HYPOTHESIS AND IT'S TESTING

- During investigation there is assumption and presumption which subsequently in study must be proved or disproved.
- Hypothesis is a supposition made from observation. On the basis of Hypothesis we collect data.
- Hypothesis is a tentative justification, the validity of which remains to be tested.

Two Hypothesis are made to draw inference from Sample value-

A. Null Hypothesis or hypothesis of no difference.
B. Alternative Hypothesis of significant difference.

CONT.....

The Null Hypothesis is symbolized as Ho and Alternative Hypothesis is symbolized as H_1 or H_A.

In Hypothesis testing we proceed on the basis of Null Hypothesis. We always keep Alternative Hypothesis in mind.

The Null Hypothesis and the Alternative Hypothesis are chosen before the sample is drawn.

CHARACTERISTICS OF HYPOTHESIS

1. Hypothesis should be clear and precise.
2. Hypothesis should be capable of being tested.
3. It should state relationship between variables.
4. It must be specific.
5. It should be stated as simple as possible.
6. It should be amenable to testing within a reasonable time.
7. It should be consistent with known facts.

NULL HYPOTHESIS

A Null Hypothesis or Hypothesis of no difference (Ho) between statistic of a sample and parameter of population or between statistic of two samples nullifies the claim that the experimental result is different from or better than the one observed already. In other words, Null Hypothesis states that the observed difference is entirely due to sampling error, that is - it has occurred purely by chance.

EXAMPLES OF NULL HYPOTHESIS

- There is no difference between the operational procedures of open prostatectomy and TURP.
- There is no difference between open operation and transsphenoidal approach.
- There is no difference in the incidence of measles between vaccinated and non-vaccinated children.
- Drugs chloramphenicol is as good as drug cotrimoxazole in treating enteric fever.

THE ALTERNATIVE HYPOTHESIS

Alternative Hypothesis of significant difference states that the sample result is different that is, greater or smaller than the hypothetical value of population.

A test of significance such as Z-test, t-test, chi-square test, is performed to accept the Null Hypothesis or to reject it and accept the Alternative Hypothesis.

INTERPRETING THE RESULT OF HYPOTHESIS

- The Hypothesis Ho is true - our test accepts it because the result falls within the zone of acceptance at 5% level of significance.

- The Hypothesis Ho is false - test rejects it because the estimate falls in the area of rejection.

