(logic) —(DS) = (Desc p) (Stats)

{ ① MCT - Mean/ median/ mode }
{ ② Var / std-dev }

(Mean) ⇒ (graph)

(Problem)

$(\bar{x})$

0 1 2 3 4 5 6 7 . . . .

(Mean) info

(Mean) — $\bar{x}$

-4 0 → 4 (S)

-6 0 → 6 (SL)

-8 0 → 8 (L)

(spread)

(5 3 7 - 9 10)

(Analysis)

(Variance) = $\boxed{\dfrac{\sum (x_i - \bar{x})^2}{n-1}}$

Sample

2 3 4 5 6

2 ← [2, 4, 6] = $\boxed{\bar{x} = 4}$

$$\frac{(2-4)^2 + (4-4)^2 + (6-4)^2}{2} = \frac{(-2)^2 + 0 + 2^2}{2}$$

$$= \frac{4+4}{2}$$

$$= \frac{8}{2}$$

$$= 4$$

(love) = $\frac{a}{a}$

(Quantification)

→ I love you 3000

→ " " " 8000

— " " 19000

✗ [2, 3, 9] = 3.6

✓ [1, 3, 19] → (1, 3, 19)

V = 8.3

Pun...

bias

① [1 7 9 10]

② [2, 7, 15, 20]

(why) ?

V

V ...

m | std

CI

① 3 GB
② 3 GB } Compress

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

$$Std = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} \rightarrow \text{Same}$$

$V_1 = 10{,}000 \rightarrow V_1 = 100$

$V_2 = 100 \rightarrow V_2 = 10$

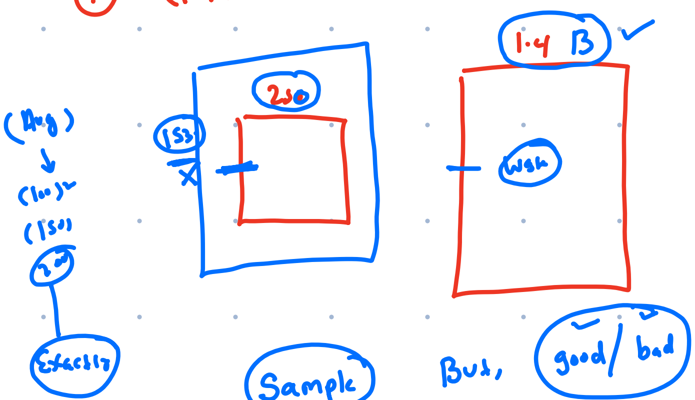
$\boxed{V_1 > V_2}$ $\boxed{V_1 > V_2}$

① (Pop) = diff sizes ?

(pop) large / small

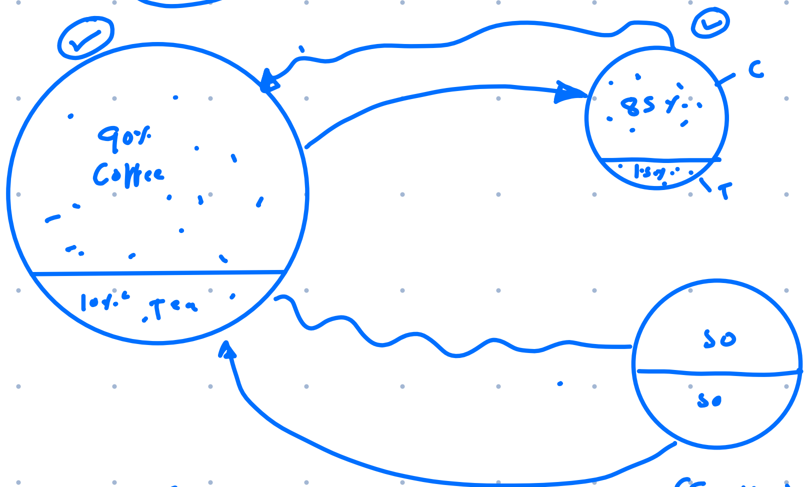
Yes

(pop_mean)
(pop_std)
(pop_ros)



