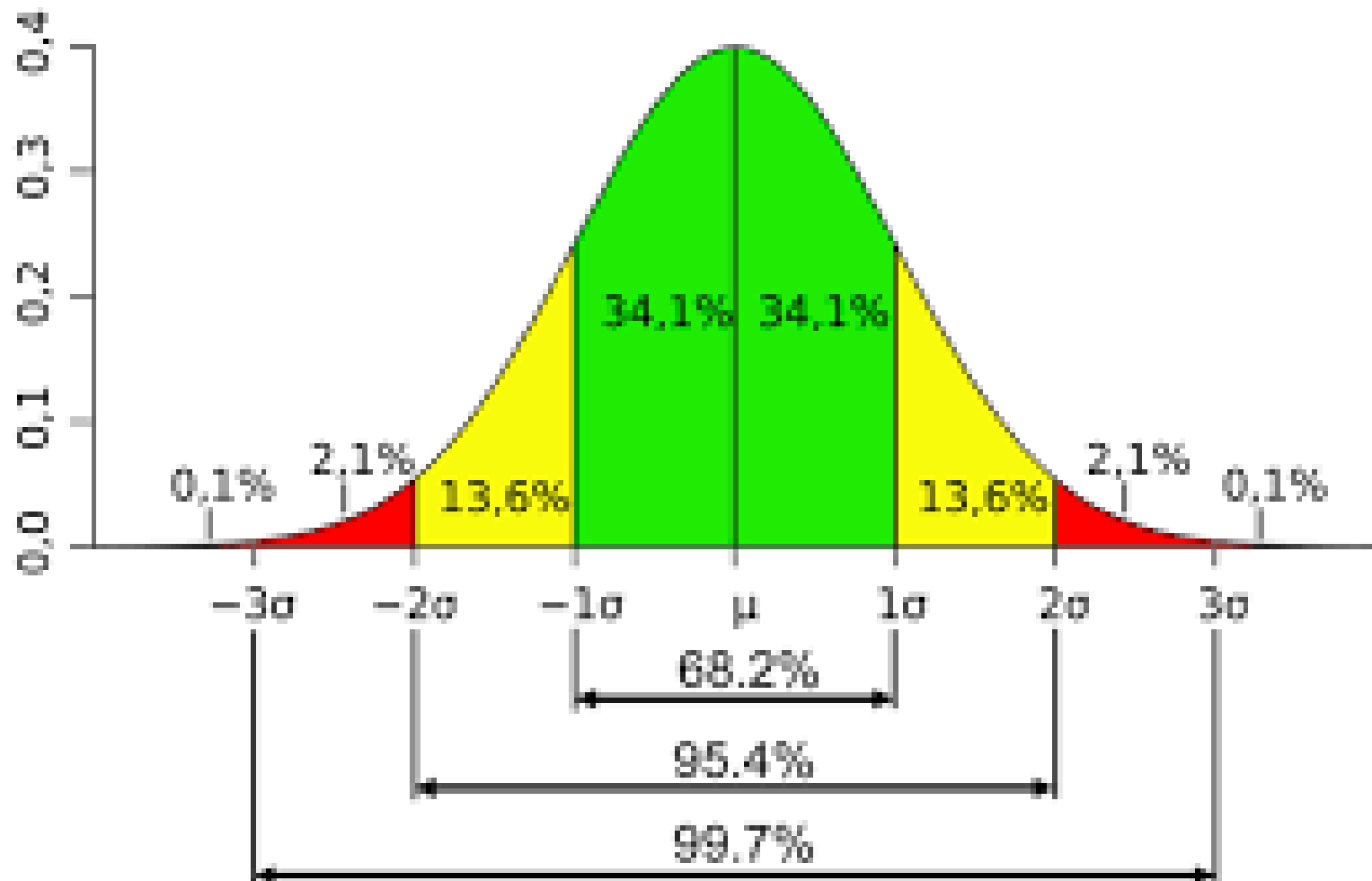
Skewness?
Kurtosis?
Class Interval?

