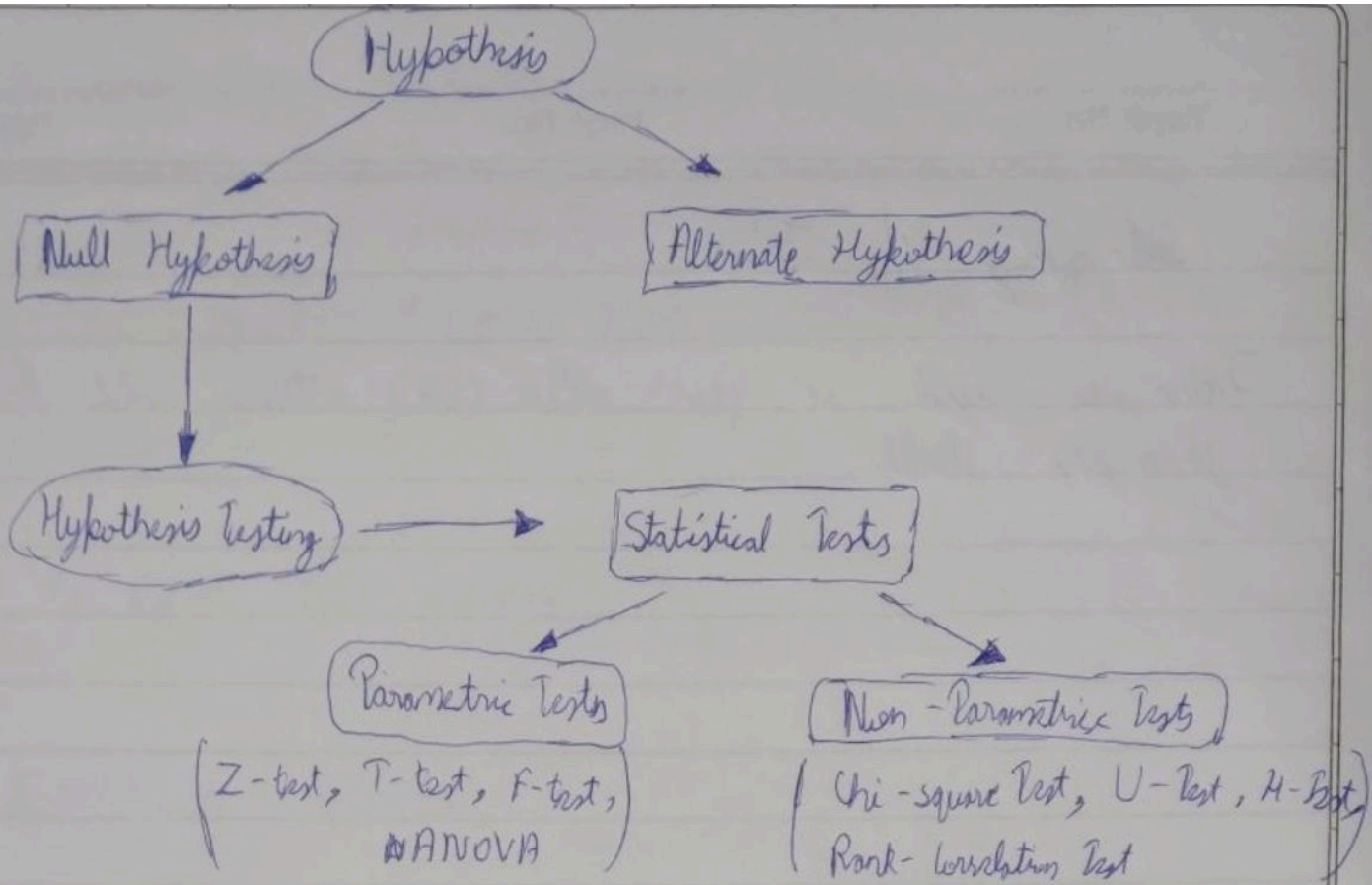

Hypothesis

Educated guess about Population

A prediction of the relationship b/w or more variables.

Null Hypothesis

A statement which states that there is no relationship b/w the variables.

Alternate Hypothesis

A statement which states that there is relationship b/w the variables.

Statistical Tests :-

- They are conducted to test the hypothesis and to find the inferences about the population.
- For that, samples are selected & various test are performed on them to find the inference about the population under study.

Parametric Tests

- They are applied under the circumstances where the population is normally distributed or is assumed to be normally distributed.
- Parameter like mean, standard deviation etc are used.
- For example, T-test, Z-Test, F-Test, ANOVA, Pearson's Correlation Coefficient.
- These are applied where data is quantitative, numerical.

Non Parametric Test

- They are applied under the circumstances where the population is not normally distributed (skewed distribution) or is not assumed to be normally distributed

Teacher's Signature :.....