Sample But, good / bad

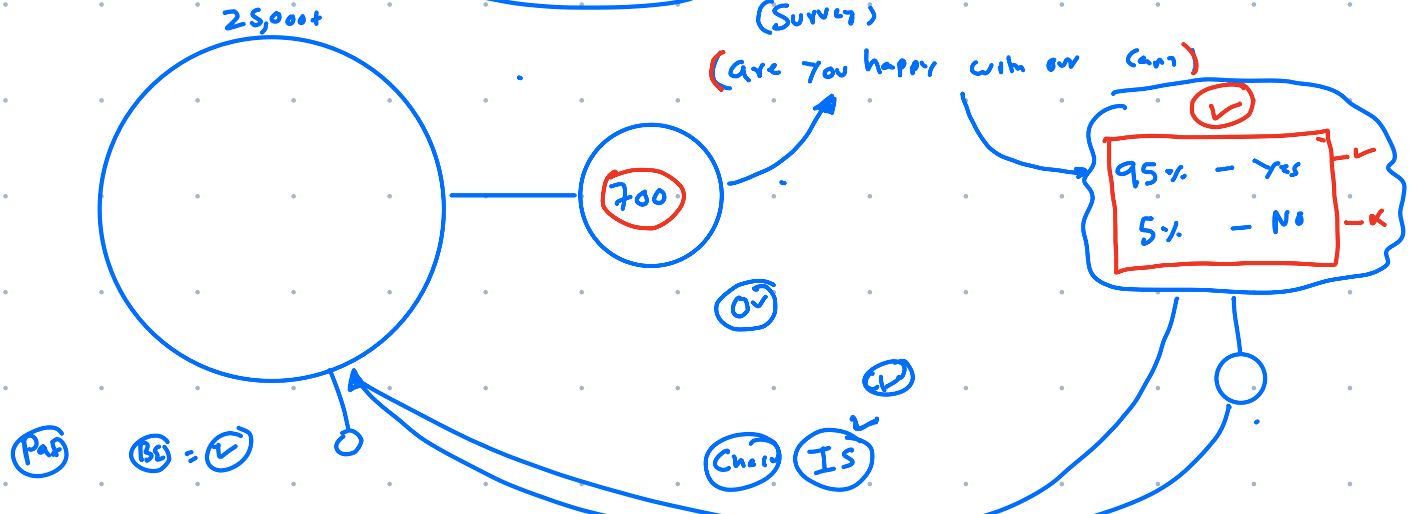
representive Samp



biased Sample

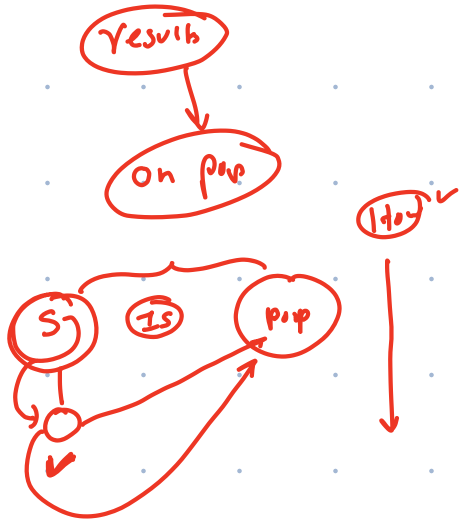
(Survey)

(are you happy with our cars)



~~While descriptive statistics describes the data,~~ inferential statistics is used to draw conclusions about the population based on statistical findings on sample analysis.

Ex



CI

(3.9 #) = Int

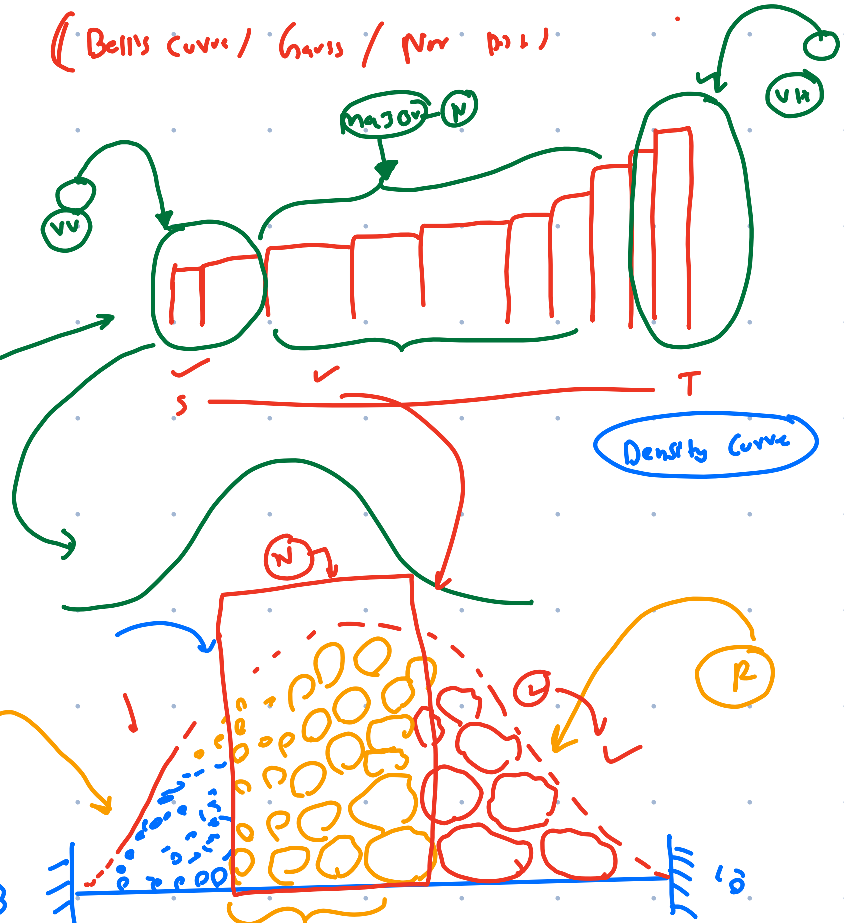
(Bell's curve / Gauss / Nor Dist)

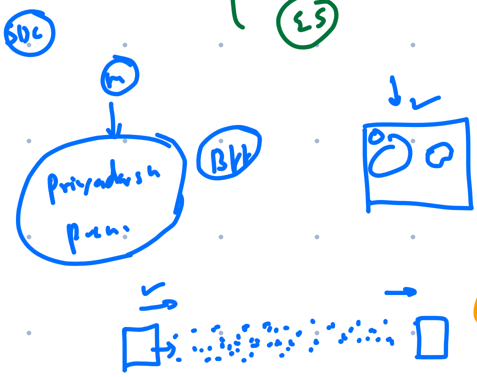
(Village) (200) → (height)