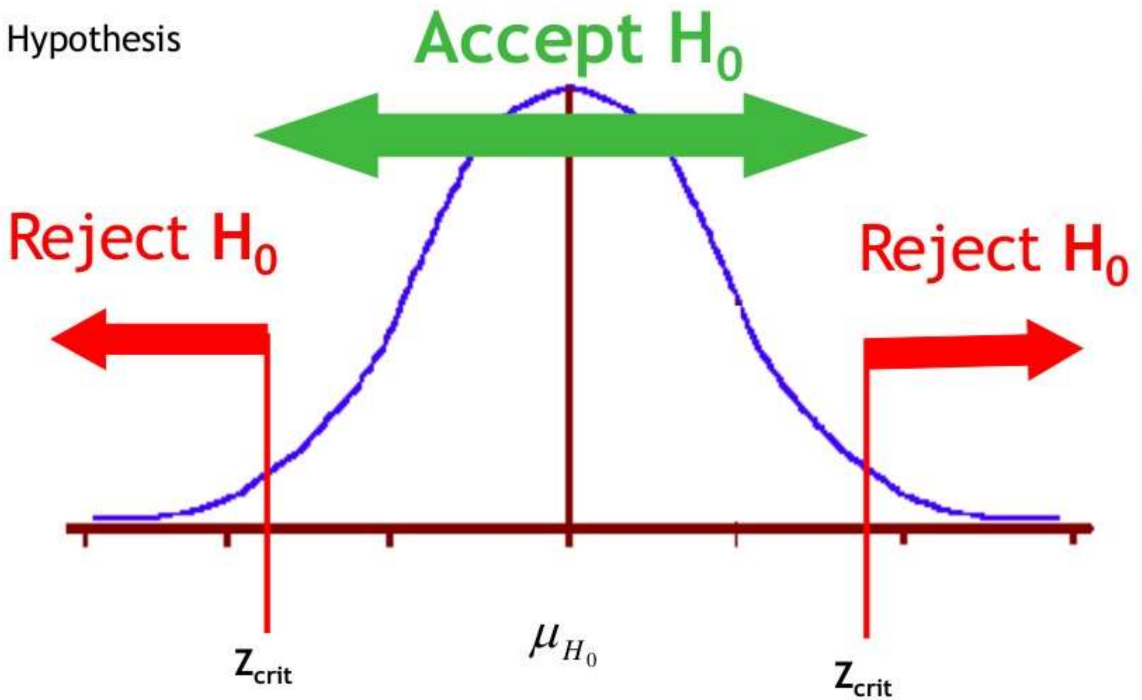
ZONE OF ACCEPTANCE & ZONE OF REJECTION

Zone of acceptance- If the results of a sample falls in the plain area i.e. within the mean+/-1.96 standard error the Null Hypothesis is accepted- the area is called zone of acceptance.

Zone of rejection-If the result of a sample falls outside the plain area, i.e. beyond mean +/-1.96 standard error, it is significantly different from population value. So Null Hypothesis is rejected and alternative hypothesis is accepted. This area is called zone of rejection.

Setting a criterion

Null Hypothesis



TYPE 1 AND TYPE 2 ERROR

When a Null Hypothesis is tested, there may be four possible outcomes:

i. The Null Hypothesis is true but our test rejects it.
ii. The Null Hypothesis is false but our test accepts it.
iii. The Null Hypothesis is true and our test accepts it.
iv. The Null Hypothesis is false but our test rejects it.

Type 1 Error – rejecting Null Hypothesis when Null Hypothesis is true. It is called 'α error'.

Type 2 Error - accepting Null Hypothesis when Null Hypothesis is false. It is called 'β-error'.

TYPE 1 AND TYPE 2 ERRORS IN TABULAR FORM

	Decision	
	Accept Ho	Reject Ho
Ho true	Correct decision	Type 1 error
Ho false	Type 2 error	Correct decision

POWER OF TEST

- The statistical power of a test is the probability that a study or a trial will be able to detect a specified difference . This is calculated as 1- probability of type II error, i. e. probability of correctly concluding that a difference exists when it is indeed present. Thus, power = **$1-\beta$.**

ONE-TAILED TEST

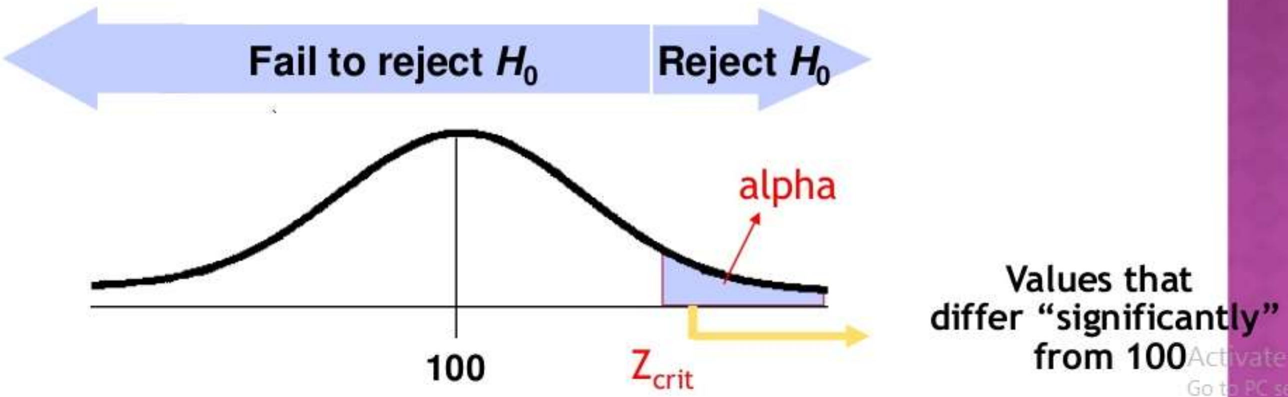
- If H_A states μ is < some value, critical region occupies left tail.
- If H_A states μ is > some value, critical region occupies right tail.

