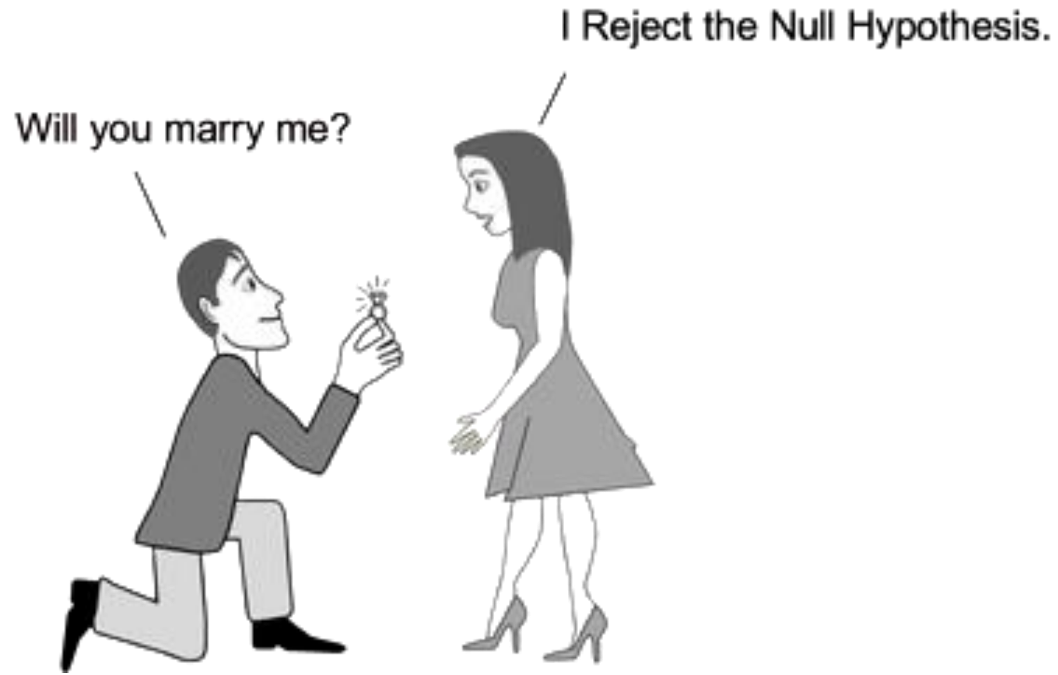
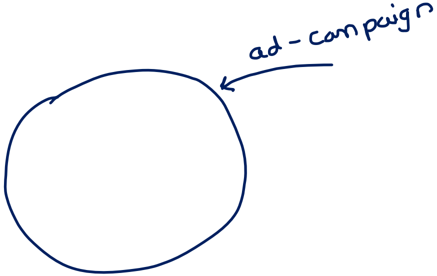
Hypothesis Testing



What is Hypothesis Testing?

→ Testing our assumptions based on the data using power of stats and prob.

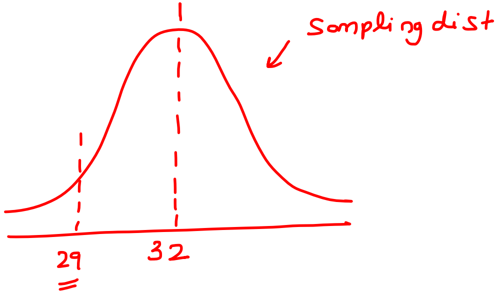


You work for a marketing firm and for the previous ad-campaigns that you have been running, the avg conversion was 32%.

but the last campaign that you executed, the avg conversion was 29%.

Can we conclude that the avg conversion has dropped?

Date	ad-c-no	Conversion
01/01/2020	1	30%
01/02/2020	2	31%
01/03/2020	3	32.5%
01/04/2020	4	30.9%
⋮	⋮	⋮
01/01/2024	120	29.9%



Campaign no. 121

avg (conversion) = 29

Hypothesis testing
1. formulate Hypothesis
2. conduct test
3. conclude based on test

What is Hypothesis Testing?

