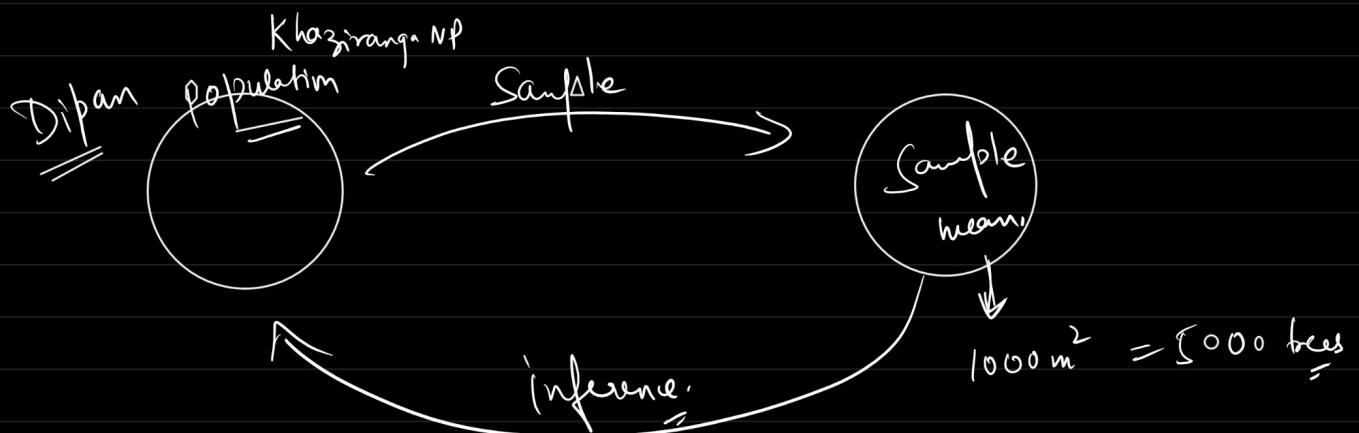


Agend
→ Hypothesis testing

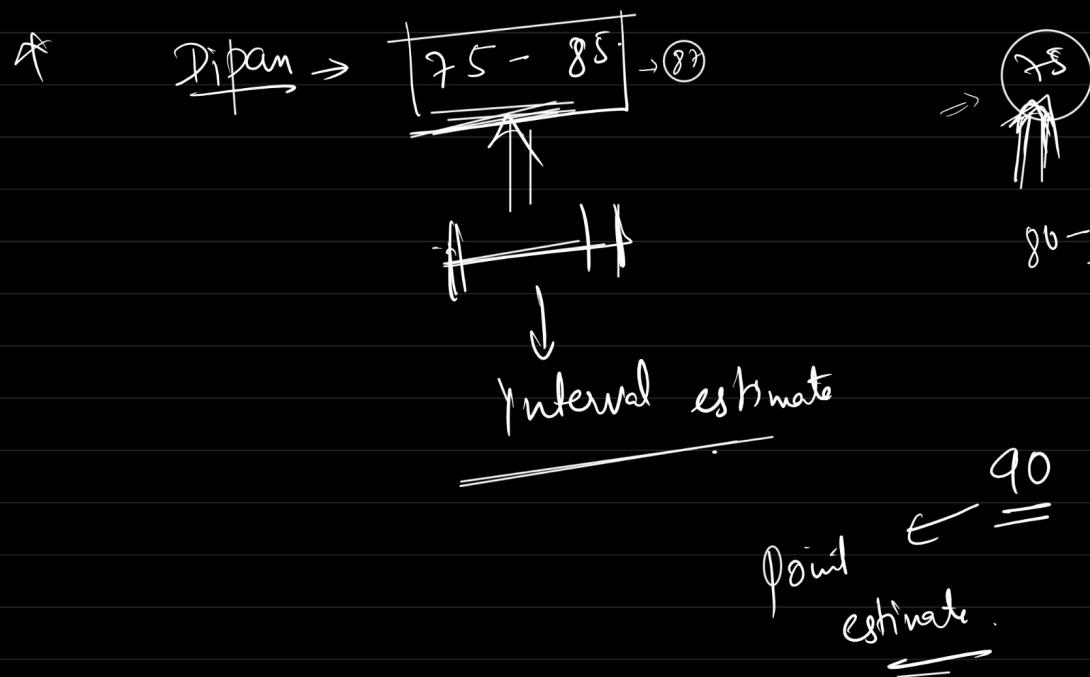
Till now
→ descriptive stats
→ Correlation / covariance
→ Prob., Prob dist
→ Pdf, Pmf
→ Hypothesis testing