Central Limit Theorem

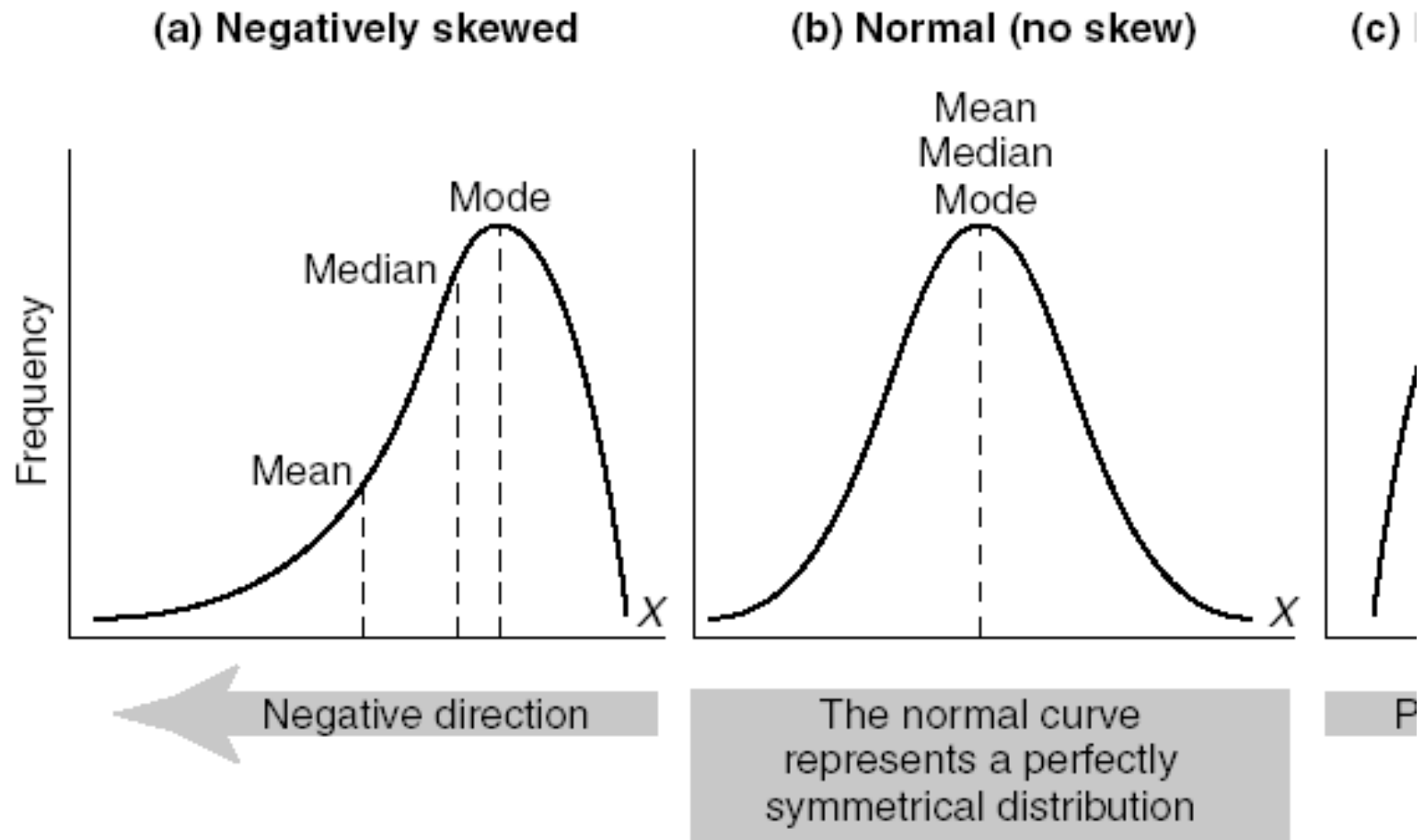
- -is a statistical concept that states that the sample mean distribution of a random variable will assume a near-normal or normal distribution if the sample size is large enough.
- - the theorem states that the sampling distribution of the mean.