RIGHT-TAILED TEST

H_0: μ = 100

H_1: μ > 100

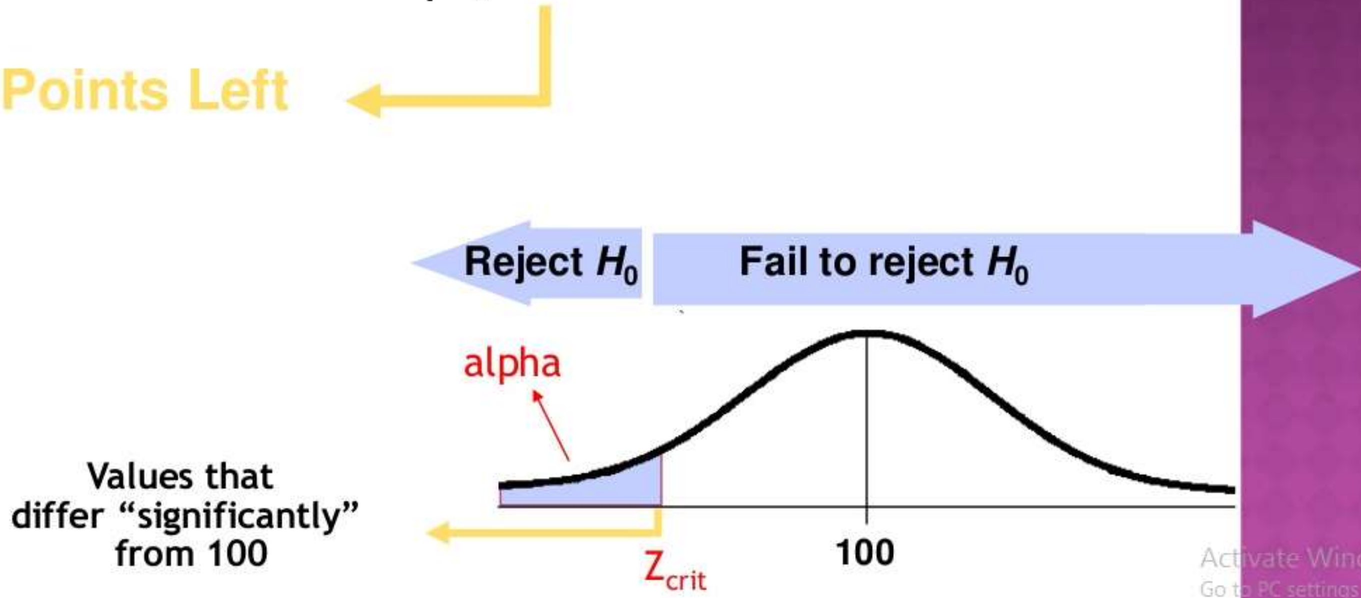
Points Right



LEFT-TAILED TESTS

H_0: μ = 100

H_1: μ < 100



TWO-TAILED HYPOTHESIS TESTING

- H_A is that μ is *either* greater or less than μ_{H0}

  H_A: $\mu \neq \mu_{H0}$

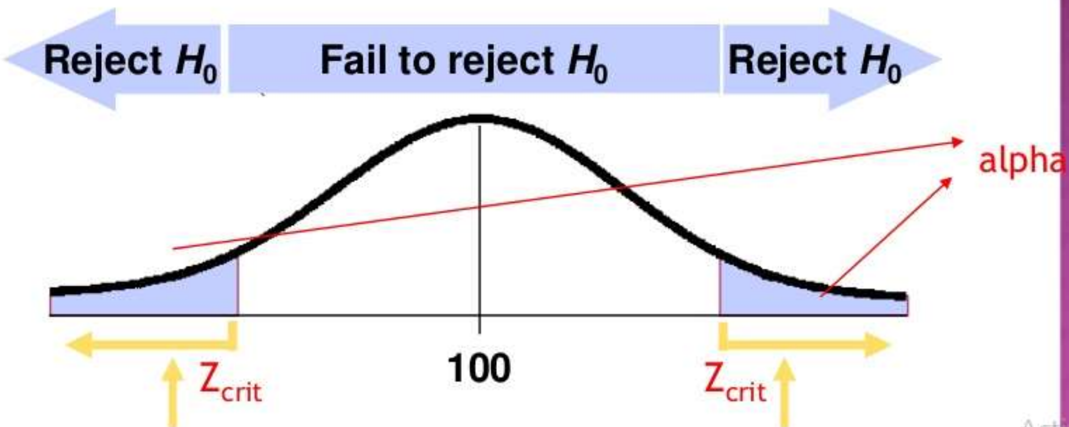
- α is divided equally between the two tails of the critical region.

TWO-TAILED HYPOTHESIS TESTING

H_0: μ = 100

H_1: μ ≠ 100

Means less than or greater than



Values that differ significantly from 100

EFFECT OF SAMPLE SIZE ON TEST

- With large n (say, $n > 30$), assumption of normal population distribution not important.

- For a given observed sample mean and standard deviation, the larger the sample size n, the larger the test statistic (because denominator is smaller) and the smaller the P-value.

- We're more likely to reject a false H_0 when we have a larger sample size (the test then has more "power")

- With large n, "statistical significance" not the same as "practical significance."

TEST OF SIGNIFICANCE

Test of significance is a formal procedure for comparing observed data with a claim (also called a hypothesis) whose truth we want to assess.

Test of significance is used to test a claim about an unknown population parameter.

A **significance test** uses data to evaluate a hypothesis by comparing sample point estimates of parameters to values predicted by the hypothesis.

We answer a question such as, “If the hypothesis were true, would it be unlikely to get data such as we obtained?”

PARAMETRIC TESTS- TYPES