- Where parametric tests cannot be applied, then non-parametric tests come into play. (Where we have no idea about the population)

- These tests are called as Distribution-free tests.
  Independent of Pop. distribution
- Parameters like mean, std etc are not used.
- For eg, Chi-square test, U-test (Mann Whitney Test), H-Test (Kruskal Walls Test), Spearman's Rank correlation Test.
- These are applied when data is qualitative.
  categorical
- Applied where scale of measurement is either an ordinal or a nominal scale.

	Parametric Test	Non Parametric Test.
Advantage :-	More Powerful	More Robust
Disadvantage :-	Less Robust	Less powerful.

Steps in Hypothesis Testing?

[State the Null hypothesis & Alternate Hypothesis]

↓

[Set the criteria for the decision i.e., Level of Significance]

↓

[Collect the data (select your Sample)]

↓

[Decide which test is to be performed]

↓

[Compute test statistic / Value]

↓

[Find the Critical Value]

↓

[Compare the critical value with test statistic / value]

↓

[Make a decision to either reject or not reject the null hypothesis]

Analysis of each step:-

1) Set the null & alternate hypothesis:-

- Null Hypothesis: ⇒ A statement which assumes that there is no significant relationship b/w the variables.
  ⇒ It is to be tested for its verification and validity.

Teacher's Signature :.....

- Alternate Hypothesis : A statement which assumes that there is a significant relationship b/w the variables.

⇒ Also called as Research Hypothesis.

Statistically significant :- implies difference in result doesn't occur by chance.

The relation b/w variables is not just by chance.

ii) Set the criteria for the decision, i.e., Level of Significance

- It is the probability of rejecting the null hypothesis when it is true. Also called as Type I error.
- It is set prior to conducting the hypothesis testing.
- Can be set at 5% or lesser.

For eg, significance level of 5% indicates, a 5% risk of concluding that a difference exists when there is no actual difference.

- Lower significance level indicate that stronger evidence is required before rejecting the null hypothesis.
- It is denoted by 'α'.

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iii) Select the sample. (Sampling methods)

iv) Decide the test and compute the value of test statistic.

v) Find critical value

- Critical value is the cut-off value which is to be compared with the test value to take a decision about the null hypothesis.
- It divides the graph into two sections: Rejection area and Acceptance area.
- If test value falls into the rejection area, then reject the null hypothesis.
- It is derived from the level of significance of the test.
- It is the table value of Level of Significance of the test.
- ~~It is the table value~~
- The table / critical value of 5% level of significance is 1.96.

vi) Compare the critical value with Test Value

If value of test statistic is greater than the critical value ⟹ Reject the null hypothesis

If the value of test statistic is less than the critical value ⇒ Fail to reject the null hypothesis

Teacher's Signature :

What is P-value?

- It is the probability of getting the value of our test statistic if the null hypothesis is true.
- The lower the p-value, the stronger is the evidence that the null hypothesis is false.
- Since, p-value is a probability value, therefore, it will always lie b/w 0 & 1.
- A high p-value indicates that the observed results are likely to occur by chance under the null hypothesis & that's why, in this case, null hypothesis would not be rejected.
- On the other hand, a low p-Value indicates that the results are less likely to occur by chance under the null hypothesis & hence, in this case, null hypothesis would be rejected.

Relationship b/w p-value, Critical Value & Test statistic

- The benefit of using p-value is that it calculates probability estimate, which can be tested at any desired level of significance by comparing this probability directly with significance level.
- For eg, assume z-value comes out to be 1.98 which is greater than the critical value at 5% which is 1.96.

- Now, to check for a different significance level of 1%, a new critical value is to be calculated.
- But by calculating the p-value, no critical value is then to be calculated.
- We can compare p-value directly with significance level (5% or 1%)

Parametric Tests

I- Test

- It is a parametric test of Hypothesis testing based on Student's T distribution.
- It was developed by William Sealy Gosset.
- It is essentially, testing the significance of the difference of the mean values when the sample size is small (i.e., less than 30) & when population standard deviation is not available.
- It assumes:-
  - ⇒ Population distribution is normal.
  - ⇒ Samples are random & independent.
  - ⇒ Sample size is small.
  - ⇒ Population standard deviation is not known.

- Mann-Whitney 'U' Test is a non-parametric counterpart of T-test

A T-Test can be a

One Sample T-test

To compare sample mean with that of Population mean.

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

$\bar{x}$ is the sample mean

s is sample std

Two Sample T-test

To compare means of two different samples.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$\bar{x}_1$ → Sample mean of Ist grp

$\bar{x}_2$ → " " IInd grp

s_1 = Sample std of Ist group

s_2 = " " IInd group

If the value of test statistic is greater than the table value ⇒ Reject the null hypothesis

If the value of test statistic is less than the table value ⇒ Do not Reject the null hypothesis.

