Hypothesis Testing 16 Feb

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Defining Null and Alternate Hypotheses →

Claim → Apollo Tyres claims that the average life of their tyres is more than 30 months. → PM

Null Hypothesis: Average life <= 30 months.

Null Hyp. contains → =, <=, >=

Alternate Hypothesis: Average life > 30 months

Alternate Hyp. contains: ≠, >, <

Hypothesis Testing can consist of 2-sided hypothesis or 1-sided hypothesis

Ex → Suppose if a company claims that the life of its product is exactly 20 months.

$H_0 = 20$ months , $H_A \neq 20$ months

No

51M

500

SS

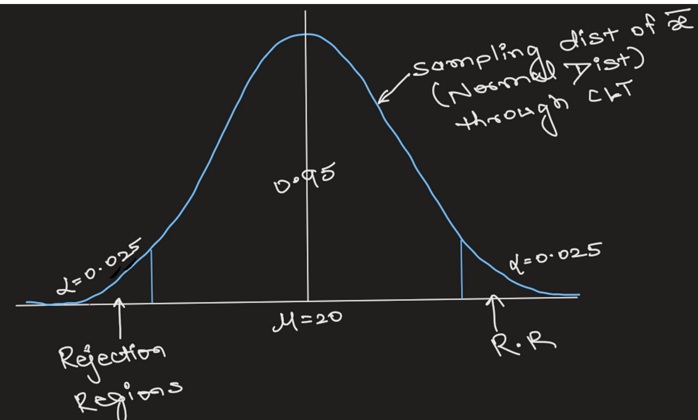
1. 28
2. 27.2
3. 31
4. 30.5

⋮

500

sample data

SM = 29.5

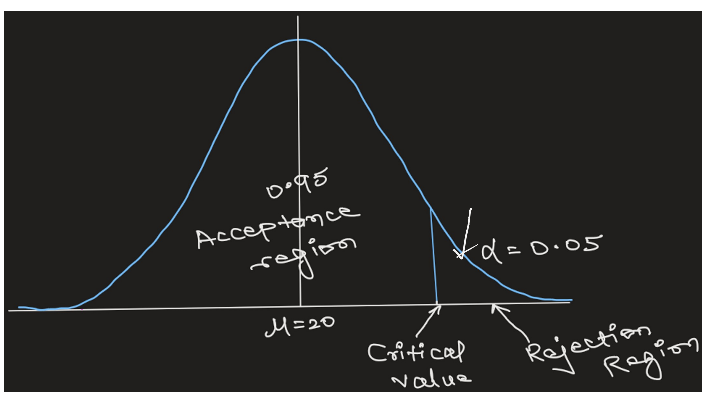


Note: Here the significance level is taken $\alpha = 0.05$, but since it is a two sided hypothesis and rejection region has to be on both sides equally so,

$$\alpha = \frac{0.05}{2} = 0.025 \text{ (each side)}$$

Ex 2 → One-sided hypothesis

$H_0: \mu \leq 20$ months , $H_A: \mu > 20$ months



Steps in Hypothesis Testing →

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① Defining/Formulating the Null and Alternate Hypothesis.

② Mention the significance level.

$\alpha = 0.05$ (most common)

Note: If we have very small sample size then we can take α to be 0.10.

→ If we have a very large sample size the we can take α to be 0.01 or 0.02 or 0.03.

③ Run the Hypothesis Tests to collect the evidence against the null hypothesis.

Z-test, T-test, Chi-square Test, ANOVA Test.

④ We get the evidence from these tests in the form of 'p-value'

⑤ To reject the Null Hypothesis

$\boxed{\text{p-value} < \text{significance level } (\alpha)}$

Inferential:

We were interested to find Population Mean but it is not easy to calculate so we take sample then calculate sample mean and finally we use sample mean to infer the population mean with some margin.

Hypothesis Testing:

Here we solve those business case in which population mean is given, but before we

Here we solve those business case in which population mean is given, but before we trust it, we test it.