Formulate Hypothesis

H_0 : Null Hypothesis ← ① Initial Assumption (Assumption without test / data or the value prove and reported)

H_a or H_1 : Alternative Hypothesis ← ② Counter Assumption (Assumption that you are looking to prove)

Rules

① Always start with formulation of null

② Null & alternative hypo are 100% opposite to eachother

③ null : $\geq$, $\leq$, $=$

alternative : $>$, $<$, $\neq$

④

H_0	H_a
$\geq$	$<$
$\leq$	$>$
$=$	$\neq$

Judge In Court

1 Initial assumption about the criminal =
The criminal is innocent

counter assumption about the criminal =
The criminal is guilty

Based on data
(evidences)

2 Data point
→ carrying a knife
→ knife had blood on it
→ found in CCTV

3 conclusion based on data

Covid Test

Assumption

null Hypo : covid -ve

alternative Hypo : covid +ve

Test $\longrightarrow$ Test result

$\downarrow$

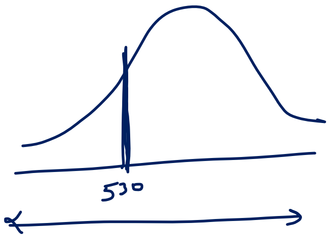
Based on test result] Conclusion

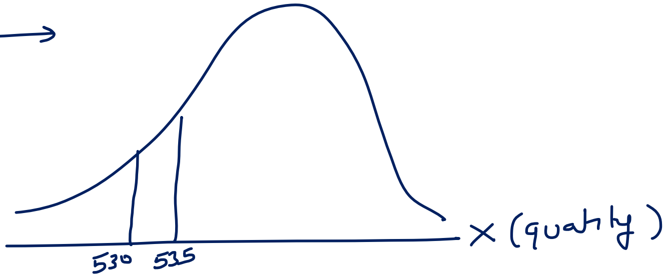
=

Example-1: A restaurant owner installed a new automated drink machine The machine is designed to dispense 530 mL of liquid on the medium size setting. The owner suspects that the machine may be dispensing too much in medium drinks. They decide to take a sample of 30 medium drinks to see if the average amount is significantly greater than 530 mL.

$H_0: \mu \leq 530\,\text{ml}$

$H_a: \mu > 530\,\text{ml}$





$P(530) = \underline{\underline{0}}$

Question: eHealthInsurance claims that in 2011, the average monthly premium paid for individual health coverage was $183. Suppose you are suspicious that the average, or mean, cost is actually higher. State the null and alternative hypothesis you would use to test this.

$H_0: \mu \leq 183$
$H_a: \mu > 183$

$H_0: \mu = 183$
$H_a: \mu > 183$

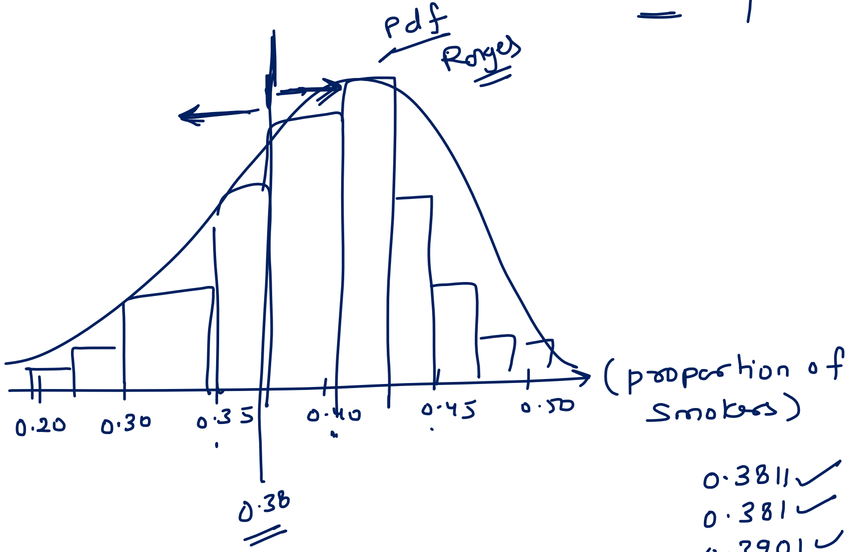
Question: A survey was conducted to get an estimate of the proportion of smokers among the graduate students. Report says 38% of them are smokers. Chatterjee doubts the result and thinks that the actual proportion is much less than this. Choose the correct choice of null and alternative hypothesis Chatterjee wants to test.