Normal Distribution (Gaussian curve/bell curve)

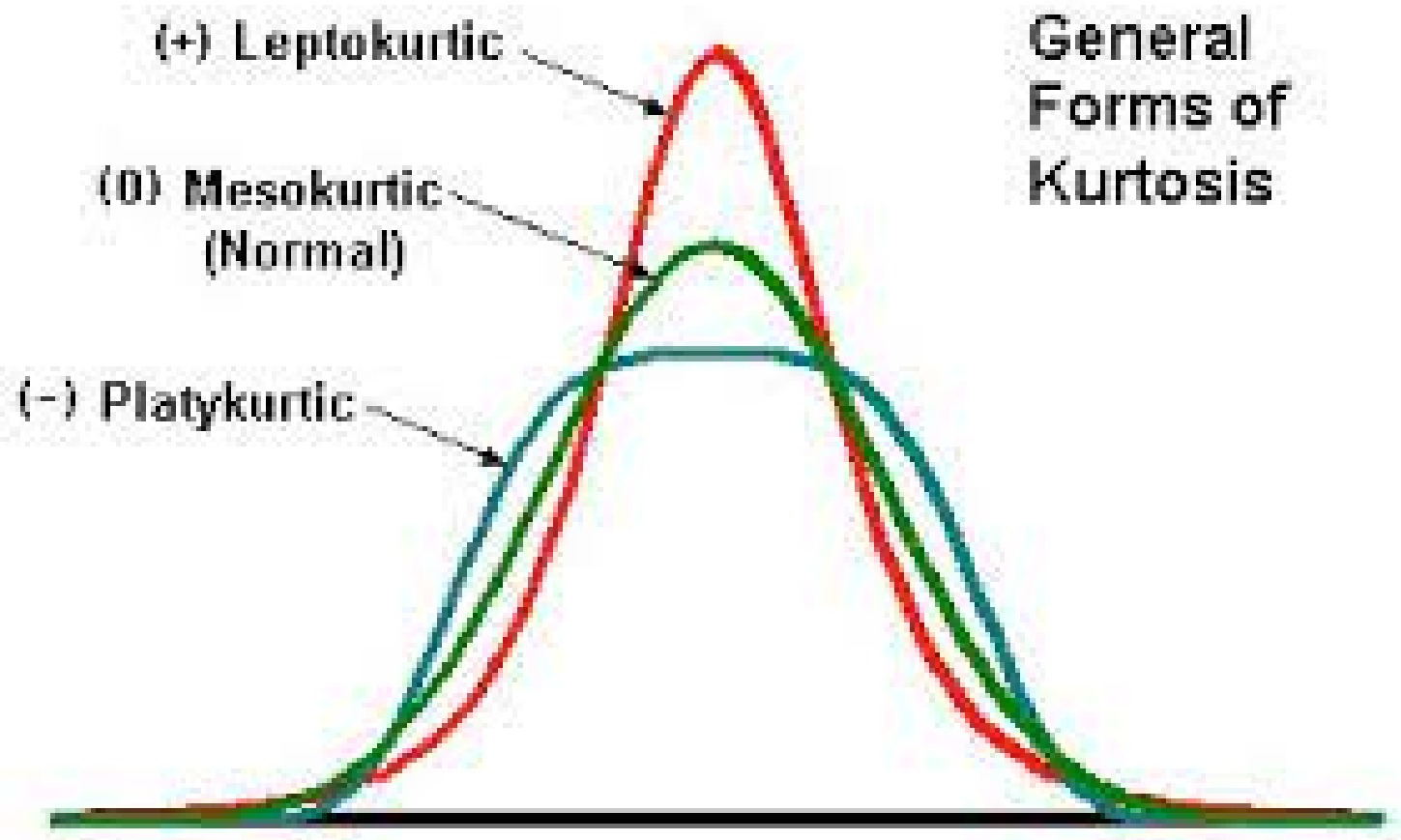


Types of Distribution Based on Skewness



Examples of normal and skewed distributions

Types of Distribution Based on Kurtosis



Measure of Central Tendency

- Also known as averages
- Mean, median and the mode
 - a) Mean - arithmetic average score in a distribution
 - b) Median – midpoint in a distribution
 - c) Mode -score in the distribution which has the highest frequency

Averages (Grouped data)

X	f	Xf	$M = \sum X/N$
1	2	2	$M = 37/14$
2	5	10	$= 2.64$
3	4	12	$M_o = 2$
4	2	8	$M_d = 14/2$ Where to find M_d ?
5	1	5	$= 2.5$

Measure of variability

- Standard Deviation: Average deviation around the mean
- Variability: Difference in means between sets of scores
- Variance: Average squared deviation around the mean