CI = SM ± Margin

= 29.5 ± 1

= 28.5 to 30.5

95%
90%
99%

PM

PM ≥ 30

PM

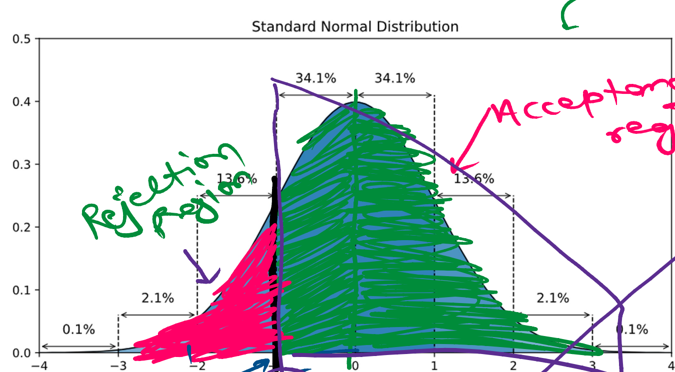
Through CLT

SS ≥ 30

500 Tyres
SS

Yes

SM = 31.8



Acceptance region

Rejection region

26 Months

29 Months

28.5 30

Critical value ≥ 28.5

One-tailed test

~~PM ≥ 30~~

Sample 500

SM = 31.8

29.5

Lays
QCA

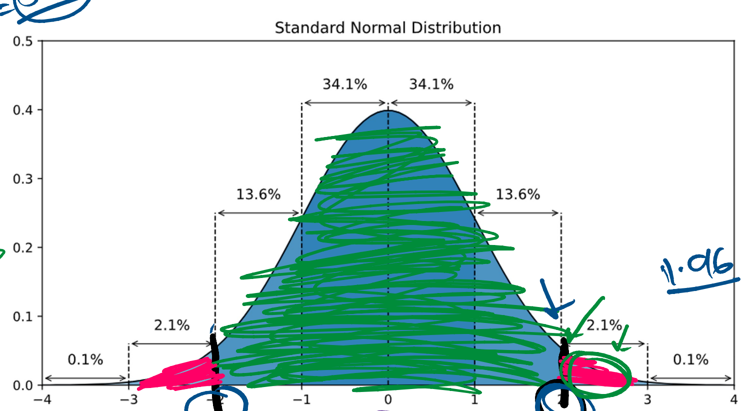
Rs10

50 gms chips
PM

57 gms

44 gms

Rejection Region = 5%



Z-Score
Z-values

Two-tailed test

1.96

0.975

97.5%

50

Critical value

Critical
SS

critical value

critical

ss

1 47.6

2 52.1

3 49.1

200 50

Sm = 48.1 gms

50 gms

pm

200 Lays Packet

10 Rs

≥ 30

Significance Level →

→ claim

Reject it → NH & AH

Sample Data (to find evidence against Null Hyp)

Run some tests on the sample data

The test will provide the proof whether we should reject the Null Hyp or not.

Rejection Region Method (critical value)

p-value method (p-value) (New)

will help us decide whether we have enough proof against Null Hypothesis to reject it or not.

Person → Court → Policemen

Null Hyp: Person is innocent] ← Reject this

Alternate Hyp: Person is guilty

100 → witness

60%

Against NH → 60 → Guilty

Favour of NH → 40 → Innocent

Reject 95 → Guilty (Against NH)

Reject the Null Hypothesis →

95 → Guilty (Against NH)

5 → Innocent (Favour of NH)

There's still 5% chance that we are rejecting the Null Hyp. when it should have been actually accepted.

5%

Significance Level

(Possibility of making error while rejecting NH)

↓

We are ready to make 5% error $\boxed{\text{max}}$ while rejecting Null Hypothesis.

Z-test   T-test   Chi-squared Test   ANOVA

↓

Sample Data → Proof whether we should reject the Null Hyp or not.

↓

p-value or critical value

↓

(0-1) (0.03) or (0.57)

The p-value is the probability that the Null Hyp. is True.

or

The p-value is the evidence in the favour of Null Hypothesis (recieved from test applied

The p-value is the evidence in the favour of Null Hypothesis. (recieved from test applied on the sample data).

Note: To reject the Null Hypothesis

$$\boxed{\text{p-value} < \text{significance level}(\alpha) \quad (5\%) \; (0.05)}$$

(3%) 0.03 < 0.05

Favour of NH

Reject the NH →

97% → Against

Problem statement for Z-test:

Suppose a company is evaluating the impact of a new training program on the productivity of its employees. The company has data on the average productivity of its employees before implementing the new training program. The average productivity was 50 units per day with a known pop standard deviation of 5 units. After implementing the training program, the company measures the productivity of a random sample of 30 employees. The sample employees have an average productivity of 53 units per day. The company wants to know if the new training program has significantly improved the productivity of the employees.

Rejection Region Approach or the critical value approach:

1. Formulate the Null and Alternate Hypothesis
2. Select the Significance Level(5%).
3. Collect the Sample Data.
4. Check the assumption of the data and then decide which test will be applicable on the data.
5. Decide the appropriate test among Z-test, T-test, Chi-Squared Test, ANOVA.
6. State the relevant test statistic
   a. Z-statistic for Z-test
   b. T-statistic for t-test
   c. Chi-square statistic for chi-square test
   d. F-statistic for ANOVA test
7. Conduct the test
8. Reject or fail to reject the Null Hypothesis.

Z-score of SM

Z-test assumption

Z-test assumption

1. Normally Distributed → Shapiro-wilk Test
   CLT
2. Sample size ≥ 30
3. Pop. Std dev is given.
4. Sample should collected randomly.