initial

$H_0: \mu \geq 0.38$

$H_a: \mu < 0.38$

$\mu \equiv 0.38$



0.3811

0.381

0.3901

continuous quantity

pmf $\times$ pdf $\longrightarrow$

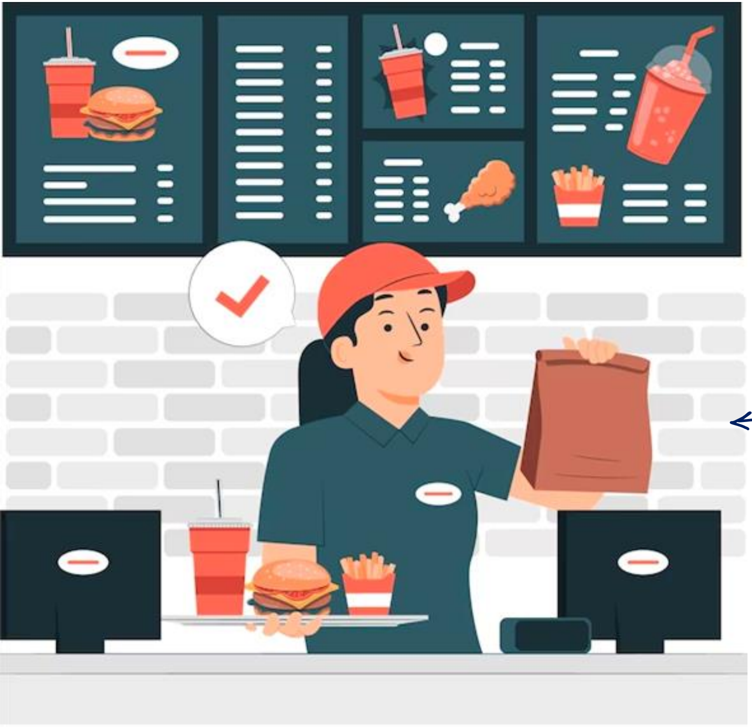
Quiz-2: **As per the NBA, the avg height of the NBA player is 66.3 feets .** Reported
For CSK the avg height of the players is 65.5 feets.
Can we conclude that the avg height of team CSK is significantly less than the avg height of a NBA registerd team?

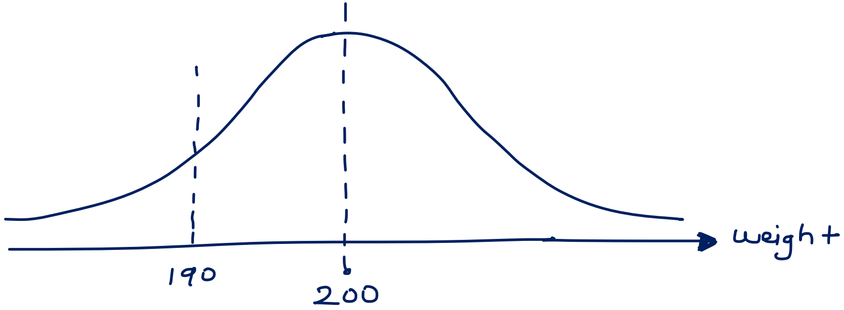
$$H_0: \mu \geq 66.3$$
$$H_a: \mu < 66.3$$

Left/Right and Two Tail Test

Lali went to a burger shop and ordered a burger. The shop claims that the burger weighs at least 200g. Lali is doubtful about their claim and weighs his burger, which is found to be 190g. What should he do? Is the burger shop wrong about their claim?