* Hypothesis

India-Pakistan
→ Stat Prob Iran
II
Statistics
II
Statistics \Rightarrow {
Hypothesis: \hat{A} India 200
 \hat{A} 34%, 90%
Chance \hat{E} }
Inferential Statistics:



* I believe that the no
of bees on an average here is
5000 per 1000 m^2 , 95% confidence



* Hypothesis \rightarrow Hypothesis is a

<u>claim</u>	<u>predictive</u>	<u>generic</u>
<u>statement</u>	<u>capable</u>	<u>being</u>
<u>tested</u>	<u>by</u>	<u>scientific</u>
<u>=</u>	<u>=</u>	<u>=</u>

method.

eg India is going to win next t-20 match.

eg Consumption of Ice-cream sales increases in a summer.

eg There is tons of water on Pluto. X

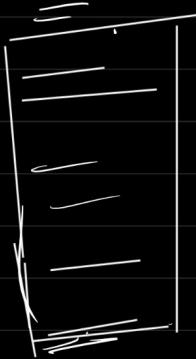
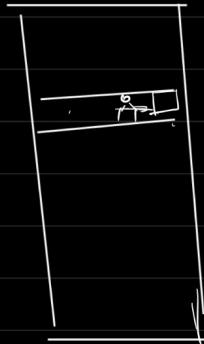
eg In Patall lok, Shesh Naag leaves X

eg Swarlok \rightarrow we will go when ~~we~~ die

Dibam

Peltitte

PwC



➤ Average age of
PwC Employees
is 45 years

➤ Razi → A sample of 20 people were picked.
Aagam → 20 people → Sample Stats 62 years
Adieeb. → 2000 people. Sample Stat = 49 years.

* Framing of hypothesis

Null hypothesis. Alternative hypothesis.

equals to sign

Opposite of H_0

Statement ⇒ Avg age of PwC Employees is 45 years

$H_0: \bar{X} = 45$

$H_A: \bar{X} \neq 45$

$$H_0: \text{Mage} = 45$$

$$H_A: \text{Mage} \neq 45$$

* Avg age of people in PwC is greater than 45 years



* Whichever statement has equals to sign that will be your H_0

$$\begin{array}{ccc} & \swarrow & \searrow \\ \text{Mage} \geq 45 & & \text{Mage} \leq 45 \\ \downarrow & & \downarrow \\ H_A: \text{Mage} \geq 45 & & H_0: \text{Mage} \leq 45 \end{array}$$

Q Suppose a child psychologist says that the avg time working mother spend talking to their children is upto 11 minutes per day. To test hypothesis, you conducted an experiment with random sample of 100 working mother and find they spend 11.5 minutes per day.

Assuming the std dev is 2.3 min of pop. conduct the test with 5% level of significance.

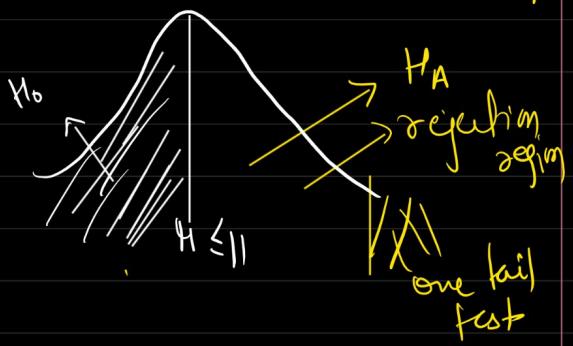
Step-1 $H_0: \mu \leq 11$

$H_A: \mu > 11$

$\mu \leq 11, \mu > 11$

$\neq \rightarrow$ one tail test

Step-2 level of significance = 5%, 0.05, one tail test.



Step-3 type of test: $\rightarrow Z$ test.

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

one tail test

$$= \frac{|1.5 - 1|}{2.3 / \sqrt{100}} = 2.17$$

if $S.S \geq 130$ & pop is given, then Z test
else t test.

Step-4 Zcritical

$$\alpha = 5\%$$

$$\hookrightarrow Z_{\text{critical}} \alpha = 0.05$$

Step-5 $2.17 > 1.64 \Rightarrow$ reject the H_0 .