PSD = 5 (σ) (sigma)

Ss = 30 (n)

PM = 50 (μ) Mu

SM = 53 $(\bar{x})$

NH $(H_0$ or $H_N)$: Average Productivity = 50 units.

AH $(H_1$ or $H_A)$: Average Productivity $>$ 50 units.

$$Z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}} = \frac{53 - 50}{5 / \sqrt{30}} = \frac{3}{5/\sqrt{30}}$$

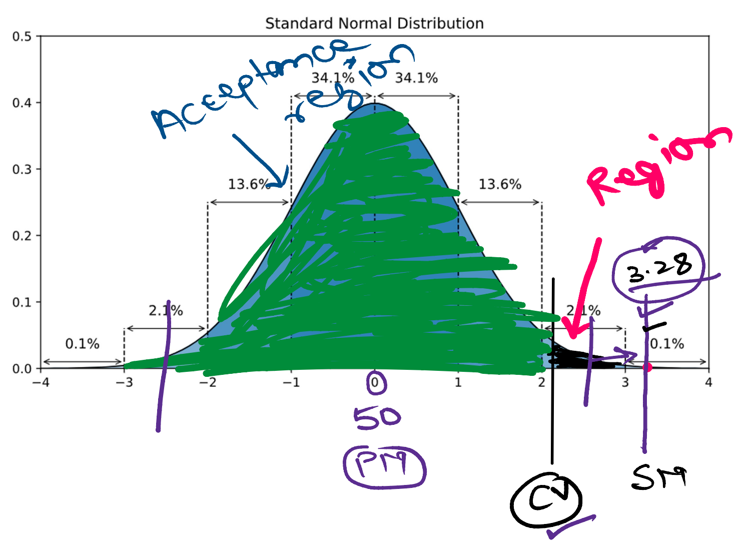
$$= 3.28$$

Z-statistic

(Z-value for 53)

50

SM < 50



SL = 5%

5%

We can reject the Null Hypothesis.

One-Tailed Test → Rejection Region either on left or on right.

Two-Tailed Test → Rejection region on both sides

Z-test

SS ≥ 30

Nor. Dist.

Pop std dev

$Z = \frac{\bar{x} - \mu}{\;}$

T-test

SS < 30 or

SS ≥ 30

Shapiro wilk test

(2) ND

(3) Will use sample std dev.

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

Normal Dist

Sample std dev.

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

t - distribution

Numerical Data

Pop → Sample

One Sample

One sample Z-test

One sample t-test

Two - Sample

Two sample z-test

Two sample t-test

More than two samples in Num Data

ANOVA Test

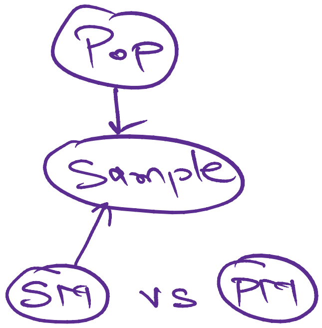
Categorical Data

Chi- squared Test of Independence.

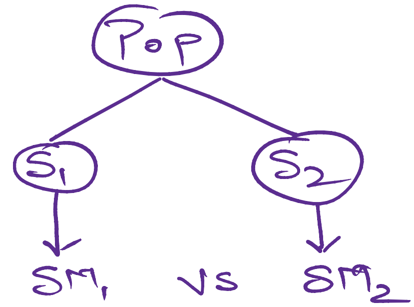
T-test

- One sample t-test
- Two sample t-test

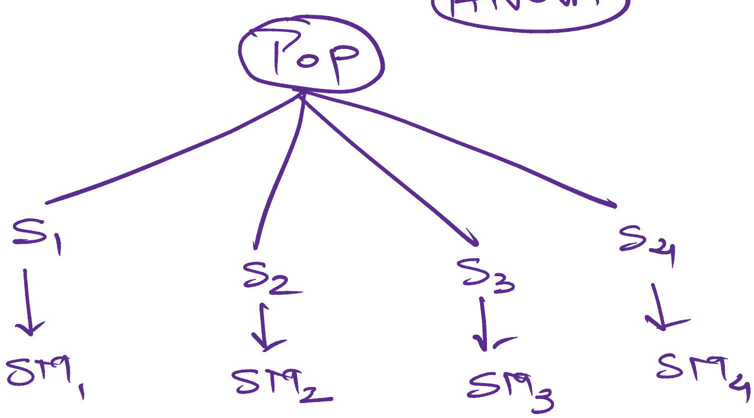
t-test



t-test



ANOVA



One-way ANOVA

Two-way ANOVA

Starbucks

200

Gender	Beverage Preference?
M	Tea
F	Coffee
F	Tea
M	Tea
M	Coffee
F	Coffee
F	Tea.