$$\left.\begin{aligned} H_0 &: \mu \geq 200gm \\ H_a &: \mu < 200gm \end{aligned}\right\}$$





H_a :

$>$ $\longrightarrow$ Right

$<$: Left

$\neq$: Two tail

when we try to find evidence on lef of the mean $\longrightarrow$ Left tailed test

when we try to find evidence on right of the mean $\longrightarrow$ Right tailed test

when we try to find evidence on either side of the mean $\longrightarrow$ Two tailed test

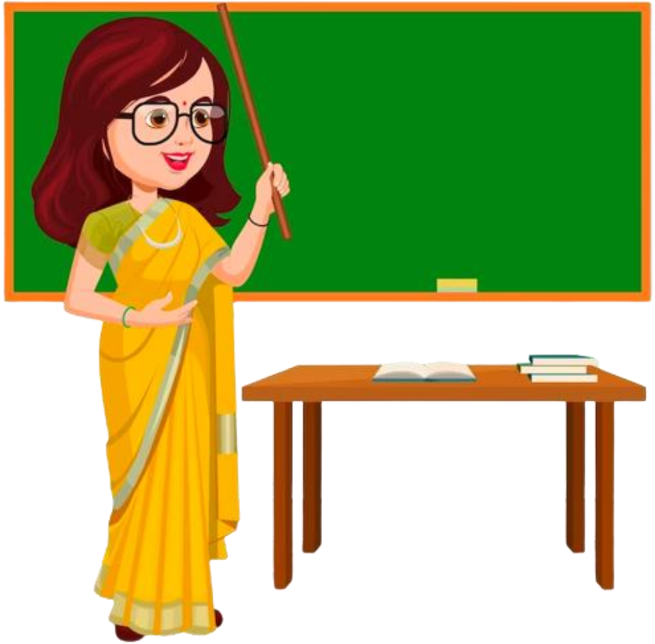
The English teacher of KV Delhi has developed a special course that can enhance students' English proficiency scores. The average score of the last batch was 500/700. She selected 40 students and provided rigorous training using her newly developed approach. After the students took the exam, the average score of the batch improved to 544/700. Can we conclude that her special course boosts the scores?

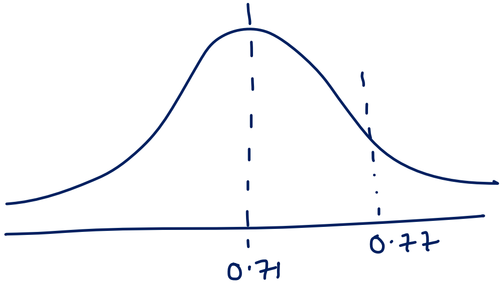
new reported value $= 0.77$

$\mu = 500/700$

$= 0.71$

$$\left.\begin{aligned} H_0 &: \mu \leq 0.71 \\ H_a &: \mu > 0.71 \end{aligned}\right\}$$





right tail test

According to Lay's, they claim that the shelf life of one packet of Lay's salted flavor is 36 months. The FSSAI conducted a nationwide test in India on Lay's packets to check the shelf life of their salted flavor chips. With a sample of 1500 packets, they found that the average shelf life was not equal to 36 months and was instead found to be 34 months.