Q. A factory manufactures the bulb with an avg warranty of 5 years with $\sigma = 0.50$

A bulb malfunctions in less than 5 years is a claim given by a worker.

To test the claim a sample of 40 bulbs were taken and avg time of bulb is 4.8 years

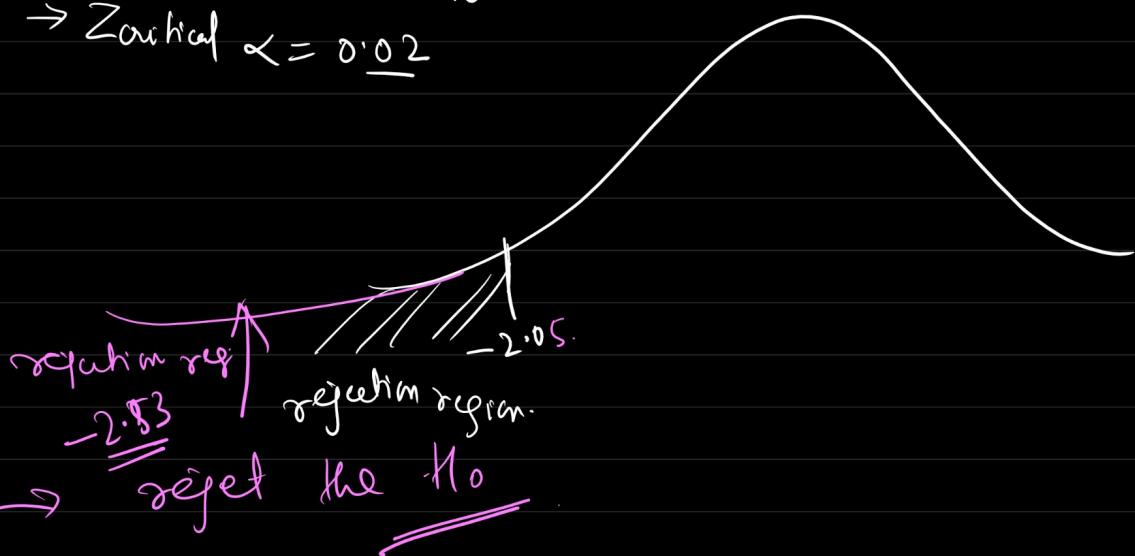
2.1. significance level test the hypothesis.

Step-1 $\rightarrow H_0: \mu = 5, H_A: \mu < 5$.

Step-2 $\rightarrow \alpha = 2.1 \rightarrow$ 1 tail test.

$$\underline{\text{Step-3}} \rightarrow Z_{\text{Score}} = \frac{4.8 - 5}{0.5} / \sqrt{40} = -2.53$$

Step-4 $\rightarrow Z_{\text{critical}} \alpha = 0.02$



Step-5 \rightarrow reject the H_0

Q A complain was registered, the boys in a primary school is Underweight. Avg wt of boys of age 16 is 32 kg with $S_d = 9$ kg. A sample of 40 boys was selected from school and the avg weight was found to be 29.5 kg. with $\alpha = 0.05$, check whether its true or false.

$$\rightarrow \text{Step-1} \quad H_0: \mu = 32 \quad (\mu = 32), \sigma = 9 \text{ kg}, n = 40,$$

$$H_A: \mu < 32$$

Step-2 $\alpha = 0.05$, Z test, one tail

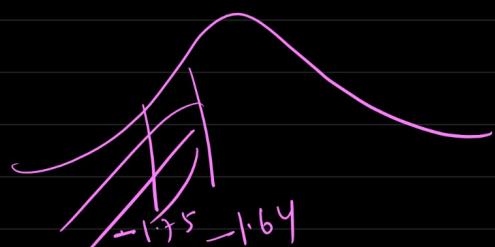
$$\bar{x} = 29.5$$

$$\alpha = 0.05$$

$$\text{Step-3} \quad Z_{\text{stats}} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = \frac{29.5 - 32}{9 / \sqrt{40}} = -1.75$$

$$\text{Step-4} \quad Z_{\text{crit}} \alpha = 0.05 = -1.64$$

Step-5 \therefore reject the H_0



t-test A battery manufacturer company manufactures batteries with life span of 2 or more years. An Engineer believes this value is less. 10 samples he measured and the avg life span he found to be 1.8 years with Std of 0.15. test the hypothesis with 5% level of significance.