Z - Test

- It is a parametric test of hypothesis testing.
- It is used to determine whether the means are different when the population variance is known & sample size is large (i.e., greater than 30).
- It assumes:
  - ⇒ Population distribution is normal
  - ⇒ Samples are random & independent.
  - ⇒ Sample size is large.
  - ⇒ Population standard deviation is known.

A Z-Test can be a

One Sample Z-Test
To compare sample mean with that of population mean.

$$Z\text{-test} = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

Two Sample Z-Test
To compare means of two different samples.

$$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

T-test is used when ⇒ Sample size is small and the Population variance is not known

Z-test is used when ⇒ Sample size is large and Population variance is known

Sample size is large and the population variance is not known. ⇒ Z-test is used.

Sample size is small and population variance is known ⇒ Z-test is used.

F-Test

- It is a parametric test of hypothesis testing based on Snedecor F-distribution.
- F-test is named after its test statistic, F.
- It is a test for the null hypothesis that two normal populations have the same variance.
- An F-test is regarded as a comparison of equality of sample variances.

- F-statistic is simply a ratio of two variances.
- It is calculated as:-

$$F = \frac{s_1^2}{s_2^2}, \text{ where } s^2 = \frac{\sum_{i=1}^{n} (x - \bar{x})^2}{n-1}$$

- By changing the variance in the ratio, F-test becomes a very flexible test. It can then be used to:-
  - ⇒ Test the overall significance for a regression model.
  - ⇒ To compare the fits of different model.
  - ⇒ To test equality of means.
- It assumes:-
  - ⇒ Population distribution is normal.
  - ⇒ Samples are drawn randomly & Independently.

ANOVA

- Also called as (Analysis of Variance), it is parametric test of hypothesis testing.
- It was developed by Ronald Fisher, also referred to as Fisher's ANOVA.
- It is an extension of T-test & Z-Test.
- It is used to test the significance of the difference of the mean values among more than two sample groups.

Teacher's Signature :

- It uses F-test to statistically test the equality of means & the relative variance b/w them.
- It assumes:
  - ⇒ Population distribution is normal.
  - ⇒ Samples are random & independent.
  - ⇒ Homogenity of sample variance.
- One-way ANOVA & Two-ways ANOVA are its types.

F-statistic = $\frac{\text{Variance b/w the sample means}}{\text{Variance within samples}}$

Chi-Square Test

- It is a non parametric test of hypothesis testing.
- As a non parametric test, chi square can be used:
  - i) As a goodness of fit
  - ii) As a test of independence of two variables.
- It helps in assessing the goodness of fit b/w a set of observed values and those expected theoretically.
- It makes comparison b/w the expected & observed frequencies.
- ~~Greater~~ Greater the difference, greater is the value of chi square.

- If there is no diff. b/w expected & observed frequencies, then the value of Chi-Square is 0.
- It is also called as the 'Goodness of fit Test' which determines whether a particular distribution fits the observed data or not.
- It is ~~oth~~ calculated as:-

$$\chi^2 = \sum (O - E)^2 / E$$

O → Observed freq. E → Expected freq.

- Chi-Square is also used to test the independence of two variables.
- Conditions of Chi-Square Test:
  - ⇒ Observations recorded & used are collected on a random basis.
  - ⇒ All the items in the sample must be independent
  - ⇒ No grp should contain very few items, say less than 10.
  - ⇒ The overall no. of items must also be reasonably large. It should normally be at least 50, however small the no. of grps may be.
- Chi Square can be used as a parametric test to test for a population variance on the basis of sample variance.

Teacher's Signature :.....

- If we take each one of a collected of sample variances, divide them by the known population variance and multiply the quotients by $(n-1)$, where n means the no. of items in the sample, we get the value of chi square.

- It is calculated as:

$$\chi^2 = \frac{\sigma_s^2}{\sigma_p^2}(n-1)$$

Mann-Whitney U-Test

- It as a non-parametric test of Hypothesis testing.
- This test is used to investigate whether 2 independent samples were selected from population having same distribution.
- It is a true non-parametric counterpart of T-test & gives the accurate estimate of significance especially when sample sizes are small & population is not normally distributed.
- It is based on the comparison of every observation in the first sample with every observation in the other sample.
- The test statistic used here is 'U'.

- Max. value of 'U' is 'n1 * n2' and min. value is 0.

"Kruskal - Wallis H - Test"

- It is a non parametric test of Hypothesis testing.
- This test is used for comparing two or more independent samples of equal or different sample sizes.
- It extends the Mann Whitney U-Test which is used for comparing only 2 grps.
- One way ANOVA is the parametric equivalent of this test. And that's why, it's also called as "One way ANOVA on ranks".
- It uses ranks instead of actual data.
- It uses ranks ~~on~~
- It doesn't assume the pop" to be normally distributed.
- The test statistic used here is 'H'.