Already prove and reported value $\mu = 36$ months

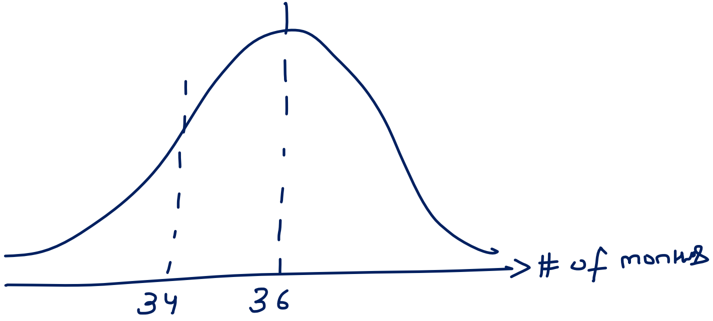
$H_0: \mu \geq 36$

$H_a: \mu < 36$

$H_0: \mu = 36$

$H_a: \mu < 36$

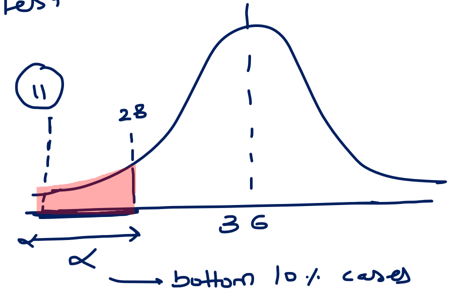
correct



left tailed test

observed value = 11

$\alpha = 10\%$



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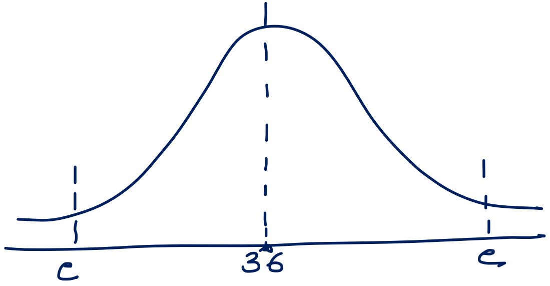
Ha	Ho
$>$	$\leq$
$<$	$\geq$
$\neq$	$=$

Prove : shelf life can be more than 36 or less than 36 but it's not 36

$H_0 : \mu = 36$

$H_a : \mu \neq 36$



Two-tailed test

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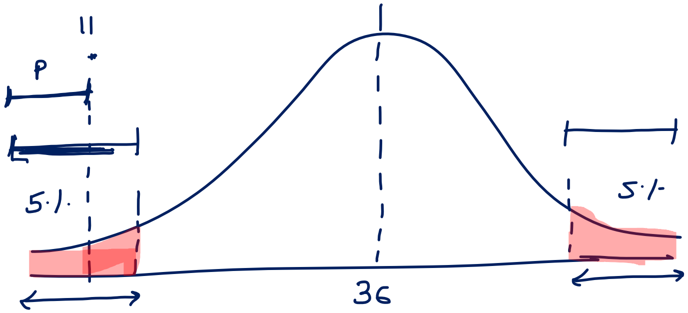
$H_0: \mu = 36$

$H_a: \mu \neq 36$



$\alpha = 10\%$

↓

percentage of cases for which we will reject null

(null → already reported and proved)

11 months → observed

→ 0.005

$\alpha = 5\%$

0.05

P is low null will go

p is high null will fly

P — prob. of null Hypo to be true

p is low null will go

Quiz-3*: A city had an unemployment rate of 7%. Mayor pledge to lower this figure and supported programs to decrease unemployment. A group of citizens wanted to test if the unemployment rate had actually decreased. Choose the correct area of investigation.