$$\rightarrow ① H_0: \mu \geq 2, H_1: \mu < 2$$

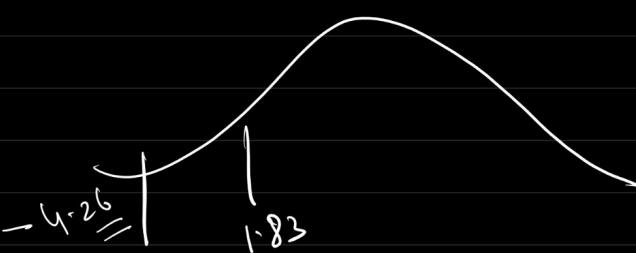
② $\alpha = 0.05$, one tail test

③ $S.S < 30 \rightarrow$ So + - test

$$t_{\text{stats}} = \frac{\bar{x} - \mu}{S / \sqrt{n}} = \frac{1.8 - 2}{0.15 / \sqrt{10}} = -4.216$$

$$④ t_{\text{critical}} \alpha = 0.05, \text{dof} = 9, 1 \text{ tail test}$$

$$\begin{aligned} df &= S.S - 1 \\ &= 10 - 1 \\ &= 9 \end{aligned}$$



rejection region

\therefore reject the H_0

Chi-Square test

In 2010 census of the city, the weight of people in a city were found to be follows:

	< 50kg	50-75kg	> 75kg
20%			

In 2020 wt of 500 people were sampled.

$\alpha = 0.05$, conclude if pop has changed or not?

	< 50	50-75	> 75
140			
160			
200			

H_0 : the data is as per expectation
 H_A : the data is not as per expect

$$② \alpha = 0.05$$

$$③ \chi^2_{\text{start}} = \sum \frac{(O - E)^2}{E}$$

$$= \frac{(140 - 100)^2}{100} + \frac{(160 - 150)^2}{150} + \frac{(200 - 280)^2}{250}$$

	< 50	50-75	> 75
<u>observed</u> →	140	160	200
<u>Expected</u> →	100	150	250
	0.2×500	0.3×500	0.5×500

$$④ \chi^2_{\text{critical}} \text{ dof } = 3-1 = 2$$

$$\Rightarrow 28.625$$

$$\alpha = 0.05$$

$$\Rightarrow 5.99$$

Step-5 $\chi^2 > \chi^2_{\text{cr}} \rightarrow \underline{\text{reject H}_0}$



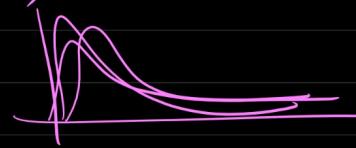
* F test

↳ F dist

↳ compare variance

$$F_{\text{start}} = \frac{s_1^2}{s_2^2} \left(\frac{\text{Variance of } s_1}{\text{Variance of } s_2} \right)$$

↳ Positive



* F test

radius of Tomatoes from field A and field B are given below:-

Group A: 16, 17, 25, 26, 32, 34, 38, 40, 42

Group B: 14, 16, 24, 28, 32, 35, 37, 42, 43, 45, 47

$\text{Var A} = \text{Var B}$ is statistically significant

→ Step-1 $H_0: \text{Var A} = \text{Var B}$, $H_A: \text{Var A} \neq \text{Var B}$

Step-2 $\alpha = 0.05 \rightarrow F \text{ test}$

Step-3 $F_{\text{statistic}} = \frac{\text{Var A}}{\text{Var B}} = \frac{91.75}{129.8} = 0.7068$

Step-4 Critical

$$df_1 = 9 - 1 = 8 \quad df_2 = 11 - 1 = 10$$

$$F_{\text{critical}} = 3.07$$



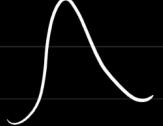
(3)

fail to reject H_0

$\uparrow 0.2 \quad \sqrt{3.07}$ rejecting H_0

~~ANOVA~~

$S > 30 \Rightarrow z\text{ test}$
 $S < 30 \Rightarrow t\text{ test}$
Cont $\rightarrow \chi^2\text{ test}$
Varia - f test
Two mean \rightarrow ANOVA

z test, t test \rightarrow 
f dist \rightarrow 