Shot

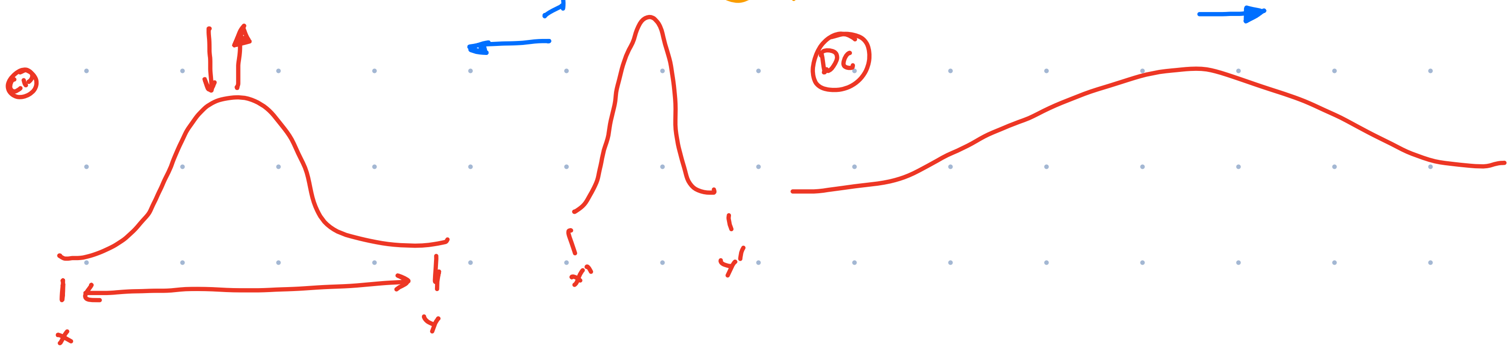
Pattern

(height) (wei) (wen) n ES

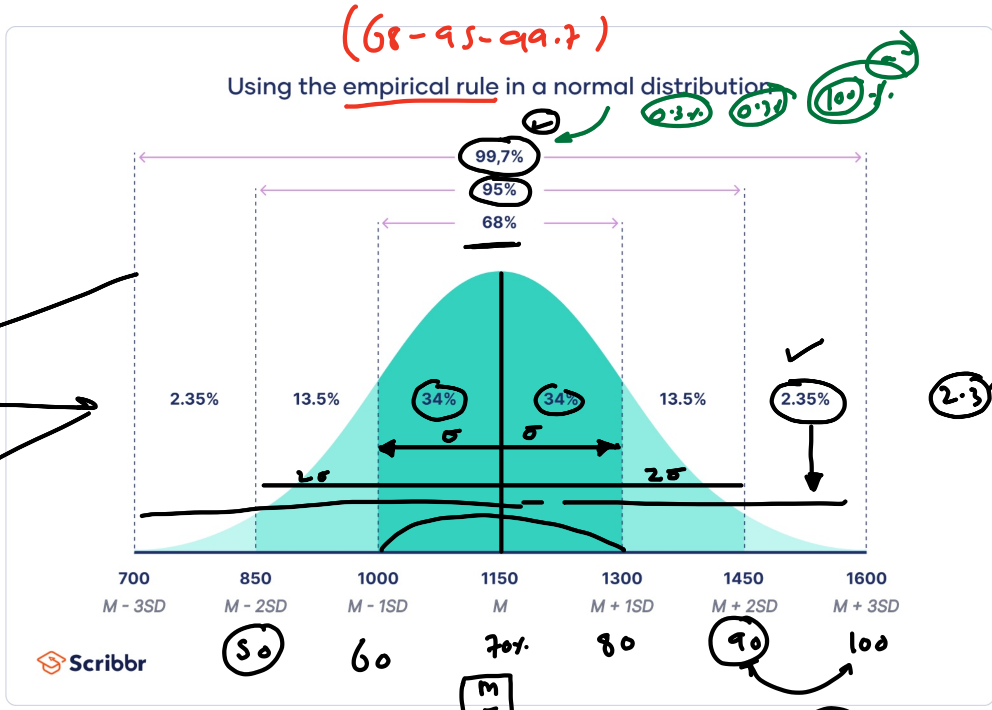




DC



(68 - 95 - 99.7)



100

$\bar{x} = 70\%$

$\sigma = 10$

2.3

%

$68 = (60 - 80)\%$

60

M = M = M

M + 5

70 + 10

80

M

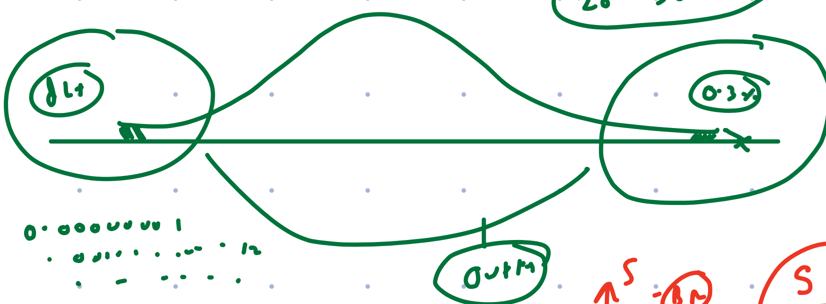
95

(BQ)

(99.7% why) — 100%

(Asymptotic ...)

25 35 45 — 100



0.000000001

$\uparrow s$ — BR

$\frac{s}{\sqrt{n}}$

$\{ CI = \bar{x} \pm z \cdot \frac{s}{\sqrt{n}} \}$

$\bar{x}$ = Sample mean

$z = Z$ _ Critical Value / Z_Score

S = Std _ Dev

n = Sample Size

CI = don't Calculate / assume

$CI = \bar{x} \pm z \cdot \frac{s}{\sqrt{n}}$

Margin of Error

Clear

Upper Bound

lower Bound

$UB = \bar{x} + z \cdot \frac{s}{\sqrt{n}}$

$LB = \bar{x} - z \cdot \frac{s}{\sqrt{n}}$

Ex — Def

1.4 Bharti's (Avg Cons of protein by Indians) = 1.4 — 5,00,000/-

5,00,000/- — guess

A random sample of 55 males were taken and they show that their average protein consumption is 122 g of protein with a standard deviation of 14 g at 95% confidence interval, can you calculate the range?

Z — 95% UB LB

A random sample of 55 males were taken and they show that their average protein consumption is 122 g of protein with a standard deviation of 14 g at 95% confidence interval, can you calculate the range?

99% (Yes)

YES

$\bar{x} = 122$ grm

$n = 55$

$s = 14$

Z = Z-table (1.96) 2.57

1.96

Clear

z

SS

$$UB = \bar{x} + Z \cdot \frac{s}{\sqrt{n}}$$

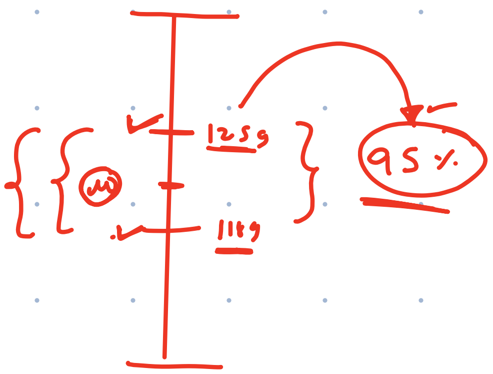
$$= 122 + (1.96)\left(\frac{14}{\sqrt{55}}\right)$$