- Students t- tests - A statistical criterion to test the hypothesis that mean is superficial value, or that specified difference, or no difference exists between two means. It requires Gaussian distribution of the values, but is used when SD is not known.

- Proportion test - A statistical test of hypothesis based on Gaussian distribution, generally used to compare two means or two proportions in large samples, particularly when the SD is known.

- ANOVA F-test - used when the number of groups compared are three or more and when the objective is to compare the means of a quantitative variable.

TYPES OF STUDENT T-TEST

- One sample– only one group is studied and an externally determined claim is examined.

- Two sample– there are two groups to compare.

- Paired– used when two sets of measurements are available, but they are paired .

EXAMPLE

There are 10 patients of arthritis. Suppose the reduction in pain after using newspirin is as follows on a 10-point visual analog scale:

0	3	6	1	1	4	0	2	1	5

Mean reduction, x = 2.3 points and SD, s=2.11.

By using the formula :

t = 2.3-3.0/(2.11/10^½)

= -1.049

n = 10, df = 10-1 = 9

For one-tailed $\alpha = 0.05$, and df = 9 , the critical value of t is 1.833

Since the calculated value 1.049 of t is less than the critical value 1.833, the Null Hypothesis that the mean reduction in pain is 3 point can not be rejected.

TWO SAMPLE STUDENT T-TEST STEPS

$$t = \frac{\text{Signal}}{\text{Noise}} = \frac{\bar{y}_1 - \bar{y}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

- Sp – is the pooled SD.