Standard Deviation F

Population

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

X – The Value in the data distribution

μ – The population Mean

N – Total Number of Observations

X – The

x̄ – The

n – Total


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

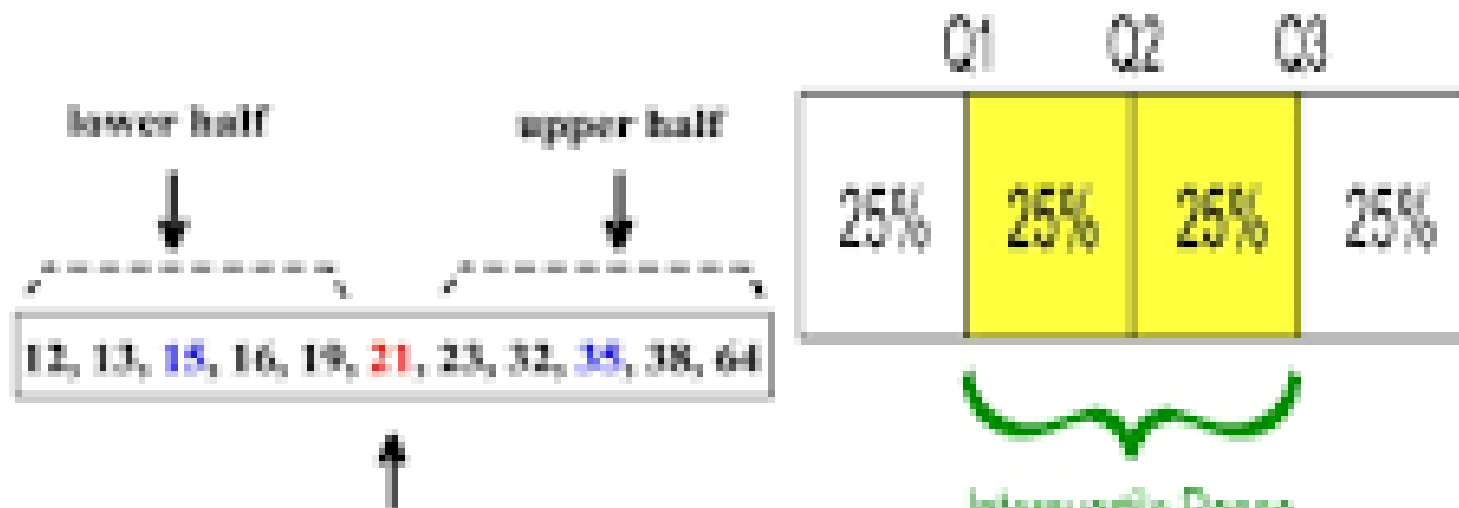
$$s^2 = \frac{\sum (x - \bar{x})^2}{n - 1}$$

$$QD = (Q3 - Q1) / 2$$

DEFINITION : QUARTILE DEVIATION (QD) MEANS THE SEMI VARIATION BETWEEN THE UPPER QUANTILES (Q3) AND LOWER QUANTILES (Q1) IN A DISTRIBUTION. Q3 - Q1 IS REFERRED AS THE INTERQUARTILE RANGE.

Quartile Deviation

Interquartile Range



Scale of Measurement

- Nominal
- Ordinal
- Interval
- Ratio

Nominal

- This is a nonquantitative measurement scale.
- The simplest form of measurement
- Used to categorize, label, classify, name, or identify variables. It classifies groups or types.
- Numbers can be used to label the categories of a nominal variable but the numbers serve only as markers, not as indicators of amount or quantity (e.g., if you wanted to, you could mark the categories of the variable called "gender" with 1=female and 2=male).

Ordinal

- This level of measurement enables one to make ordinal judgments (i.e., judgments about rank order).
- Any variable where the levels can be ranked (but you don't know if the distance between the levels is the same) is an ordinal variable.
- Some examples are order of top performers in the board exam, rank in class.

Interval

- This scale or level of measurement has the characteristics of rank order and equal intervals (i.e., the distance between adjacent points is the same). It does not possess an absolute zero point.
- Some examples are Celsius temperature, Fahrenheit temperature, IQ scores.