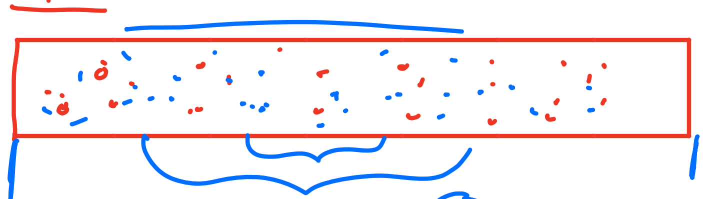
$\boxed{UB = 125g}$

$$LB = \bar{x} - Z \cdot \frac{s}{\sqrt{n}}$$

$$= 122 - (1.96)\left(\frac{14}{\sqrt{55}}\right)$$

$\boxed{LB = 118\ g}$

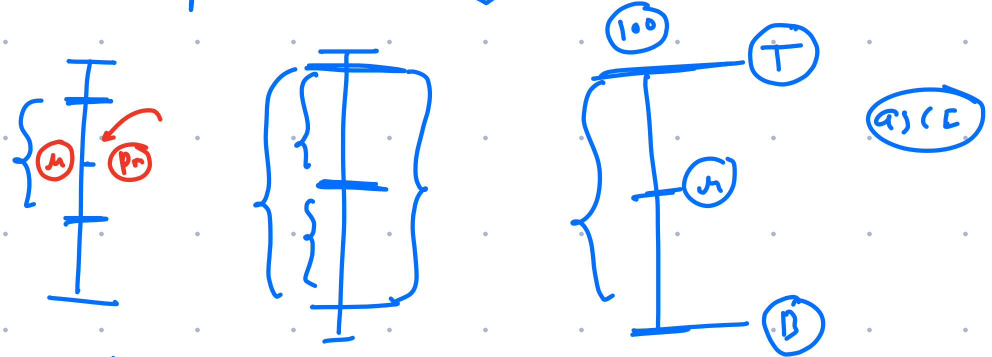




95 = c

5% = v

less



CI — Statistical range..

A confidence ~~central wall~~ is a statistical range with a specific probability that a population parameter will fall within. It represents the uncertainty in the calculation of an estimate and is expressed as a percentage usually given in the range of 95, 92,99, 93, 9468, it could be any range.

95%

5%

500 × (0.30) = 150

(CI) :

(Hyp test)

(assumption)

Mani — Same (H_0)

Nanda

mani — Not Same (H_a)

(Taking assumpt)

① H_0 : Null

② H_a : Alternate

(H_0) — Null ⟶ (No change)

(H_a/H_1) = Alternate ⟶ (Change)

Ex : Survey 2019, Avg sweet 23g

2025, 55 ⟶ 48g

H_0 : Avg(μ) = 23g

H_a : Avg(μ) ≠ 23g

(>, <)

(Stand)

Ex

(Choc) — Bar = 100 grams

50,000/- → 600 → 99.25 grams

$H_0 : (\mu) = 100g$

$H_a : (\mu) \neq 100g$

(>, <)

Ho	Ha
Ha	Ho

=> Ho

Ha — H_1

Ho
H_1 / Ha

HT

P → Ho, Ha } apply Test → Ho | Ha

Ho → Accepted / Rejected

2

Ho − T	Ho − F
Ha − F	Ha − T

Ho → Ha

P → Ho, Ha → T 2 F

Ho − Accepted ✓	Ho − Rejected
Ha − Rejected ✓	Ha − Accepted

m n) = p

Nohh

Namaste folks,

lets start in 2-4 minutes

(Errors) in (HT) — (wrong) → (rising)

(Ground truth) => (actual reality)

Pred / Calc

IS → 100%

deepak (R)

kind
nice

(Ankit)

hot kind
rude

Assump

(R) (P)

✓ ⟷ ×

✓	— ✓

Sarah — Pd

kind
nice

Pat

✓ FT Pl ~ Cap = ✓

+
+

−
−

m) c

id

id

Co ✓

Cr ✓

+
−

−
+

Clr

Pat : + Doc : + (True positive)	(Pat : −) (Doc : $\boxed{+}$) → 14 alone [False positive) Error] → [Type-1 / α / FPE]
Pat : $\boxed{+}$ Doc : $\boxed{-}$ = 100 [False Negative Error] (Type-2 / β / FNE)	Pat : − Doc : − (True Negative)

MI (FNF) D = MI

dat =

T I / II

Don

jdan

Cn ↓

Guy : + Judge : + TP	Guy : − Judge : +
Guy : + Judge : −	Guy : − Judge : − TN

1.1

PS =>

2019 - IT - 32,000/-
2024 → 45,000

H0
Ha

→ (Ha)

↓ (H0)

1 One

PS < Ho, Ha → T / I / β / α → Ho | Ha

Ha - True

PS

(Pred)	Null Hypothesis is TRUE	~~Null Hypothesis is FALSE~~
Reject null hypothesis	Type I Error (False positive)	Correct Outcome! (True positive)
~~Fail to reject null~~ Accept hypothesis	Correct Outcome! (True negative)	Type II Error (False negative)

Real	Pred	Real
Ho - T	Rej- Ho	Ha - T
Ho - T	Ho - T	

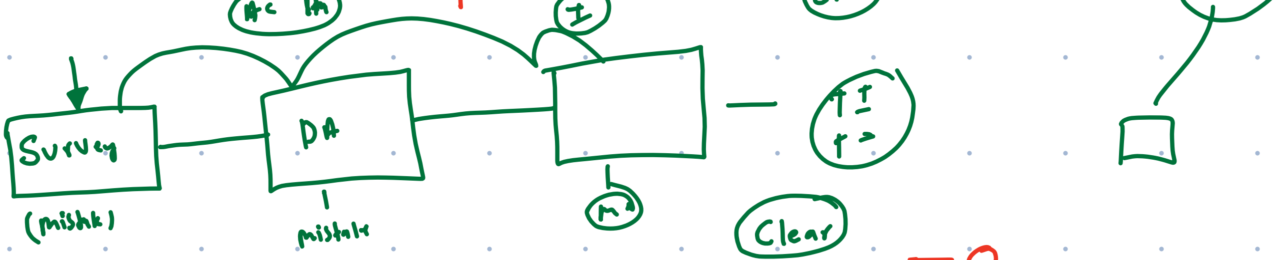
Ha ✓

(Reality)

idea

PS

(Pred)	Ho - True	Ha - True ✓
Accept Ho	✓	X - TS
✓ Reject Ho (Ac Ha)	X (I)	✓



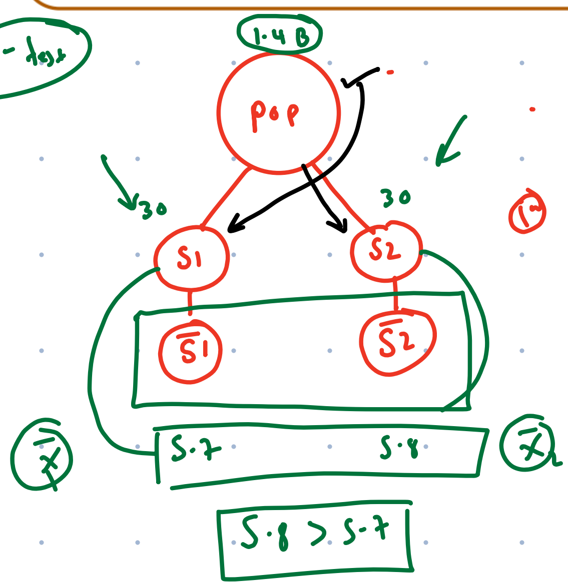
(T- test)