EXAMPLE

A study on 24-hour creatinine excretion in male and female healthy adults to examine if a difference exists. For our illustration ,we give value obtained for 15 subjects in group in table:

Men	16.6	19.8	17.1	15.6	20.3	24.7	18.5	17.6	22.0	24.9	18.4	16.9	21.1	17.0	23.3
Women	23.2	22.0	21.9	14.2	23.2	24.8	25.5	28.1	21.8	20.9	18.0	19.5	20.6	16.7	17.3

df = n1+n2-2 = 15+15-2 = 28

in men, y1 = 19.59 and s1 = 3.03

in women, y2 = 21.18 and s2 = 3.65

$s_p = \left[(15-1)x(3.03)^{\wedge 2}+(15-1)x(3.65)\ ^{\wedge 2} / 15+15-2\right]^{\wedge}½$

=3.35

Thus,

t = 19.59-21.18/3.35(1/15+1/15) ^½

= -1.59/1.2232 = -1.30

The critical value of t is 2.048, the calculated value is less than the critical value. Thus the Null Hypothesis of equality can not be rejected.

PAIRED T- TEST : STEPS

- Obtain the difference for each pair and test the null hypothesis that the mean of these differences is zero(this null hypothesis is same as saying that the means before and after are equal).
- For paired samples : $t = d/(Sd/(n)^{1/2})$

d : is the sample mean of the differences

Sd : is standard deviation.

EXAMPLE

Consider serum albumin level of 8 randomly chosen patients of dengue haemorrhagic fever before and after treatment. The value has been tabulated :

Before treatment	5.1	3.8	4.0	4.7	4.5	4.8	4.1	3.6
After treatment	4.8	3.7	3.8	4.7	4.6	5.0	4.0	3.4
Difference(d)	0.3	0.1	0.2	0	-0.1	-0.2	0.1	0.2

Mean difference, d = 0.6/8 = 0.075g/dl, and SD of difference, s_d = 0.17.

$t = 0.075/0.17/(8)^{\wedge}½ = 1.25$

df = 8-1 =7

The critical value of t is 2.365, since the calculated value is less, the null hypothesis of difference can not be rejected.

Z-TEST

Used for large Quantitative data (i.e. n>30) .

- Application: To find out Standard Error of difference between two sample means

  i.e. S. E. (X1 - X2)

  e.g. To find our significant difference between two different variables/groups i.e. Efficacy of two drugs, difference between two groups etc.

STEPS IN Z -TEST

- **State the Null Hypothesis i.e. H0 and its Alternative Hypothesis i.e. H1**
- **Find out the values of test statistic i.e. value of 'Z' as follows:**

$$Z = \bar{X}1 - \bar{X}2 \,/\, SE\,(\bar{X}1 - \bar{X}2)$$

where,

- **SE (X1 – X2)=** $\sqrt{(SD1)^2/n1 + (SD2)^2/n2}$

NON-PARAMETRIC TEST
CHI-SQUARE TEST

- Alternative to the test of significance of difference between two proportions

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

- O : Observed frequencies.
- E : Expected frequencies.

EXAMPLE

Do you know that prevalence of cataract is more in males or in females? Consider a study on prevalence of cataract in males and females of age 50 years and above. The results are as follows. Number of males examined (n1) = 60: found with cataract 37. Number of females examined (n2) = 40 : found with cataract 30. This is stated in a table format

Gender	Yes	No	Total
Male	37	23	60
Female	30	10	40
Total	67	33	100

Expected frequency = Corresponding row total X Corresponding column total / Grand total

=60x33/100 = 19.8

Applying the formula

$$x_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

=(37-40.2)^2/40.2+(23-19.8) ^2/19.8+(30-26.8) ^2/26.8+(10-13.2) ^2/13.2

= 0.2547+0.5172+0.3821+0.7758

= 1.93

The critical value of chi-square is 3.84 at 5% level of significance. Since the calculated value is less than the critical value, the Null Hypothesis can not be rejected.

ANOVA (ANALYSIS OF VARIANCE) F-TEST

- Situations where it is used are
- 1.in two sample situation
- 2. in paired set-up
- 3.in repeated measures, when the same subject is measured at different time points such as after 5 minutes, 15 minutes, 30 minutes, 60 minutes etc,.
- 4.removing the effect of a covariate
- 5. regression.

$$F = \frac{\text{explained variance}}{\text{unexplained variance}},$$

$$F = \frac{\text{between-group variability}}{\text{within-group variability}}.$$