Ratio

- This is a scale with a true zero point.
- It also has all of the "lower level" characteristics (i.e., the key characteristic of each of the lower level scales) of equal intervals (interval scale), rank order (ordinal scale), and ability to mark a value with a name (nominal scale).
- Some examples of ratio level scales are number correct, weight, height, response time, Kelvin temperature, and annual income.

Multiple choice questions

1. A psychologist classifies clients according to their primary diagnosis (e.g., Depression, Anxiety Disorder, ADHD). What scale of measurement is used?

- A. Ordinal
- B. Ratio
- C. Nominal
- D. Interval

2. In a personality assessment, applicants are ranked from most suitable to least suitable for a position. What scale of measurement is represented?

- A. Ratio
- B. Nominal
- C. Interval
- D. Ordinal



3. An IQ test produces scores where equal differences between scores represent equal differences in intellectual functioning, but there is no true zero. What scale is used?

- A. Ratio
- B. Interval
- C. Ordinal
- D. Nominal

4. A psychologist records the amount of time (in minutes) a child spends completing a cognitive task. What scale of measurement is represented?

- A. Nominal
- B. Ratio
- C. Interval
- D. Ordinal

Answers

- 1. **C. Nominal**
- 2. **D. Ordinal**
- 3. **B. Interval**
- 4. **A. Ratio**

Scale Of measurement	MCT	MV
Nominal	Mode	range
Ordinal	mode median	Quartile deviation Percentiles
Interval	Mode Median mean	Standard deviation Variance
Ratio	Mean Median Mode	Standard deviation variance

Correlation

- statistical measure that expresses the extent to which two variables are linearly related (meaning they change together at a constant rate). It's a common tool for describing simple relationships without making a statement about cause and effect.

Correlation

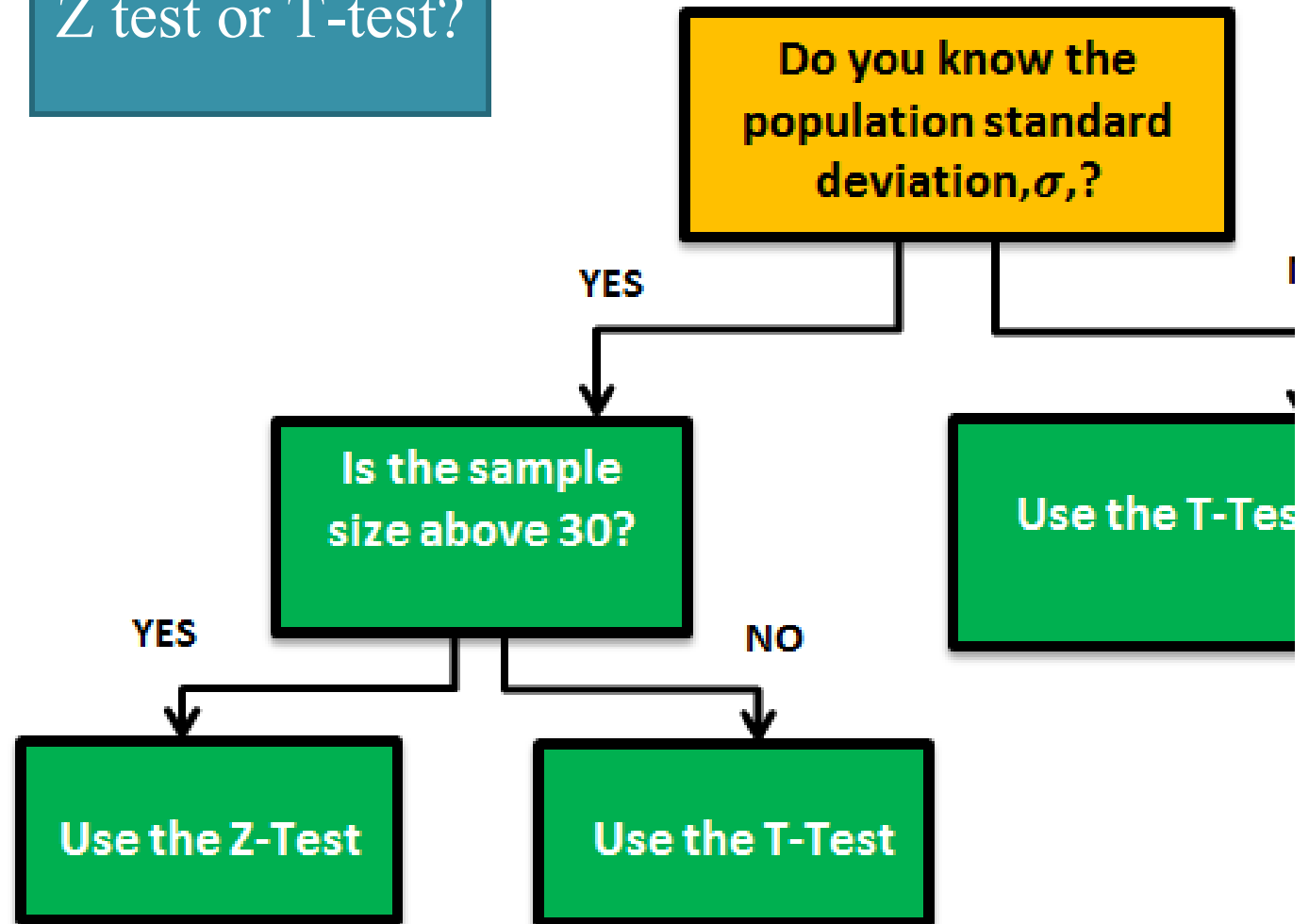
- Pearson's r = 2 interval data
- Spearman's ρ = 2 ordinal data
- Point –biserial = interval and nominal
- Phi-coefficient = 2 nominal data