CI =

{T-test is a parametric test that compares the means of the two samples. group

~~Ideally, a sample for t test should have less than 30 values. There are a few other assumptions that are taken before we can conduct a t-test.~~

T- test



$\bar{S}_1 > \bar{S}_2$

$\bar{S}_2 > \bar{S}_1$

$\bar{S}_1 \approx \bar{S}_2$

$\bar{S}_1 = \bar{S}_2$

$\bar{S}_1 \neq \bar{S}_2$

C MS

T — OST, IST, PTT

fn(s) = 1,00,000/-

Cm

$\overline{S1} \approx \overline{S2}$ (Consistent)

Vaccine m-1

V1 → S1 → 1u

V2 → S2 → 28

(Parametric)

$\boxed{(\text{Data}) = (\text{ND})} \rightarrow T$

PT → T

NPT

$T = \text{ND} \rightarrow \text{PT}$ ✓

$\quad \llcorner \times - \text{NPT}$

Plot

T (-test)

One Sample T-test ✓	Ind-Sample T-test ✓	Paired T-test

One Sample T-test

Drug $\xrightarrow{\text{(fever)}}$ (15mg - Paracit)

↓

Standard

50,000 → 30 → 14.98 ✗ 15 mg (Std)

FMCG

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

$\bar{x}$ = S mean

μ = Pop mean

s = Std

n = s_1

$T = 2$

$\boxed{\times > 2}$ Clear

Ind-Sample T-test

P1 ⟷ P2 (Ind)

P1 → S1 $\cancel{\ }$ P2 → S2

Cd

idea

USA ⟷ India

USA → 30 India → 30

0 — ⊖

-ve

-30

0 - 100

(+) ⊕ ⊖

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

+ −

⊕ ⊖

✓ $\bar{x}_1 > \bar{x}_2$ =

✓ $\bar{x}_1 > \bar{x}_2$ =

↓

H_0 H_1

Main

$T = \alpha$ $\frac{1}{p}$

α / α — t

S 2r

Paired T-test

B A

dp = ✓

	Before	After
P_1	97	92
P_2	82	81
P_3	83	82
P_4	91	87

$$t = \frac{\bar{x}_d}{\frac{s}{\sqrt{n}}}$$

B	A	x_d
92	81	11
81	72	9

30

C

$\frac{11+9}{2} = 10$

$\bar{x}_d$

Clear

(Pop | Para) = (Tc)

P T => 2

$R_{TJ \cdot 2}$: ✓ [OST | IST | PTT]

done?

(The average salary of an Indian IT worker is approximately hundred dollars and this survey has been conducted in 2019.) If I take a new survey and 30 participants in 2025, we find out that their average salary is $140 with a standard deviation of $20. Can you calculate whether the salaries have significantly changed or not and can you do this at a 95% confidence interval, state alternate and null hypothesis for the given question?

100 90

(Data)

Pop Mean (μ) = 100 | Sample mean ($\bar{x}$) = 140 | CI = 95%

n = 30 (Sample Size) | Std_dev = 20 (Standard dev)

Ep Clean ✓

One

① Hyp

~~H_0 : Avg (μ) = 100~~

H_a : Avg (μ) $\neq$ 100 (>, <) (Two-tailed T-test)

Note :

LT $\alpha/2$ 2.5 $\alpha/2$ RT 2.5%

logic

① 2-tail test

$\alpha \longrightarrow \alpha/2 =$

$\longrightarrow \alpha/2 =$

② $\alpha - \alpha$

② Significance level (α)

α = 100% − CI(%)