$H_0: \mu \geq 7\%$

$H_a: \mu < 7\%$

alredy prove and reported value

$\mu = 7\%$

Left tail test

Metric for Test

fair coin

1 — Head $P(H) = 0.5$

1 — Tail $P(T) = 0.5$

Random Exp: Tossing a fair coin

$n = 100$ times

$X = \#$ of heads $\{0, 1, 2, 3, \ldots\ldots 100\}$

Binominal

1. Binary outcome
2. prob. of success is same throughout exp
3. n - trails

Result-1

$H = 89$

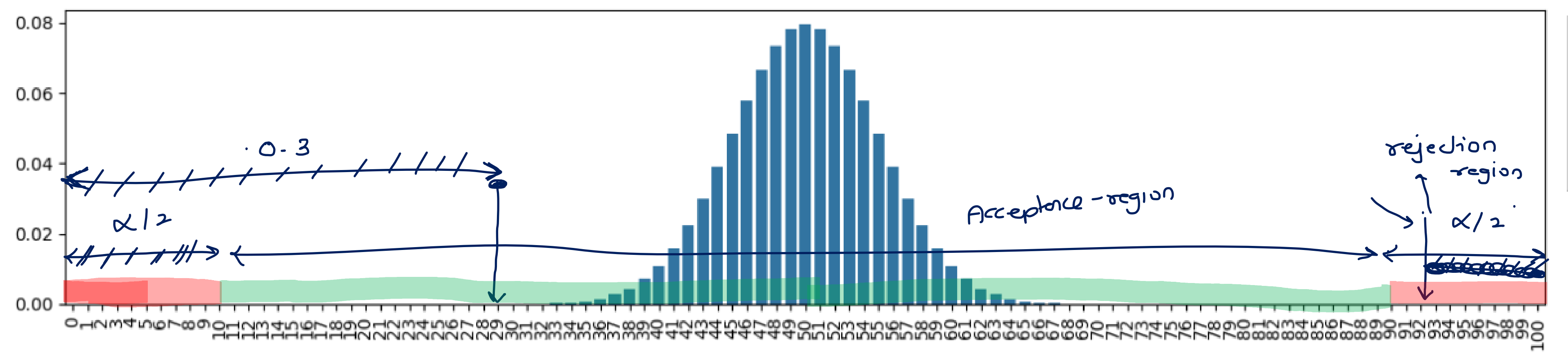
$T = 11$

Result-2

$H = 64$

$T = 36$

Errors In Hypothesis Testing



If observed value is very far away from mean/majority then it is rare to occur

Set a cuttoff-

If the observed value is either on bottom 10% cases or top 10% cases, I will conclude that the observed is statisically different from actual/mean

α = Area of Rejection (what % cases, we are going to reject null Hypo)

H_0: $\mu = 0.5$

H_a: $\mu \neq 0.5$

p-value → prob of null Hypo to be True

observed value = 28

P-value = 0.3

observed value = 92

p-value = 0.00005

- If p is low, null will go $p < \alpha$
- If p is high, null will fly $p > \alpha$

Deep Dive in coin toss example.

Covid test
- H_0 : covid -ve
- H_a : covid +ve

Reality

H_0 : True : covid -ve → covid +ve ✗ → Type - I
H_0 : True : covid -ve → covid -ve ✓

Test Result

H_0 : False : covid +ve → covid +ve ✓
H_0 : False : covid +ve → covid -ve ✗ → Type - II

→ conclusion

Type - I : Reject null, when null was actually true

Type - II : fail to Reject null when null was actually false

Deep Dive in coin toss example.

I → we Reject null when null was True

II → we fail to reject null when null is False

$\alpha = 0.05 \longrightarrow \alpha = 0.10$

An MLA is planning to build a new parking area in the city center, but they want to be sure that there is a need for it and that the citizens are in favor of the project. They plan to survey a group of people, and if 40% of the sample expresses support for the new parking area, the MLA will proceed with the contract to build it; otherwise, they will not.

→ H_0: No need of parking area

H_a: There is a need of parking area

α

↑ Type – I : MLA built parking area when it was not required

↓ Type – II : MLA didn't built the parking area when it was ~~is~~ indeed required.

$\alpha \uparrow \longrightarrow$ Type – I $\uparrow$

Deep Dive in coin toss example.

Conclusion after test

Type - I : Reject Ho when Ho is actually True

Type - II : fail to Reject Ho when Ho is actually false

Realities.

Employees at a school conduct daily water quality tests of the drinking water tank to ensure that the water is suitable for consumption. If the water quality is found to be below standards, the school temporarily shuts down the public drinking fountain and asks the students to use their own bottled water. If the water quality is deemed good, the water supply is not interrupted.

Conclusion

Test — water is good

Reality

water is bad

H_0: water quality is good

H_a: water quality is bad

α

I : we closed tank for cleaning when its not required

II : we didn't clean the tank when it was actually required

$\alpha \uparrow$ to reduce type - II