Is the instrument consistent?

- Correlate the scores in set A and in set B
- $n=50 - r_{xy}$
- $n=20 - \rho$

Comparative groups	Parametric	Non-parametric
Sample v population	Z-test	t-test
2 independent samples	T-test for independent samples	Mann-Whitney U test
2 dependent samples	T-test for dependent samples	Wilcoxon Rank test
3 or more independent samples	1-way ANOVA	Kruskal-Wallis H test
2 or more samples (2 factors)	2-Way ANOVA	Friedman's Test
Comparison between 2 categorical variables	none	Chi-square test of independence

Z test or T-test?





Formula for T-test & Z-test

Z-test

$$Z = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}}$$

T-test

$$T = \frac{\bar{X}}{c}$$

d.f. =

where

- $\bar{X}_{\text{bar}}$ = mean of the sample
- μ = mean of the population (value in
- $\sigma_{\bar{X}}$ = standard error of the mean


$$Z = \frac{x - \mu}{\sigma}$$

Score Mean
SD

$$\frac{67.49 - 67.37}{1.30} = .061$$

T – test for independent samples

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\left[\frac{SS_1 + SS_2}{N_1 + N_2 - 2} \right] \left[\frac{1}{N_1} + \frac{1}{N_2} \right]}}$$

$$t = \frac{(7.00 - 3.25)}{\sqrt{\left[\frac{6.00 + 4.75}{5 + 4 - 2} \right] \left[\frac{1}{5} + \frac{1}{4} \right]}} = 4.52$$

$$df = 7 \quad t = 2.365$$

How to Perform Mann-Whitney U-Test

$$U_{stat} = \text{Rank Sum} - \frac{n(n-1)}{2}$$

$$U_1 = R_1 - \frac{n_1(n_1+1)}{2}$$

or

$$U_2 = R_2 - \frac{n_2(n_2+1)}{2}$$

Treated d	Untreated d	Treated (R1)	Untreated (R2)
24	20	18.5	7.5
25	23	21.5	14.5
21	21	10	10
22	25	12	21.5
23	18	14.5	4
18	17	4	1.5
17	18	1.5	4
28	24	24	18.5
24	20	18.5	7.5
27	24	23	18.5
21	23	10	14.5
23	19	14.5	6
		R1=172	
		R2=128	
		N1=12	
		N2=12	
		$U1 = (R1 - n1)(n1 + 1) / 2 = 94$	
		$U2 = (R2 - n2)(n2 + 1) / 2 = 89$	
		thus, $U = 89$	
		Critical value = 12.12 = 37	

1. Solution Steps

1. Step 1: State the null and alt hypothesis and rejection criteria
2. Step 2: Rank all Observations
3. Step 3: Calculate Rank Sums
4. Step 4: Calculate U
5. Step 5: Determine Critical Value and Draw Conclusion