= 100 − 95

$\boxed{\alpha = 5\%}$ or $\boxed{\alpha = 0.05}$

③ degrees of freedom $\boxed{df = n-1}$

= 30 − 1

$\boxed{df = 29}$

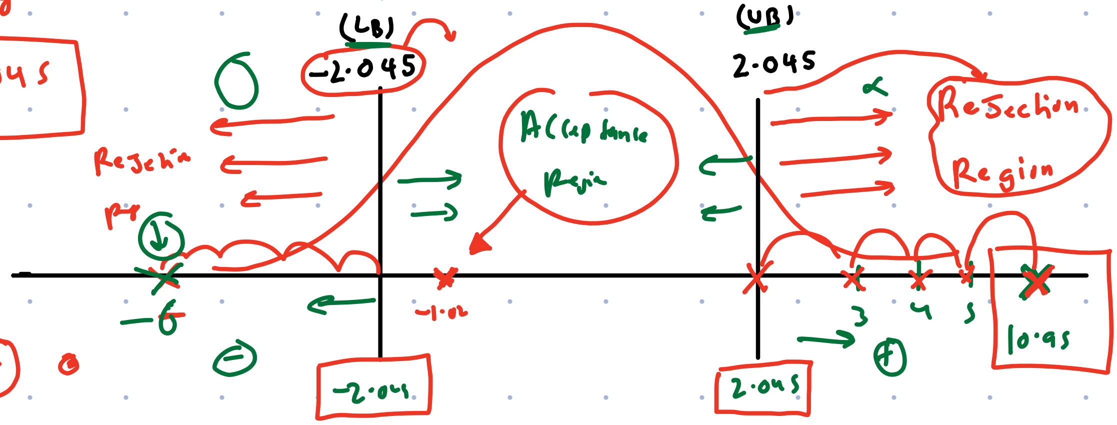
Pyth

log = T-table

idea

④ Decision Boundary

$\boxed{t\_critical\_value = \pm 2.045}$



Reject H_0 ✓

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551

α ⇒ P

S

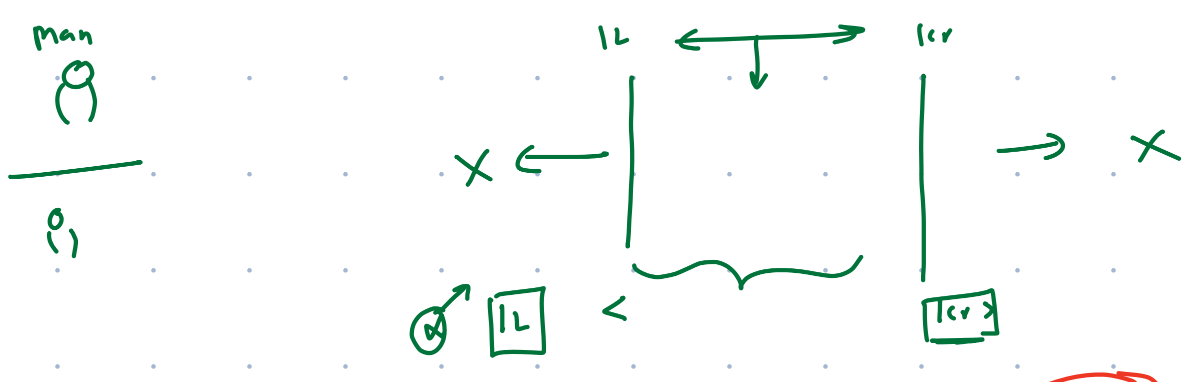
S t- Statistic

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{140 - 100}{20/\sqrt{30}} = +\boxed{10.95}$$

= − → $\boxed{-1.02}$

−   −6

$\boxed{tc / tB}$ = A/R − CV



Ma Jdor

(Significan)

(>, <)

Namaste folks,

lets Start in 2-4 minutes

Tail - 2

$\alpha/2$

$\alpha = \alpha/2$ - RT, $\alpha/2$ - LT

```python
#ctitical value
t_critical_upper_bound = stats.t.ppf(1- alpha/2, degrees_of_freedom)
t_critical_lower_bound = stats.t.ppf(alpha/2, degrees_of_freedom)

print(f"t_critical_upper_bound : {t_critical_upper_bound} || t_critical_lower_bound:{t_critical_lower_bound}")
```

= UB

```
t_statistic : 10.954451150103322

degrees_of_freedom : 29

t_critical_upper_bound : 2.0452296421327034 || t_critical_lower_bound:-2.0452296421327034
```

Clear

Ok = ✓

·ppf = (Percent Point function)

df

Show

Code

Same

Pen/Pen

α

t_critical / t_stat = α

P_value ≤ alpha

Belr

P_value = ✓

Walr = ✓

Signific

Diabt

No Diab

4

2

1

10

2

no diff

ST

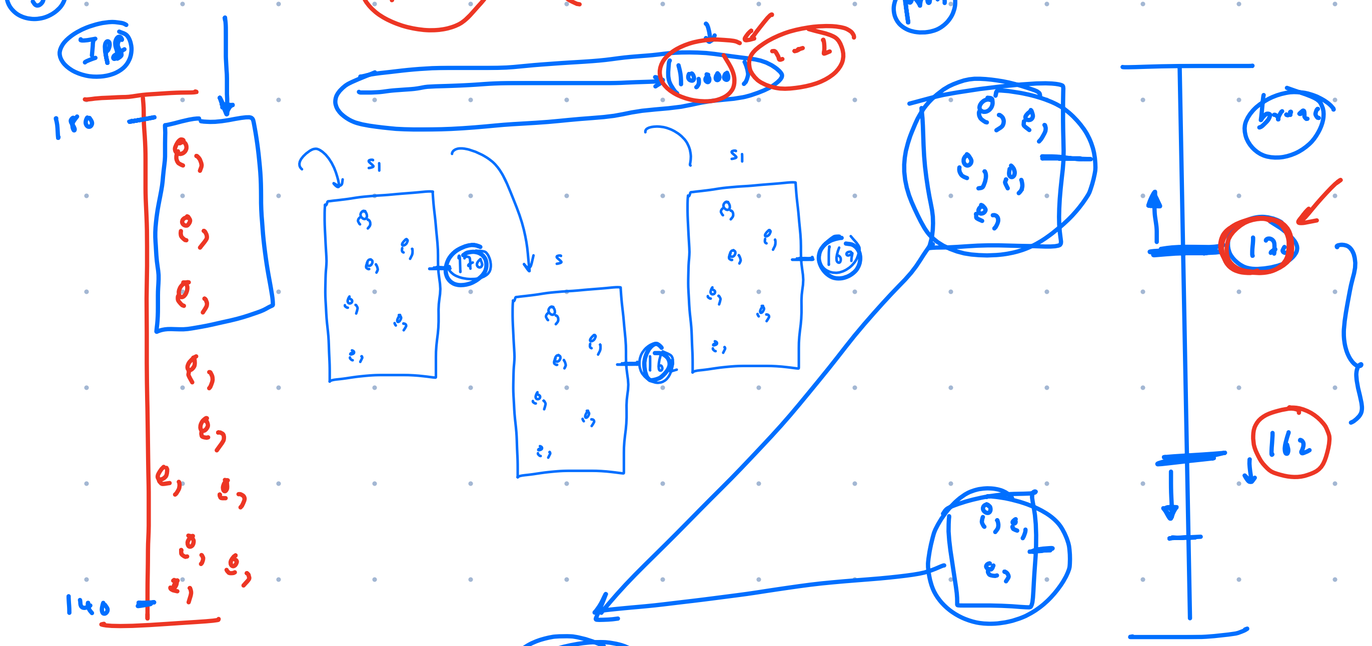
Un

TS

HS

3

P_value = (Probability val)



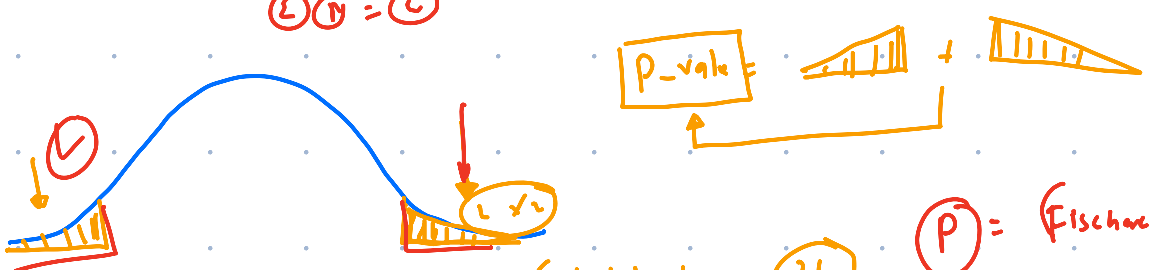
Extreme

P-v =

P_vau : 3% = ✓

CDF

P_vale =



P = (Fischer Exact test)

$(L + L) = 2L$

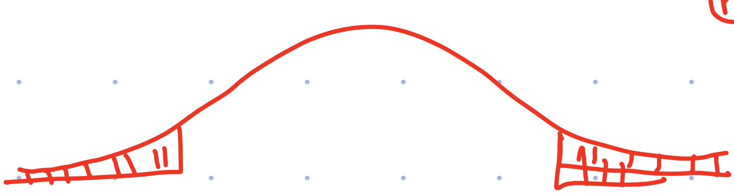
(DS/MLF) → Is = 1%

T

P

P

P-v = ✓

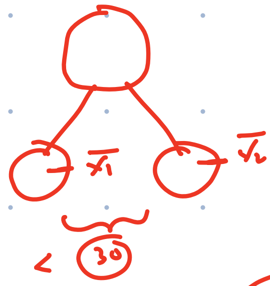


< P
> P

goal = ✓

$$P\_value = P(\bar{X}_n \geq 170 \mid H_0\_true)$$

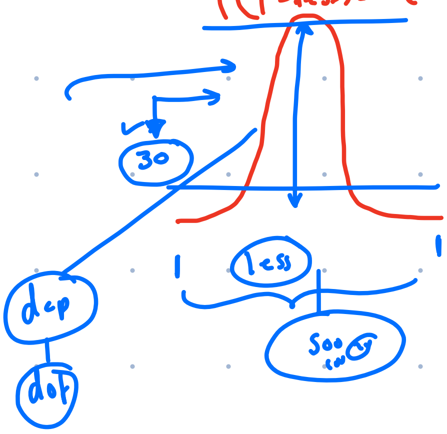
T	Z
✓Parametric	✓Parametric
✓2 group	✓2-group
$\boxed{t<30}$	$\boxed{(Z > 30 - \infty)}$
(Means)	$\boxed{\text{(Mean)}}$

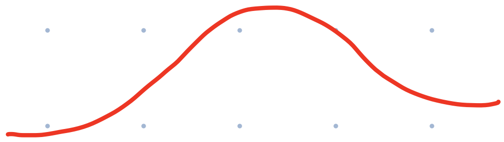


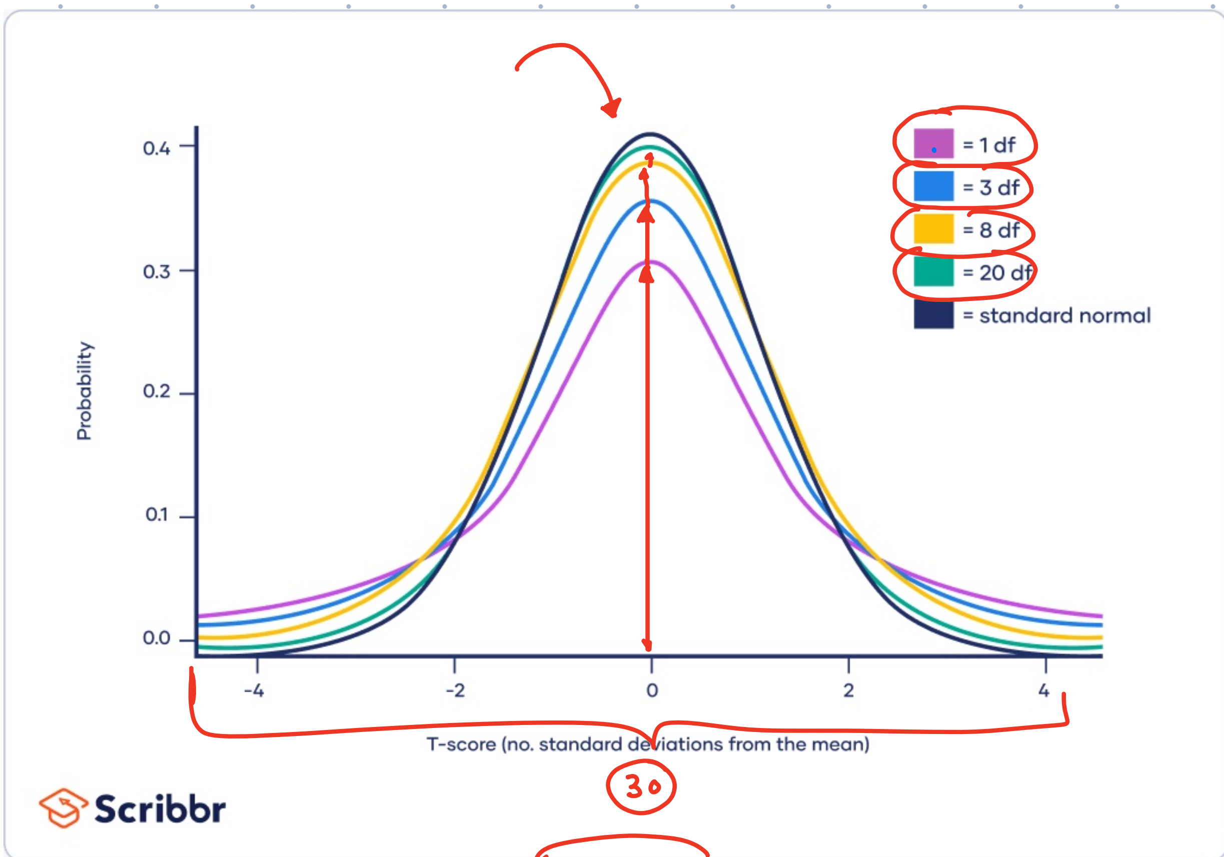
Z > 30

Why?