T test for dependent /paired samples

Paired T-test Formula

$$t = \frac{\sum d}{\sqrt{\frac{n(\sum d^2) - (\sum d)^2}{n-1}}}$$

where d: difference per pair

n: number of samples

Player	Max Vertical Jump Before Training Program	Max Vertical Jump After Training Program	Difference
Player 1	22	24	-2
Player 2	20	22	-2
Player 3	19	19	0
Player 4	24	22	2
Player 5	25	28	-3
Player 6	25	26	-1
Player 7	28	28	0
Player 8	22	24	-2
Player 9	30	30	0
Player 10	27	29	-2
Player 11	24	25	-1
Player 12	18	20	-2
Player 13	16	17	-1
Player 14	19	18	1
Player 15	19	18	1
Player 16	28	28	0
Player 17	24	26	-2
Player 18	25	27	-2

$$\begin{array}{r}
 -18 \\
 \hline
 \sqrt{20(50)-324} \\
 \hline
 19 \\
 -18 \\
 \hline
 \sqrt{676} \\
 = \hline
 19 \\
 \text{obt} = .50 \\
 \text{Crit} = 1.72 \\
 \text{Fail to reject} \\
 H_0
 \end{array}$$

Wilcoxon Signed-Rank Test

- The formula for the Wilcoxon signed rank test is:

$$Z = \frac{w_s - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}}$$

- where
 - n = number of pairs where difference is not 0
 - w_s = smallest of absolute values of the sums

The marks obtained, in both the mock examination and the A level examination, by a random sample of 13 students are shown below.

Candidate	1	2	3	4	5	6	7	8	9	10	11	12
Mock	40	65	53	79	87	42	80	63	51	82	27	7
A level	45	68	47	75	88	60	77	69	60	88	30	7

5% significance level

Did the students perform better in the A level than the mock examination?

WILCOXON SIGNED RANK TEST

A-level	Mock	Difference	Rank	Signed Rank
45	40	(+)5	7	7
68	65	(+)3	4	4
47	53	(-)6	9.5	-9.5
75	79	(-)4	6	-6
88	87	(+)1	1	1
60	42	(+)18	13	13
77	80	(-)3	4	-4
69	63	(+)6	9.5	9.5
60	51	(+)9	12	12
88	82	(+)6	9.5	9.5
30	27	(+)3	4	4
73	71	(+)2	2	2
35	29	(+)6	9.5	9.5

www.statisticalaid.com

Formulas for the One-Way ANOVA

$$F = \frac{MS_{\text{between}}}{MS_{\text{within}}}$$

$$MS_{\text{between}} = \frac{SS_{\text{between}}}{df_{\text{between}}}$$

$$MS_{\text{within}}$$

$$SS_{\text{between}} = \sum \frac{(\Sigma x_i)^2}{n_i} - \frac{(\Sigma x)^2}{N}$$

$$SS_{\text{within}} = \sum$$

$$df_{\text{between}} = k - 1$$

$$df_{\text{within}}$$

Source of Variation	d.f.	SS
Factor A (between groups)	$a-1$	$SSA = \sum_{j=1}^a J_j$
Factor B (between groups)	$b-1$	$SSB = \sum_{j=1}^b J_j$
Error (within groups)	$(a-1)(b-1)$	$SSE = SST$
Total	$N-1$	$SST = \sum_{i=1}^a \sum_{j=1}^b Y_{ij}$



Source of Variation	d.f.
Factor A (between groups)	$a-1$
Factor B (between groups)	$b-1$
Error (within groups)	$(a-1)(b-1)$
Total	$N-1$



Is the instrument a diagnostic instrument

- Normal population vs the disturbed?
- Normal population vs the PD and those with anxiety disorders?
- Baseline data vs post-intervention data (pre-test vs post test)



What statistical technique will you apply?

Is there a significant difference in the degree of hallucination of male ($n=25$) and female ($n=25$) patients after cognitive therapy?

Does the relationship between gender and intervention affect affect the level of hallucination of patients?

Is there a need to establish a separate norm for males and females for a Self-esteem test?

	Sample	Population
Male		
Female		

	Cognitive Therapy	
	Before	After
Male		
Female		

between the participants are more likely to be