(v) ((T-test) = t(dist)) | (v) (Z - z dist)



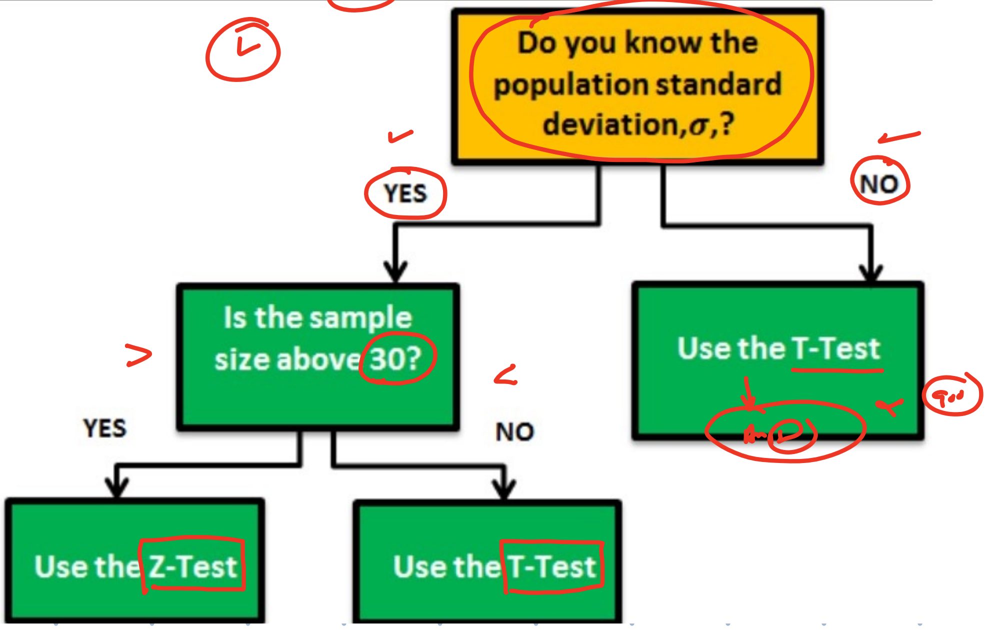




15 → $\boxed{t > 30}$

$\boxed{\text{CA}}$ 2*

t = 99% <30 >30



T	
OST	OSZ
1ST	1SZ
PTT	P2T
<30	>30

A factory that manufactures shampoo has a machine that dispenses 80 mL of shampoo in a bottle.
Now an employee believes that the machine is not working properly. He takes a sample of
40 bottles and find out that the machine is giving 78 ML on an average of all the shampoo bottles
with a standard deviation of 2.5 ML, can you state the null and alternate hypothesis at 95% confidence interval and
working properly

Pop-Mean (μ) = 80 mL

n = 40

Sample-mean ($\bar{x}$) = 78 mL

Std-dev = 2.5 mL

CI = 95%

α

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

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

$\pm$ 0.02 ml

($\pm$ 0.02 ml)

T / Z

(Z test for proportion)

Sir, generally speaking the person who doubt about shapoo machine issue will not know about standard deviation value or say 2.5 ~~exact~~, right . ~~he might just think that quantity isnt right.~~ so how should we do if std is not there ? we calculate it by ourselves ?

80

40

1 = No std

40

100

Pop std ✗ ⇒ 40

manipu

given — Sol

Sam std

Pop std

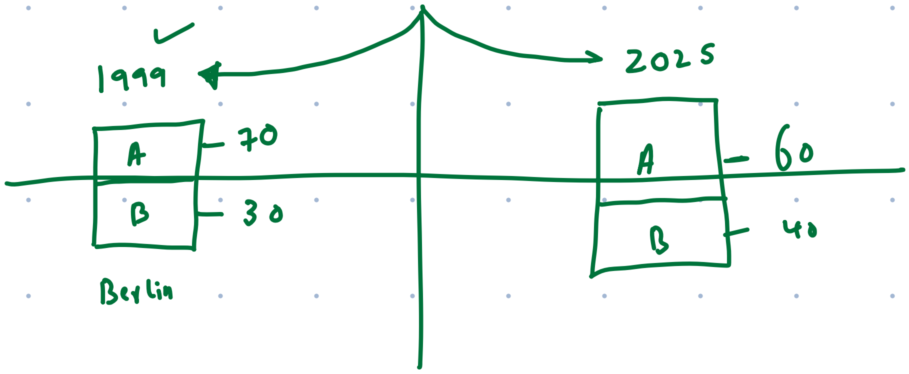
((Yrlio) & (Prol))

(IIT) = $\left(\frac{20}{100}\right)$

AP = 20%

A : B

A : B



V TP

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In a sample survey conducted in Bangalore, it is found that 960 people out of 1860 people were vegetarian and the
rest
were non-taste whether both vegetarian and non vegetarian are equally popular and in same proportion and
at 1% level of significance
```

$\hat{p}$ = Sample proportion = $\frac{960}{1860}$ = 51.61%

$$Z = \frac{\hat{p} - P}{\sqrt{\frac{P.Q}{n}}}$$

P = prop of success – [85%]

Q = " " failure [15%]

$\boxed{P + Q = 100\%}$ or $\boxed{P + Q = 1}$

70
30

① $H_0 : (P_{veg} = P_{non-veg} = 0.50)$

$H_a : (P_{veg} \neq P_{nv} \neq 0.50)$

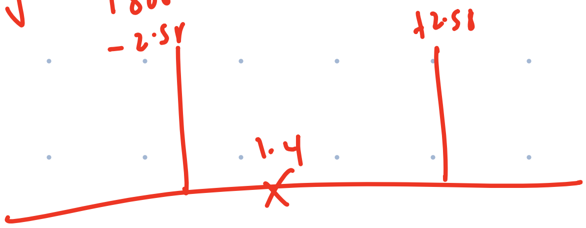
$\alpha = 1\%$ – $\boxed{\alpha = 0.01}$

② $n = 1860$ | $\hat{p} = 0.5161$ | $P = 0.50$ | $Q = 0.50$

$Q = 1 - P = 1 - 0.5 = 0.5$

$$Z = \frac{\hat{p} - P}{\sqrt{\frac{PQ}{n}}} = \frac{0.5161 - 0.50}{\sqrt{\frac{(0.50 \cdot 0.50)}{1860}}} \approx 1.4$$

$Z = 2.58$



$\frac{960}{1860} = 5 \approx 50$

$$\frac{960}{1860} = \frac{400}{1860} = 21\%$$